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Guidelines for Designing Green Products Considering Customers' Cultural Preferences

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Abstract: The increasing customer awareness of environmental sustainability during the last decade has had an influence on many manufacturers to produce green products. However, issues arise regarding the actual preferences of customers for green products, which often differ depending on cultural influences. Cultural values can affect the decisions of designers to determine detailed design specifications that relate to customer preferences. Currently, few guidelines consider cultural values as an aspect of green product design. Thus, the aim of this study is to develop a guideline that incorporates the influence of cultural values on green product design. Malaysia was selected as the location of this study. The sources of data to establish a guideline were obtained from customer perspectives on green products. Structural equation modeling (SEM) was used to identify cultural influences and preferences on green product characteristics as the input strategies for the proposed guideline. Professional designers from different profiles were asked to identify the applicability of the guideline. Based on the results, the designers agreed that the influence of cultural values is an important aspect that should be considered in the development of green products. The implication of the guideline is discussed in this paper to accelerate decisions of designers in developing green products.

Keywords: sustainability; environmental concern; green product design; cultural influences; Malaysia

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1. Introduction

Increasing levels of environmental pollution have become a major concern of all countries around the world. To minimize environmental issues, manufacturers are now encouraged to ensure that their products have a desired environmentally friendly impact throughout their entire product life span. Products with inherent environmental characteristics are mostly known as green products, which are not expected to harm the living environment [1]. Less material usage or light-weight material [2], less energy consumption [3,4], easy reuse [3], made with recycled or recyclable materials [5] are some examples of green product characteristics that may appear in the market. However, the

preferences of customers regarding green products can be differently expressed. During the development phase of a new product, designers have to account for customer preferences. Moreover, to understand customer preferences is not easy, and they can be influenced by many factors, such as level of education and knowledge, financial strength, and cultural preferences. It is found that cultural values, as a collective of the mind in the group or area, can influence customer preferences on specific products [6,7]. In product development, the designers need to determine which particular green characteristic of the product relates to a particular customer culture preference [8].

The consideration of cultural value influences can be used to evaluate collective preferences based on local character behaviors of targeted customers rather than individual evaluations [9]. It can assist designers in minimizing the misinterpretation of product specifications in the next phase of product design. Currently, there is a lack of guidelines for the consideration of cultural values in green product design. Thus, the aim of this study is to develop a guideline to incorporate the influence of cultural values into green product design. The guideline consists of strategies to evaluate suitable green product characteristics, with consideration of cultural value influences. The strategies were generated based on the data that were collected from customer perspectives. This study also applies evidence from the literature to confirm the relevance of the generated strategies used in the guideline with the existing theories. The designers considered as the experts in designing the product were asked to evaluate the applicability of the guideline.

2. Green Products

The world population is predicted to increase to more than 9.7 billion by 2050 and 11 billion by 2100 [10]. Increasing population may negatively impact the environment, such as the depletion of natural resources, an increase in waste generation, and pollution. Ljungberg [1] explained that environmental issues can be caused by three factors: (1) overconsumption of natural resources, (2) high levels of pollution, and (3) overpopulation. Steffen et al. [11] argued that environmental problems persist because the effort to participate in environmental protection is not balanced with the depletion of natural resources and the increase in waste generation. Therefore, to address this issue, there is a need to consider strategies on how to fulfill the needs of humans in the present to ensure the least impact as possible on the environment in the future. This approach is largely considered a suitable method to achieve sustainable development [12].

Beckerman [13] explained that the goal of sustainable development is to achieve social equity and responsibility, economic prosperity, and environmental protection. However, the question regarding the concept of sustainable development is what is to be developed and sustained, and for how long can it be sustained. Hence, to support the sustainable development goal, manufacturers are encouraged to increase the production and supply of environmentally friendly products in the market [14]. Environmentally friendly products, also known as green products, have minimal impact on the environment during their entire life cycle [1]. During the production process, manufacturers could incorporate green characteristics into their products such as reducing the use of virgin material, reducing energy consumption, and utilizing environmentally harmless materials [15]. However, when the products eventually reach the market, it is reported that not all customers show concern about environmental impact. This is because the preferences for green products often depend on the perception and knowledge of the customer about green characteristics [16]. A compilation of green product characteristics discussed in the literature is presented in Table 1.

Table 1. Common green product characteristics found in the literature.

Green Product Characteristics	References
Resources efficiency	[3,17–21]
Size and weight reduction	[2,22–24]
Using harmless material	[25–29]
Using recyclable material	[5,30–34]
Easy to reuse	[35–38]
Using recycled material	[39–41]
Easy to maintain	[42–45]
Providing product service	[46–49]
Eco-labelling	[50–53]
Using biodegradable material	[54–56]
Easy to upgrade	[57–59]

It is suggested that designers should relate suitable green characteristics to customer preferences in order to develop successful green products in the market. Ulrich and Eppinger [60] explained that consideration of customer preferences is very important and should be evaluated at an early stage of product design before continuing to the next phase of product development. That is because incorrectly identifying the preferences of customers can lead to technical issues in the next phase of product design. However, determining the suitable characteristics of green products from customer preference remains a challenge to designers since customers have different viewpoints on the embedded green characteristics of a product they desire to buy. The characteristics may be perceived and valued either positively or negatively, depending on the individual preferences of consumers [14]. These preferences can be caused by cultural value influences as the natural setting of consumer characters.

3. Culture and Green Preferences

There are broad aspects of culture in the literature, such as norms, beliefs, values, attitudes, behaviors, goals, rituals, and traditions [6,61]. Culture can be defined as the natural setting of social relations, which is how a civilization may arrange their habits in the group [62]. Hofstede [63] pointed out that culture is a combination of mind programming, which distinguishes between one group of people and another. Birukou et al. [64] described culture as a collection of ordinary behaviors naturally formed for a particular concern. A number of previous studies described these aspects of culture from a different point of view since culture is revealed by the natural setting of human actions. Hofstede [63], one of the pioneers of cultural studies, categorized cultural aspects into five cultural dimensions: individualism-collectivism, masculinity-femininity, uncertainty avoidance, power distance, and long- and short-term orientation.

3.1. Collectivism–Individualism

Collectivism refers to the sense of belonging to a group that looks out for the subject's interests in exchange for loyalty instead of being alone. The opposite of collectivism is individualism, which is described as the subjects' intention to only look after themselves, independent of social interactions [65]. Malaysia is indexed with a high level of collectivism [66]. However, this finding is different from Huff and Kelley [67], who examined these dimensions in a specific segment. Huff and Kelley assessed the influence of collectivism-individualism on organizational trust and customer orientations in seven countries, including Malaysia. The results showed that Malaysian customers are more affected by individualism than collectivism in terms of organizational trust. Nowadays, the increase in environmental awareness has influenced the customer's willingness to purchase

green products [68]. This awareness can be affected by collectivistic or individualistic characteristics. Collectivist-oriented customers prefer green products because they want to participate in environmental protection or follow the current trend. Their preferences may also be due to the group's influence to purchase green products. On the other hand, individualist-oriented customers purchase green products due to self-interest and are not affected by other people's or groups' intentions. In other words, they are drawn to protect the environment, motivated by their own self-preferences. To identify the influence of collectivism on customer preferences towards green products, the following hypotheses are proposed:

Hypothesis 1. *Collectivism has a significant influence on customer preferences for green products.*

3.2. Masculinity-Femininity

Masculinity and femininity are representations of gender role distinction. The masculine society is more concerned with assertiveness, acquisition of wealth, achievements, and success. In contrast, the feminine society is more concerned with care for others, lifestyle, and improving the quality of life [63]. This dimension has been used in several studies to evaluate the characters of the customers' purchasing intention. Moon et al. [69] evaluated the influence of masculinity on the purchasing intentions of customers towards personalized products. Srite [70] tested a model to determine the influence of four Hofstede cultural dimensions on customer acceptance towards perceived ease of use and usefulness of a product. They found that only the masculinity-femininity dimension has a significant influence on the two product characteristics. Hence, this dimension can also be used to evaluate customer preferences for green products. For instance, in order to reduce the usage of materials, green products are designed with embedded environmental characteristics (e.g., reusable and recycled materials), which can influence the quality and durability of the products. This, in turn, can influence customer preferences. However, this depends on the personal character of the customers. Although companies can produce green products with high quality and good appearance, the customers may still perceive green products differently as they may have masculinity or femininity characters when selecting green products. Thus, in order to evaluate the influence of this dimension towards the customer preferences on the green products, the following hypothesis is proposed:

Hypothesis 2. *Masculinity has a significant influence on customer preferences for green products.*

3.3. Uncertainty Avoidance

Uncertainty avoidance refers to the extent to which people feel threatened by uncertainty and ambiguity and try to avoid these situations [63]. Despite the numerous studies available that strongly advocate protecting the environment, uncertainty is still one of the common factors influencing customers' willingness to pay for green products [71]. It should be highlighted that not all individuals who can be considered "green buyers" have a better understanding of green products than "non-green buyers" [72]. This may be due to the uncertainty towards green products, which influence customer preferences [73]. For example, green products can be made from recycled, harmless, or recyclable materials that can affect the performance of the product in terms of quality and texture. Uncertainty may influence customer preferences on these products due to their perceptions that green products may have lower quality than that of the conventional products that were made from virgin materials. Thus, this affects customer willingness to pay for green products [74]. In order to reduce this uncertainty, customers may ask questions of other customers who have experience using green products to get more information on the products [75]. Therefore, to identify whether uncertainty avoidance has a significant influence on customer preferences for green products, the following hypothesis is proposed:

Hypothesis 3. *Uncertainty avoidance has a significant influence on customer preferences for green products.*

3.4. Power Distance

Power distance is "the extent to which fewer powerful members of the organizations and institutions accept and expect that power has been delivered unequally" [76]. High power distance implies that the relationship among the powerless is difficult to manage since hierarchy means inequality and latent conflict may exist between the powerful and the powerless [65]. Since the authority is centralized and lacks autonomy, power and wealth will foster inequalities. In contrast, lower power distance implies harmony between the powerful and the powerless, and cooperation among the powerless can be based on solidarity and accessibility to the superiors [66]. Power distance may play a significant role in customer choices or decisions regarding green products. For example, it can cause a gap in customer understanding or knowledge of green products. Not all customers can understand which green product is in the market and what benefits they will get if they purchase it [77]. In addition, power distances can also be interpreted as a purchasing ability. A lower-level customer may have fewer preferences for green products due to unbearable prices than those at a higher level. Furrer et al. [78] suggested that customers with high power distance find reliability and responsiveness less important. This study proposes that the high power distance character in a society provides significant influence towards customer preferences on green products in Malaysia. Hence, the proposed hypothesis is as follows:

Hypothesis 4. *Power distance has a significant influence on customer preferences for green products.*

3.5. Long- and Short-Term Orientation

Finally, long-term orientation stands for "fostering of virtues orientation towards future rewards, in particular, perseverance and thrift" [63]. One of the important aspects of purchasing a particular product is its performance and quality [79]. Green products minimize the usage of natural resources and energy consumption and thus may influence the long-term orientations of customers due to the performance and quality of green products [80]. Some studies on green products highlighted that there are several characteristics of green products related to the long-term orientation of customers. For example, some customers are willing to pay more for a product that consumes less energy since it can save them money from a long-term perspective [21]. Another characteristic is providing long-term product services. Product services, such as providing regular maintenance, may have a positive effect on the long-term orientation of the customers since the lifetime of the product can be extended [79]. Therefore, customers with a long-term orientation characteristic are more concerned about the long-term usage of the products. For green products, high product quality and durability, as well as their usefulness for environmental protection, may have a significant influence on customer preferences. Therefore, to identify whether long-term orientation has a significant influence on customer preferences for green products, the following hypothesis is proposed:

Hypothesis 5. *Long-term orientation has a significant influence on customer preferences for green products.*

4. Methodology

The purpose of the guideline is to help designers create green products that are appealing to the customers' culture. Three steps are performed to develop the proposed guideline. The first step identifies cultural value influences on green product preferences and identifies preferences for green product characteristics based on cultural influences.

To achieve this, structural equation modeling (SEM) analysis is performed to obtain cultural preferences on green product characteristics from customers. This study adopts the established method from Ghazali et al. [81] to identify the relationship between cultural values and green product preferences. However, the focus of this study is not only to assess the relationship between cultural values and green preferences but also to extract the outer weight from the calculation of SEM as the input for the proposed guideline. In SEM, the outer weight is used to indicate the absolute contribution of an indicator to the assigned construct [82]. Some studies (e.g., Punniyamoorty et al. [83]; Jakhar and Barua [84]) used the outer weight from the SEM to identify a specific rank of characteristics that they wanted to evaluate. However, to ensure the accuracy of the provided outer weight, all validation criteria of the structural model evaluation must first fulfill the requirement of the critical threshold.

The second step identifies potential strategies and sub-strategies regarding cultural considerations when designing green products. Strategies were generated based on the identified findings in the first phase (identified cultural influences and green characteristic preferences), and sub-strategies were based on literature analysis. These strategies and sub-strategies are used to develop the proposed guideline. The last step conducts a validation of the proposed guideline to the practices. Designers from different profiles were selected to evaluate the applicability of the proposed guideline. The flow of guideline development for cultural consideration in green product design is illustrated in Figure 1.

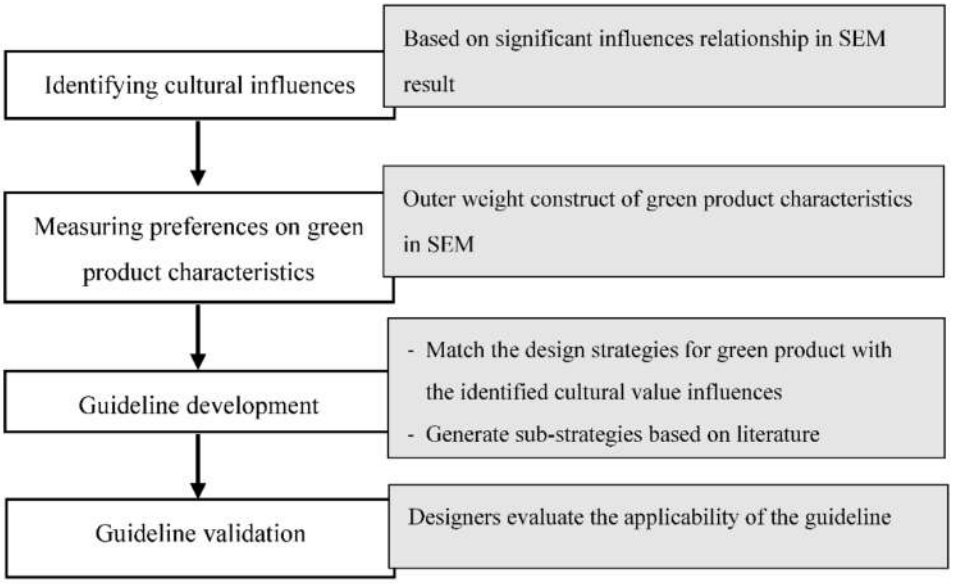

Figure 1. Process of guideline development.

Malaysia was selected as the location of the data collection. The sample used in this study consists of ordinary people who can be considered as potential green customers. However, to ensure data reliability, a preliminary screening process was conducted to ensure that the recruited respondents only consisted of those aware of the environmental issues. This means that the respondents who were found to have little knowledge of green products were removed for the analysis.

The minimum sample size required was calculated based on the following rule of thumb as suggested by Cohen [85]. The minimum sample size was determined (with 80% statistical power) based on the maximum number of arrowheads that point to the construct of the model developed. In this study, there were nine arrowheads that point to the construct, that is, five from the cultural dimensions and four from the green product preferences (appearance, functionality, price, and green characteristics). Appearance, functionality, and price were included in the construct since these three components are common factors that cannot be ignored when customers purchase a product. For these

nine pointing arrowheads, the minimum sample size required was 247 samples with a minimum R^2 of 0.10. A total of 615 samples was collected. There were 208 questionnaires that were not included as the answers were incomplete. Thus, the sample size number was satisfactory for the measurement as the amount exceeded the threshold requirement.

Questionnaires were used to collect the data on customer preferences in this study. Each questionnaire contains five sections. The first section consists of the items related to the demographic information of the respondents. A pre-test was performed to ensure that the respondents had no issue with answering the questions. The questionnaires were directly delivered to the respondents in order to identify whether the respondents had difficulties filling out the questionnaires. Once the pre-test was completed, the questionnaires were then distributed for a pilot test.

Measuring Cultural Influences and Preferences

In this study, the cultural value construct is tested in relation to the customer preferences for green products. The cultural value construct consists of five cultural dimensions (i.e., collectivism-individualism, masculinity-femininity, uncertainty avoidance, power distance, and long-term orientation. Customer preferences for the green product construct consist of 4 sub-constructs (i.e., appearance, functionality, price, and green product characteristics). A total of 24 indicators are involved in the construct. The framework for hypotheses testing is described in Figure 2.

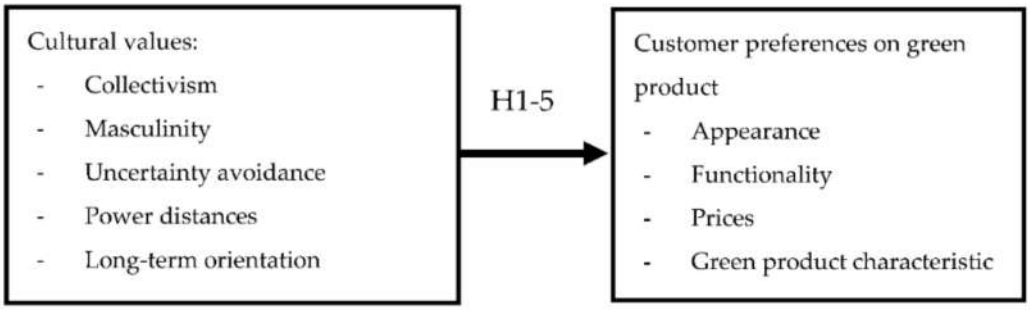

Figure 2. Hypotheses testing to identify preferences based on cultural influences.

In this study, the data analysis identifying the cultural value influences on green product preferences was classified into four steps. In the first step, an analysis of data adequacy and reliability is performed. This is important to ensure that the collected data and its reliability exceeds the critical threshold. Once this has been done, the second step extracts the items used by performing the Exploratory Factor Analaysis (EFA). The Statistical Package for Social Science (SPSS) was used to evaluate all the calculations involved in the first step. In the third step, after all the critical threshold for the data reliability, sampling adequacy and factor analysis are evaluated, the next step confirms the validity items used by performing the Convergent Factor Analysis (CFA). Once the validity has been confirmed, the final step evaluates the developed hypotheses. The partial least square-structural equation modeling (PLS-SEM) approach was applied to assess the developed hypotheses. SmartPLS was used as a tool to evaluate all the validation of the items in the CFA and hypotheses development. The hypotheses result is presented in Table 2.

Table 2. Hypotheses testing calculation result.

Hyp.	Description	Result	Path Coefficient	Std. Error	*t*-Value
H1	Collectivism → Customer preferences for green products	Not Significant	0.025	0.050	0.489
H2	Masculinity → Customer preferences for green products	Not Significant	0.002	0.057	0.036
H3	Uncertainty avoidance → Customer preferences for green products	Significant	0.351	0.068	5.161 *
H4	Power distance → Customer preferences for green products	Significant	−0.101	0.052	1.952 ***
H5	Long-term orientation → Customer preferences for green products	Significant	0.280	0.071	3.946 *

* $p < 0.01$, *** $p < 0.1$.

After the data validation procedures are performed and the relationships of the five cultural value influences are confirmed, the customer preferences for green products, considering cultural value influences, can be identified. In order to identify these preferences, the outer weight of the indicator should be used in the first stage of the calculation. This outer weight was considered to be more reliable than the mean value of the questionnaire. This is because the outer weight results have been statistically validated, and the measurement errors have been evaluated. The outer weight was used to indicate the absolute contributions of the indicators to the assigned constructs [82]. The results of the outer weight for the customer preferences for green products is presented in Table 3.

Table 3. Identified green product characteristics considering cultural influences.

Preferences Rank	Green Product Characteristics	Outer Weight
1	Eco-labelling	0.261
2	Energy efficiency	0.225
3	Reduce harmful materials	0.211
4	Provide product services	0.189
5	Easy to upgrade	0.130
6	Biodegradable materials	0.127
7	Recyclable materials	0.106
8	Weight reduction	0.063
9	Easy to maintain	0.060
10	Recycled materials	−0.008
11	Easy to reuse	−0.083

5. Guideline Development

The proposed guideline was developed based on the identified cultural values that influence customer preferences for green products and the identified green characteristics rank (based on the cultural influences). This finding will be generated as strategies in the proposed guideline. In addition, input from literature was needed to explore in more detail the generated strategies as sub-strategies. The generated strategies of cultural consideration for green product design is discussed in Sections 5.1–5.3.

5.1. Uncertainty Avoidance

It was found that customers in Malaysia are mostly influenced by the uncertainty avoidance dimension. Uncertainty avoidance characteristics have been described by Hofstede [63] as higher anxiety, stress, and concern for security. Rules and regulations should be written, and uncertainty situations must be fought. Higher anxiety and wanting to be safe when using green products are issues that affect customers. Green products may be produced from several materials. However, some substances in the product can contain harmful or toxic material to the living environment and may need specific treatment to minimize their impact [1]. To reduce the uncertainty of customers for green products, consideration for using fewer toxic materials can be applied to fit the preferences of customers for green products. To provide information concerning the benefit of green products to customers, eco-labels can also be used to reduce the uncertainty concerns of customers [86]. Considering cultural influences, the eco-label was identified as the most preferred characteristic in Malaysia. In order to minimize the usage of natural resources and reduce environmental impacts, manufacturers produce products using recycled, biodegradable, recyclable, and lightweight materials [87]. However, the perception of customers regarding products manufactured with these materials can affect or increase the uncertainty of customers, especially regarding the performance of the product. Therefore, to reduce the uncertainty of customers for green products, strategies to increase the quality of recycled, recyclable, biodegradable, and lightweight material in green products are very important. Another characteristic, which should be considered as an important strategy, is minimizing energy consumption. It has been logically approved that customers are concerned about how much money they expend for their consumed energy [88]. Thus, resource efficiency is also an important element in green products to reduce the uncertainty of customers.

5.2. Long-Term Orientation

The second cultural dimension that provides a significant influence on the preferences of customers in Malaysia is a long-term orientation. The characteristics of long-term orien-

tation, emphasizing savings, persistence, and fostering pragmatic values towards rewards, should be given more attention in the future. Terms such as energy efficiency, providing product services, and easy to upgrade and maintain are considered characteristics of the long-term orientation of customers in Malaysia. In order to reduce the consumption of natural resources and minimize disposal-stage contamination, recycled, biodegradable, recyclable, and lightweight material can also be used as alternative characteristics [1,87]. However, these problems may influence customers in terms of product quality. Customers may perceive products made with these types of materials as having lower quality than products made using virgin material [74]. In this case, the preferences of customers are influenced by not only high uncertainty but also long-term orientation dimensions. Therefore, to increase customer preferences, strategies to improve the quality and durability of green products by recycled, recyclable, biodegradable, reused, and lightweight material is important. This strategy can be used to impact the long-term orientation of customers when choosing green products.

5.3. Power Distance

The last dimension that proved to have a significant influence on green product preferences in Malaysia is power distance. Malaysian consumers have a low score for power distance in terms of green product preferences. According to Hofstede [65], low power distance is indicative of harmony between the powerful and the powerless. Cooperation for achieving target orientation is based on solidarity. The whole society is considered equal and income is not an indicator of social status. This implies that green products can be accepted by customers from all levels of society in Malaysia, such as educated and less-educated customers as well as higher-income and lower-income customers. Providing eco-labels can also be used as a potential strategy to provide information on the benefits of green products to less-educated customers [89]. Providing product service also may be used to relate low power distance influences. This service can be offered in the purchasing phase, such as providing product advice or briefing to explain the details of green product specifications and answering all the questions from both levels of customers [90]. Resource efficiencies can also be applied to relate low power distance influences of customers. Lower-income customers may focus on the costs incurred by the usage of resources [91]. If the efficiency of energy during the consumption phase can be maximized, lower-income customers may have positive intention towards green products. This is due to the fact that the cost of consumed resources is still potentially reachable for lower-income customers. The compilation of identified design strategies consideraing the cultural influences is served inTable 4.

5.4. How to Use the Guideline

There are four steps that designers should follow when using the proposed guideline:

(a) Step 1: the design concept and specification of the product should be prepared initially by the designers.
(b) Step 2: based on that design concept, designers need to select possible green design strategies as presented in Table 5, which can be embedded in the design by giving a *Yes* or *No* answer. It should be noted that designers should consider the suggested priority of green product characteristics; the capability of companies to implement strategies such as time constraint and technology in the production line should also be considered.
(c) Step 3: Based on selected green strategies in Step 2, select possible sub-strategies as outlined in Table 6.
(d) Step 4: Extract the selected green design strategies and sub-strategies that can be embedded in the design concept. Write the selected green design strategies and sub-strategies in Table 7.

Table 4. The design strategies for the green product considering the cultural value influences.

Influencing Cultural Value Dimensions	Described Characters	Approach to Relate Cultural Value Influences	Possible Strategies that Can Be Applied
Uncertainty avoidance	– Higher anxiety and stress were experiencedÂThere is a great concern with security in life. – There is a need for written rules and regulations. – The uncertainty inherent in life was felt as a continuous threat that must be fought.	Reduce the uncertainty of customers for green products.	– Embed an eco-label in the product design. – Use non-toxic material. – Provide product service. – Consider resource efficiency in the consumption phase. – Use high-quality recyclable material. – Apply size and weight reduction with high- quality material. – Use high-quality biodegradable material. – Use high-quality recycled material.
Long-term orientation	– Attaching more importance to the future. – Foster pragmatic values oriented towards rewards. – Persistence. – Saving (thrift). – Capacity for adaptation.	Concern for the long-term expectation of customers regarding green products.	– Provide product service. – Consider resource efficiency in the consumption phase. – Easily maintained. – Use high-quality recyclable material. – Can be upgraded easily by the user. – Easily reused.
Low power distances	– Inequality in society should be minimized. – Everyone should have equal rights. – Latent harmony exists between the powerful and the powerless. – Cooperation among powerless can be based on solidarity. – All should have equal rights.	Concern for designing green products that do not indicate a social gap and should not negatively impact others.	– Embed an eco-label in the product design. – Provide product service. – Consider resource efficiency, especially in the consumption phase.

Table 5. Checklist of strategies for designing green products to reflect cultural value influences.

Cultural Value Consideration	Suggested Priority	Recommended Characteristics	Checklist	
			Yes	No
Reduce your customer uncertainty	1	Embed eco-label on your product design.		
	2	Use non-toxic material.		
	3	Provide product service (e.g., rent the product, provide longer service support).		
	4	Consider resources efficiency in the consumption phase (e.g., save energy, water, or material).		
	5	Apply size or weight reduction with high-quality material.		
	6	Use recyclable material.		
	7	Use high-quality biodegradable material.		
Concern for the customers' long-term orientation	1	Provide product service.		
	2	Consider resources efficiency, especially in the consumption phase.		
	3	Use durable recyclable material.		
	4	Can be upgraded easily by the user.		
	5	Easily reused.		
	6	Can be maintained easily by the user.		
Reduce your customers' power distance (gaps)	1	Embed eco-label in your product design.		
	2	Provide product services.		
	3	Consider resources efficiency in the consumption phase.		
Selected strategies (Yes answers), please prioritize your selected strategies based on the rank of the green product characteristics				
1. … … .				
2. … … .				
3. … … … … … .				

Table 6. Checklist of potential sub-strategies respect selected green design strategies in Table 5.

Strategies	Potential Sub-Strategies	Checklist		Supported Literature
		Yes	No	
Embed product with eco-label.	– Provide relevant information and state main objective of eco-label to avoid misinterpretation.			[92–94]
	– Use a certified eco-label from legislation (government) rather than self-declaration.			[52,95,96]
	– The eco-label symbols used can be easily understood by consumers.			[89,92,97]
Consider resources efficiency	– Maximize efficiency of water consumption			[98,99]
	– Minimize material used			[1,99,100]
	– Maximize efficiency of energy used in consumption phase			[1,101]
	– Reduce emission and waste produced during usage.			[1,102]
	– Provide information to consumers such as prediction of how much energy they are using within a month, year, etc.			[1,99]
Use non-toxic material	– Eliminate toxic material to decrease environmental impact and customer health contamination.			[25,29,103]
	– Consider material substitution to more superior materials in terms of sustainability.			[104,105]

Table 6. *Cont.*

Strategies	Potential Sub-Strategies	Checklist		Supported Literature
		Yes	No	
	– Assures that non-recyclable parts or materials can be disposed of in an ecological way.			[1,102]
	– Although using non-toxic material, the quality and durability of the product should be ensured.			[106,107]
	– If unavoidable, use of toxic material only when necessary.			[107,108]
Provide product services	– In the purchasing phase: provide product advice or briefing to explain the various details and functions of product.			[109,110]
	– Using phase: provide regular maintenance, upgrades, spare parts availability and responsiveness to customer complaints.			[90,109]
	– In the disposal stage, retrieval and refurbishing should be practiced to reduce landfill waste.			[109,111]
	– Offer rental of product rather than purchasing, so the producer can retrieve product at the end of its life			[112–114]
Easily maintained	– Easy to disassemble or replace for self-repairing or upgrading.			[15,115,116]
	– Make the function independent (design by module).			[115,117,118]
	– Support with spare part availability for reasonable duration of time.			[119–121]

Table 6. *Cont.*

Strategies		Potential Sub-Strategies	Checklist		Supported Literature
			Yes	No	
Applied size or weight reduction	–	Minimize material used and combination, the more material combination the more energy required in production line.			[1,102]
	–	Should not interfere with flexibility, impact strength or functional properties.			[122]
	–	Maintain produce performance by using high- quality and durable of material.			[100,108,123]
Using recyclable material	–	Focus on maximum recyclability and a high content of recycled material in the product.			[1,102]
Using biodegradable material	–	Use natural organic material; the product waste should be easy to decompose naturally.			[1,100,124]
	–	Products have high durability.			[4,100]
	–	Eliminate hazardous material; if unavoidable, use when necessary and minimize as possible.			[125]
Using recycled material	–	Eliminate the hazardous materials contained in recycled material			[102,126]
	–	Provide quality products using recycled material.			[126]
	–	Increase reparability of product.			[126]

Table 6. *Cont.*

Strategies	Potential Sub-Strategies	Checklist		Supported Literature
		Yes	No	
Easily reused	– Design proper quality assurance of used produce parts.			[102,127]
	– Easy to disassemble or replace for problem parts			[102,127]
Easily to upgrade	– Easy-to-disassemble design.			[15,115,116]
	– Consider modular design with minimal changing of product function by making structure independent.			[115,117,118]
	– Consider modular design that allows additional functions to the product without changing the structure of product.			[115,118]

Table 7. Selected green strategies and sub-strategies.

Selected Strategies.	Selected Sub-Strategies
1	a . . . . .
	b . . . . .
	c . . . . .
2	a . . . . .
	b . . . . .
	c . . . . .
3...	a . . . . .
	b . . . . .
	c . . . . .

The guideline use procedure is illustrated in Figure 3:

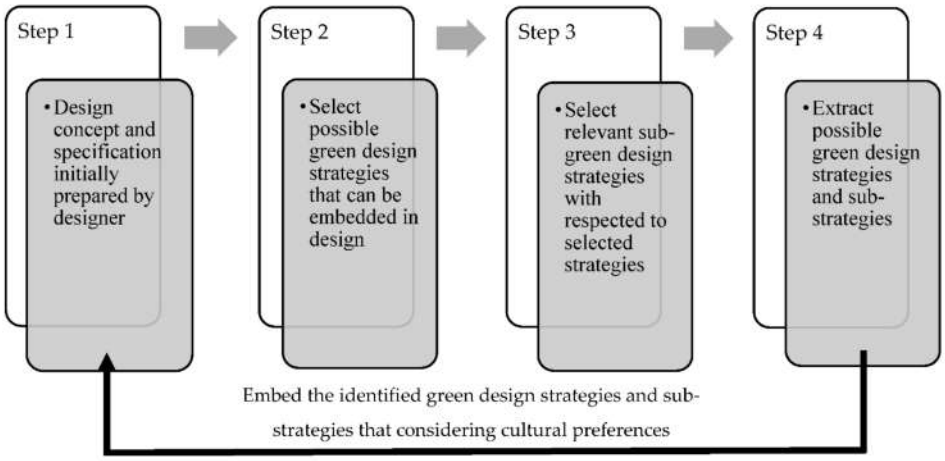

Figure 3. Procedure to use proposed guideline.

Six professional designers were asked to use and evaluate the proposed guideline. The procedure and result of the case study is discussed in Section 6.

6. Guideline Validation and Discussion

The questionnaire that contained the proposed strategies and sub-strategies on designing green products based on cultural value influences was distributed through electronic mail (email) to the designers in Malaysia. A total of six professional designers with different backgrounds were asked to give their evaluation regarding the proposed guideline. The full profile of designers for guideline validation is presented in Table 8.

There were four questions used to evaluate the proposed guideline. The first question was, *Based on your experiences, do you think cultural value should be considered in designing products*?. For this question, all designers from Malaysia agreed that the consideration of cultural influences in designing products is important. It allows the designers to explore more details in the product's specification in relation to the cultures of customers. The answers from all designers are compiled in Table 9.

Table 8. Profile of designers.

Code	Experience (Years)	Market	Product
DS-1	26	Both Malaysia and others countries	Product packaging, exhibition booths, etc.
DS-2	20	Both Malaysia and others countries	Smart forest/digital forest product
DS-3	20	Both Malaysia and others countries	Toll highway management and maintenance product
DS-4	20	Both Malaysia and others countries	Suspension system (absorber, coil spring, and stabilizer bar), brake system, engine parts for automotive industries.
DS-5	10	Both Malaysia and others countries	Machine/equipment for semi-conductor industries
DS-6	10	Both Malaysia and others countries	Juicer, food processor, blender, meat grinder product

Note: DS = Designers.

The consideration of cultural influences provides more insight to designers to create products more relevant to customer preferences; thus, the specification of products can be determined based on cultural influences. The consideration of cultural values in designing products also enhances the acceptance of products since the designed product is more suitable with customers' local characteristics. The answers from the designers in this study were in line with the theory explained by Bloch [61] as well as Salmi and Sharafuthdinova [6] where cultural values of customers is a prominent aspect and should be included in the designing process. This is because culture is naturally formed and can differentiate the behavior between groups of people in a certain area. In the next evaluation, the designers were asked to give their comments on the proposed guideline's second question: *Do you think the developed guideline provides some valuable information to support the development of green products?*

All designers agreed that the proposed guideline provides some valuable information to support the development of green products. DS-1, for instance, stated that the provided guideline gives information how cultural influences can be involved in designing green products. DS-2–DS-6 explained that the provided guideline gives a deeper understanding of how to capture the preferences of customers for green products, which can assist their decisions for setting product specifications for green products based on cultural influences. The answers from all designers are presented in Table 10.

Although the designers agreed that the proposed guideline could be used as a potential tool to incorporate cultural considerations when designing green products, they also agreed that it should be known in which design process the proposed guideline can be applied. It can be used to *identify customer needs, establish target specification, generate product concepts, select product concepts, test product concept,* or *set final specifications* [128]. To achieve this purpose, question 3 was set up as follows: *Based on your experiences, in which design process can the guideline help?* The answers from all designers are compiled in Table 11.

Table 9. Designer comments on the importance of cultural considerations in design.

Designers	Yes/No	Comment
DS-1	Yes	*Perhaps you should consider cultural values to be embedded if you were targeting a particular segment of users. You should have a look at the products that you are designing, too. Embedding such values may create a niche market for the product.*
DS-2	Yes	*The design of products should be relevant with the customers' culture, since the product design cannot be easily generalized. By considering culture in the design, we can get more detailed information to set the product specification for our particular market.*
DS-3	Yes	*It is very important as part of building and enhancing a design identity and reputation, by being trendy, attractive, likable and also applicable with current times and needs, without sacrificing the heritage, culture, customs and values. In short, an integration of both worlds.*
DS-4	Yes	*The involvement of culture enables me to explore customer requirements in designing a product.*
DS-5	Yes	*Product design that matched to the local cultural values would have an easier acceptance by the end user.*
DS-6	Yes	*Yes. Design of a product should consider cultural values to suit specific target consumers. For example, Japan culture is more towards eco-friendly, 'all-in-1' type of products, which does not create any harm towards the consumers. They really are concerned with every detail of the product, such as the guide on how to use, how to maintain, which part should be carefully handled, and* etc. *All are stated and provide with a caution label.*

Table 10. Designer comment on the proposed guideline.

Designers	Yes/No	Comments
DS-1	Yes	*It has opened my mind to consider other aspects, such as culture value influence in designing green products.*
DS-2	Yes	*This guideline provides me a new insight to understand how to set a product specification, especially for green products based on the cultural values of the customers.*
DS-3	Yes	*It has potential to support the development of a product; however, needs enforcement and audits.*
DS-4	Yes	*Malaysian culture is intangible to be measured; the guideline provides me a deeper understanding regarding how the customers perceive environmental concerns through a product.*
DS-5	Yes	*The current manufacturers in Malaysia are encouraged to consider environmental aspects within the production line as well as for the end user of the product (consumers). The guideline provides a new perspective from the natural setting of consumer behavior, which leads me to be more careful to decide the design attributes with more concern about the environment.*
DS-6	Yes	*Yes. Relevant guideline can provide some information to support the development of a sustainable product in Malaysia. This can be a good guideline or reference for a company to initiate a business plan, so that they can produce the product that the market needs. However, this guideline should be more precise, in-depth, and easy to understand by all kinds of people for future use.*

Table 11. Designer comment on which phase the proposed guideline can be used.

Designers	Design Process
DS-1	– Identify customers' needs. – Generate product concepts.
DS-2	– Identify customers' needs. – Establish target specification. – Test product concept. – Set final specifications.
DS-3	– Establish target specification. – Generate product concepts.
DS-4	– Identify customers' needs. – Establish target specification. – Generate product concepts. – Test product concept. – Set final specifications.
DS-5	– Identify customers' needs. – Establish target specification. – Generate product concepts. – Select product concepts. – Test product concept. – Set final specifications.
DS-6	– Identify customers' needs. – Establish target specification. – Generate product concepts.

For the six design process phases, the designers have different perspectives on which part should be applied to the guideline. However, most of the designers agreed that the guideline could be involved in the phase of *identify customers' needs*. For example, DS-1 agreed that the guidelines can be used to *identify customers' needs* and *generate product concepts*. DS-2 focused on *identify customers' needs, establish target specification, test product concept*, and *set final specification*. DS-4 explained that the guidelines can be used to assist designers to *identify customers' needs, establish target specification, generate product concepts, test product concept, set final specifications*. The other designers, such as DS-5 and DS-6, have the same belief that the proposed guideline is more suitable for *identifying customers' needs*. Also, almost all the designers (i.e., DS-1, DS-3, DS-4, DS-5, DS-6) agreed that the proposed guidelines are suitable to *generate product concepts*. Although the designers mostly agreed that the proposed guidelines should be applied to *identify customers' needs* and *generate product concepts*, the guidelines can also be applied, possibly, in other phases of product design. This can be seen from the different answers that were given by designers with respect to the application of the guidelines. It depends on how the designers perceive the strategies and sub-strategies in relation to the product they design. The proposed guidelines were confirmed to have a contribution in the design process.

To evaluate what should be improved in the guidelines, question 4 asked: *Considering your experience as a designer, what are things that can be improved in the guidelines?* Only one designer gave a comment for improving the guidelines. DS-1 explained that the guidelines could help guide designers to produce the best products and it can be more interesting

if social and economic aspects can be involved in the guidelines. As the three pillars of sustainable development, the expectation from DS-1 to include social and economic aspects in the guidelines is greatly appreciated. It can be considered as further action to complete the guidelines not only for green products, but also for sustainable products.

7. Conclusions

A set of guidelines that incorporate cultural influences as an approach for deciding on suitable green characteristics in product design has been developed. Professional designers were asked to evaluate and confirm the applicability of the proposed guidelines. The result emphasized that cultural influences can be considered in the phase of identifying preferences of customers and generating concepts for designing green products. This study also identified related studies concerned with developing environmentally conscious guidelines for product design. Willskytt and Brambila [129], for instance, developed guidelines that focused on improving resource efficiency for the overall lifecycle when designing green products. Maccioni and Borgianni [130] developed guidelines to incorporate green attributes into product design, namely, eco-design guidelines (EDGs). The attributes of minimizing material consumption, minimizing energy consumption, extending material lifespan, and disassembling designs were used as inputs for the proposed guidelines. Schöggl et al. [131] developed a checklist for sustainable product development (CPSD) to assist designers in embedding social, economic, and environmental aspects into product designs in the automotive industry. However, the guidelines from previous studies are limited to incorporating environmental attributes into product designs. This study extends the previous studies on the development of guidelines where the attributes of "cultural value influences" are involved in designing green products.

The result also emphasized that consideration of customer cultures should be an important factor in designing green products. It allows designers to identify suitable characteristics of green products that should be embedded in products for their targeted market. Therefore, to support the achievement of sustainable development, designers are recommended to clearly identify the characteristics of green products related to customer characteristics. It is important to increase the preferences of customers for green products. The more market interest and purchase of green products, the more environmental depletion can be minimized. This study is limited to environmental strategies for designing green products by considering cultural influences. Further studies can extend more detailed strategies regarding socio-economic considerations as another aspect supporting sustainable development. The evaluation of the proposed guideline was conducted by designers from Malaysia. The inputs to the guidelines were generated based on results from Malaysia, therefore, the proposed guidelines apply only to Malaysia.

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