

DESIGN FOR SUSTAINABILITY – TRADE-OFF DILEMMAS FROM THE CONSUMER PERSPECTIVE

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Abstract

Product designers always look at the functionality and aesthetics aspects when deciding on the features and appearance of a new product. More recently, as the environmental issue becomes increasingly a concern for an increasing number of consumers, sustainability is rapidly becoming another important aspect that product designers should also consider. To date, there is no published research in any English-written international journals that assess the trade-offs of all these three aspects in the product design process from any perspective including the consumer perspective. Considering that consumers have the final say in the market performance of any new product, this study attempts to fill the above research gap by assessing the trade-offs amongst functionality, sustainability and aesthetics from the consumer perspective.

Keywords: Sustainability, Functionality, Aesthetics, Trade-off, Consumer

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1 INTRODUCTION

There is no perfect product. Actually there should not be any perfect product because having the best quality product requires lengthy time and escalating cost (Crawford and de Benedetto 2011). A product, even though it is of the highest quality in the market, charging an exceedingly high price and slower than its substitute products in entering the market does not have a good chance of market success. There is no lacking of cases (such as Microsoft versus Apple computers in the 1980s and 1990s and Samsung versus Sony smartphones more recently) demonstrating that a better quality product is not necessarily a more successful product in the market. At many times, a company in its new product development and design process has to make trade-off decisions on what aspects of the product to be emphasized at the expense of some other aspects of the product.

Unfortunately far too often many companies in their new product development and design process make decisions on what new products to develop and what should be the features included in these new products purely or overwhelmingly driven from their technical preference perspective. Ehrenfried (1956) made the above warning nearly six decades ago but ironically still too many companies pay deaf ears to this warning and still commit the same error to their detriment. They don't pay enough attention to what the future buyers of these new products think. The reality is that these future buyers, or so-called consumers, have the final say on whether a new product developed and launched in the market is a success or a failure.

Product designers always look at the functionality and aesthetics aspects when deciding on the features and appearance of a new product. More recently, as the environmental issue becomes increasingly a concern for an increasing number of consumers, sustainability is rapidly becoming another important aspect that product designers should also consider. To date, there is no published research in any English-written international journals that assess the trade-offs of all these three aspects in the product design process from any perspective including the consumer perspective. Considering that consumers have the final say in the market performance of any new product, this study attempts to fill the above research gap by assessing the trade-offs amongst functionality, sustainability and aesthetics from the consumer perspective.

2 THEORETICAL CONCEPTS

2.1 Functionality

Functional performance is relatively closer to being a necessity of any product (Michael, Jacob and Ravindra 2012). The superior functional performance of a product can also bring greater psychological confidence of the consumer in the product.

2.2 Sustainability

Sustainability is a broad concept which comprises various dimensions including environmental, energy, health and welfare, safety and security, economic, family and society (Ming 2013). Again considering these various dimensions of sustainability, it is necessary for this study to identify a few key sustainability dimensions in order for the field work to be effectively conducted. A focus group would be conducted for this purpose.

2.3 Aesthetics

Aesthetics satisfies basic human psychological needs of consumers who pursue anything beautiful. Its effect on companies is that the greater the satisfaction that consumers draw from the aesthetics of a new product, the greater the tendency to adopt the new product (Noam 2004). What's more, Mohammad (2007) found that a product's aesthetic design can influence consumers' perception of the quality of the product. However, there are various options (e.g. shape, coolness feel) that a smart phone designer can manipulate in order to increase the aesthetics appeal of the product. A focus group would be conducted to identify a few aesthetics options that are more crucial than other options so that the field work for this study can be conducted in a managed way.

2.4 Self-identity

As noted above, functionality and aesthetics have long been the two core aspects that product designers need to include in their design process. On the contrary, sustainability is a relatively new aspect that becomes increasingly important in consumer buying process. The view about sustainability is heavily influenced by the psychological state of the consumer. It is therefore deemed appropriate for this study to draw upon the self-identity theory in order to understand in the trade-offs amongst functionality, sustainability and aesthetics in a more detailed way. According to Spalk and Shepherd (1992) a person's sense of self-identity is expected to influence his/her behaviour to the extent that the behaviour could deviate from attitudes towards that behaviour. This is because his/her self-identity makes him/her more likely to act a specific behaviour if this behaviour forms an important part of his/her self-identity. This study sets up a self-identity scale that gauges to what extent an individual identifies himself/herself as caring for the environment. The purpose is to find out whether this variable has an effect on the trade-off decisions that consumers have to make with regard to smart phone purchase. To investigate this variable, a proper measurement needs to be adopted. This study conducted an extensive literature review and concluded with three items used for self-identity. Table 1 shows the literatures that have been consulted and used for identifying the items used to represent this variable.

Table 1. Measures for the self-identity variable

Variable	Items adopted	Literatures used
Self-identity	To engage in sustainability is an important part of who I am.	Pal (2005) Deborah, Michael and Katherine (1999) Stefania (2010) Jan and Peter (2010)
	I am not the type of person oriented to engage in sustainability. (R)	Tim (2006)
	I would feel at a loss if were forced to give up sustainability.	

(R) Scoring on this statement be reversed, i.e. from 5 to 1, from 4 to 2, from 2 to 4, and from 1 to 5 as it is a reverse worded statement.

2.5 Product choice

In order to assess the trade-offs amongst functionality, sustainability and aesthetics, a product has to be chosen for the assessment for this study. Smart phone is chosen because it is increasingly common among consumers. Two advantages of this product choice are that, first, as more and more consumers own a smart phone, it would be easier for this study to find eligible respondents who must be smart phone owners. They would be investigated by asking them to make different trade-off decisions when they would be purchasing an upgraded smart phone in future. Second, as more and more consumers own a smart phone and use it frequently, their knowledge about the smart phone would be adequate for them to evaluate the functionality, sustainability and aesthetics aspects of the product.

2.6 Test market choice

The UK is a vibrant smart phone market where there is fierce competition, frequent introduction of new products, and frequent product upgrading by smart phone users. In this market, sustainability is an increasingly topical issue and more and more consumers are partially guided by it in their consumption process. It is an appropriate market in which questions about functionality, sustainability and aesthetics of new smart phones can be asked and thoughtful answers can be obtained.

Functionality

Functional performance has been found to be relatively closer to being a necessity in smart phones (Michael, Jacob and Ravindra 2012). When a consumer evaluates highly the functional performance of

a new smart phone, the likelihood of purchase will be greatly increased (Matti 2011). As there are an increasing number of functions in a new smart phone, a focus group would be planned and conducted in order to identify a few key functions so that the field work for this study can be effectively organised.

3 METHOD

This study adopted a mixed-method approach. A focus group would be conducted in order to extract the most salient attributes each for the functionality, sustainability and aesthetics of a hypothetical new smart phone product. The attribute information obtained would then be used to develop suitable questions in the next data collection stage.

Consumer choice experiment would be used as the method in the next data collection stage. This type of experiment allows researchers to evaluate and measure consumer preferences by presenting systematically varied choice sets of hypothetical options (Oppewal et al. 2004). When conducting this experiment, the information acceleration method would be adopted simultaneously in order to obtain more accurate forecasts of actual choices. The information acceleration method is to place respondents in a virtual environment that simulates the product information to be available to the respondents, so that they can make decisions with regard to the trade-off between two different products (Oppewal et al. 2004). Below Table 2 shows the different characteristics, in terms of which of the three aspects each product is strong or not strong. Table 3 provides a concise content of the six experiments planned and implemented in this study.

Table 2. The different characteristics of the six hypothetical new smart phones for this study

	Functionality	Sustainability	Aesthetic Design
Product A	Yes	Yes	No
Product B	Yes	No	Yes
Product C	No	Yes	Yes
Product D	Yes	No	No
Product E	No	Yes	No
Product F	No	No	Yes

Table 3. The six experiments planned for this study

Experiment 1	Characteristics			Experiment 2			
Product A	F √	S √	A X	Product A	F √	S √	A X
Product B	F √	S X	A √	Product C	F X	S √	A √
Experiment 3				Experiment 4			
Product B	F √	S X	A √	Product D	F √	S X	A X
Product C	F X	S √	A √	Product E	F X	S √	A X
Experiment 5				Experiment 6			
Product E	F X	S √	A X	Product D	F √	S X	A X
Product F	F X	S X	A √	Product F	F X	S X	A √

F=functionality, S=sustainability, A=aesthetic design

As outlined in Table 3, there are six experiments in this study. In experiments 1 to 3, consumers are presented with two hypothetical new smart phone products. These two products are superior in one same aspect (be it functionality, sustainability, or aesthetics) but differ in performance in the other two aspects. For example, in the experiment 1, both products A and B excel in functionality, but product A

excels in sustainability and is just average in aesthetics while product B excels in aesthetics and is mediocre in sustainability. Between the two products, consumers are asked which of them they would choose.

In experiments 4 to 6, consumers are still presented with two hypothetical new smart phone products. However, compared to experiments 1 to 3 where each product excels in two aspects and is average in one aspect, in experiments 4 to 6 each product excels in only one aspect and is average in the other two aspects. For each pair of products in each of these three experiments, consumers are asked to choose the one they would prefer to purchase.

The rationale for setting up these two sets of experiments (experiments 1 to 3 versus experiments 4 to 6) is that by comparing the results between different experiments, greater insights in consumers' trade-off decisions can be acquired because the possible effect of interaction between two aspects can be gauged.

4 FIELDWORK PROCEDURE

As noted above, a focus group would be firstly conducted in order to identify the salient attributes for each of the three aspects. This information can then be used in the second stage fieldwork, which is a series of consumer experiments.

A traditional face to face focus group was organised as this is the most effective means for getting the most from the participants (Shiu 2009). Eight UK citizens from varying backgrounds in terms of gender, age and occupation were invited. They all agreed to attend the focus group, which was held in a summer afternoon in 2014.

The topics for discussion in the focus group are to find out, for each of the three aspects of a smart phone, what attributes the participants would value the most. At the end of the focus group, as expected different participants emphasize a different set of attributes for each aspect. After analysing the focus group transcript deeply, two attributes for each aspects have been found to continuously occur in the transcript. They become the key attributes generally shared by the focus group participants. Details of these key attributes are in Table 4.

Table 4. Key attributes for functionality, sustainability and aesthetics of a smart phone

	Attribute 1	Attribute 2
Functionality	Web browsing	Battery life
Sustainability	Recycled materials	Energy saving
Aesthetics	Unique shape	Super screen

Then a series of consumer experiments were conducted on 127 respondents who live in the UK. Each respondent did six experiments. There was a rest time of 10 minutes between an experiment and the following experiment, in which the respondent took a rest and had some drink and snack provided by the researcher. In each experiment, the respondent was presented with two new smart phone products and needed to decide which one of the two s/he would choose. Any product choice varies on functionality, sustainability and aesthetics aspects. Each aspect is represented by two aspects generated by the focus group. For example, if a new smart phone product has excellent functionality, it performs excellently in web browsing (super-quick) and battery life (long-lasting); if it has average functionality, it is mediocre in terms of the same two features. At the end of the whole series of consumer experiments, this study generated a dataset of the result data of six experiments by 127 respondents, i.e. $6 * 127 = 762$ individual experiment results.

5 FINDINGS

Table 5 shows the general findings of the six experiments. In experiment 1, approximately 60% of respondents choose product B which is superior in functionality and aesthetics but average in sustainability, compared to the remaining about 40% of respondents who prefer product A which is

superior in functionality and sustainability but average in aesthetics. Therefore a significantly higher proportion of respondents prefer aesthetics to sustainability, on conditions that superior functionality is secured.

Contrast the findings of experiment 1 to those of experiment 5, a very difficult outcome picture is seen. In experiment 5, if functionality is only average, then slightly more respondents would choose product E with superior sustainability and average aesthetics at the expense of product F with superior aesthetics and average sustainability. Although the difference between the two proportions of respondents is very small, it is in sharp contrast to the findings in experiment 1 in which aesthetics is valued more than sustainability by a significantly higher proportion of respondents. In other words, with or without superior functionality, the decision on the trade-off between sustainability and aesthetics can be very different.

Without excellent functionality on their side, more than 10% of respondents who prefer aesthetics to sustainability when both product choices present them all the functions they need, would change sides and then prefer sustainability to aesthetics. For these respondents, it becomes a case of either having both functionality and aesthetics, or not having both together and instead pursuing the sustainability cause. Aesthetics is close to nothing if it is not accompanied by excellent functionality.

In the results part of experiment 3 in Table 5, between product B with excellent functionality and average sustainability and product C with average functionality and excellent sustainability, with both products having excellent aesthetics, 67% of respondents choose product B while 33% choose product C. In the results part of experiment 4, between product D with excellent functionality and average sustainability and product E with average functionality and excellent sustainability, now with both products having only average aesthetics, 62% of respondents choose product D and 38% of respondents choose product E. This indicates 4% of respondents, who prefer functionality to sustainability when excellent aesthetics is provided in both product choices, would now opt for sustainability at the expense of functionality if excellent aesthetics is not guaranteed. For these respondents, if the product does provide aesthetics they desire, they would rather chase the sustainability cause when deciding on their product choice, instead of choosing a product with excellent functionality. They can't quite bear buying a product with excellent functionality not matched by excellent aesthetics. Although this change of sides happens to less people than in the scenario where results from experiment 1 and experiment 5 are compared, this is still noteworthy to product designers.

In the results part of experiment 2 in Table 5, respondents were asked to choose between product A with excellent functionality and average aesthetics and product C with average functionality and excellent aesthetics, while sustainability is excellent in both product choices. 57.5% of respondent choose product A while 42.5% choose product C. However, when sustainability is only average in both product choices, 60% of respondents choose a product (signified as product D in experiment 6) with excellent functionality and average aesthetics while 40% choose a product (product F) with average functionality and excellent aesthetics. This indicates that 2.5% of respondents change sides as a result of product choices turning from "with excellent sustainability" to "with average sustainability". For this small minority of respondents, it seems that excellent sustainability should be accompanied by excellent aesthetics, and they may feel uncomfortable with a product with excellent aesthetics that is not matched by excellent sustainability. They are not as comfortable with a product with excellent functionality and average sustainability.

Table 5. Overall results of the six experiments

Experiment 1	Frequency	Percent	Functionality	Sustainability	Aesthetics
Product A	52	40.9	√	√	X
Product B	75	59.1	√	X	√
Total	127	100.0			
Experiment 2					
Product A	73	57.5	√	√	X

Product C	54	42.5	X	√	√
Total	127	100.0			
Experiment 3					
Product B	85	66.9	√	X	√
Product C	42	33.1	X	√	√
Total	127	100.0			
Experiment 4					
Product D	79	62.2	√	X	X
Product E	48	37.8	X	√	X
Total	127	100.0			
Experiment 5					
Product E	65	51.2	X	√	X
Product F	62	58.8	X	X	√
Total	127	100.0			
Experiment 6					
Product D	76	59.8	√	X	X
Product F	51	40.2	X	X	√
Total	127	100.0			

The self-identity scale was assessed on each respondent on a five-point rating scale. The higher the point of scale, the stronger the respective respondent felt on the particular social psychological variable concerned. In this sub-section, an examination on the potential influences of the different social psychological variables on their smart phone product choices was conducted. Between respondents who choose one product and the other respondents who choose the other product in each experiment shown in Table 5, their self-assessed scores for each social psychological variables were compared. Pair comparison t test was conducted to find whether there is any statistically significant difference in the scores between the two respondent groups in each experiment.

Table 6 shows that the average score for respondents who choose product D (excellent functionality, average sustainability, average aesthetics) and those who choose product E (average functionality, excellent sustainability, average aesthetics). The latter group recorded a significantly higher average score (3.18) than the earlier group (2.86). The t value is -2.414 and the significance value is 0.017. This demonstrates that people who prefer to buy a product with excellent sustainability even to the point of sacrificing their pursuit of excellent functionality have stronger self-identity.

Table 6. The influence of self-identity on product design trade-off choices

Product				N	Mean	T value	Significance Level
Product D	F √	S X	A X	79	2.86	-2.414	0.017
Product E	F X	S √	A X	48	3.18		
Product E	F X	S √	A X	65	3.12	2.260	0.026
Product F	F X	S X	A √	62	2.83		

However, the influence of self-identity does not apply to all the product choices in which one product has excellent sustainability and another product has average sustainability. There is no significant difference in the scores of this variable for both experiment 1 and experiment 3. The obvious difference between experiments 4 and 5, and experiments 1 and 3, is that in the former two experiments only one aspect is superior while in the latter two experiments two aspects are superior. This study hypothesizes that if a respondent is presented with two product choices with one having

superior sustainability and no other superior attributes while the other having average sustainability but having superiority in one other attributes, the self-identity variable functions strongly and makes the respondent choose the one with superior sustainability. However, if a respondent's product choices are that both have two superior attributes, s/he would be attracted by the presence of two superior attributes and/or would be confused by more complex information (higher sustainability with good performance in one other attribute versus lower sustainability with good performance in another different attribute to the extent that they sub-consciously shut off the potential functioning of their strong self-identity.

6 CONCLUSIONS

Luchs, Brower and Chitturi (2012) investigated a similar trade-off scenario but it involved functionality and sustainability only. No literature has been found that incorporated all three major aspects of product design – functionality, sustainability and aesthetics and assessed the corresponding trade-off decisions. This study is the first step to address this important research gap.

Results from this study are stimulating because they provide a glimpse of the complex trade-off scenarios and possible explanations for these scenarios. The trade-offs are not as straightforward as that one aspect of product design is always preferred at all times by the same person. The same person may change his/her preference because of the presence/absence of the superiority of another aspect of product design. What's more, different consumers are different. This study adopts the self-identity theory to attempt to explain the different choices made by different consumer when they face the same trade-off. Results show that self-identity does have a significant impact on the trade-offs that involve sustainability. But again this impact is not as straightforward as that self-identity always has an impact on trade-offs that involve sustainability. There are a couple of conditions under which self-identity doesn't come to the consumer's subconscious mind when they make decisions on these trade-offs.

Specifically, this study has found that consumers usually prefer superior functionality to superior sustainability or superior aesthetics. If they face a scenario in which both product choices have only average functionality, a slightly higher proportion of them prefer sustainability to aesthetics, but this slight difference is really meagre.

The study has found that more than 10% of consumers are not comfortable with having a product with superior functionality but with only average aesthetics. This is understandable. If they are prepared to choose and spend on a product with superior functionality which usually charges a higher price, they expect the product to be beautifully designed. If they can't get a beautiful design, they wouldn't rather totally give up on this product and pursue another product that may satisfy their social prestige desire such as a product with a high standard of sustainability.

The study has also found that more than 4% of consumers would swap sustainability for functionality when the aesthetics of both of their product choices are changed from mediocre to excellence. This implies that there is a small proportion of consumers who see a product with outstanding beauty, they expect to see it accompanied by outstanding functionality. If they see a product with mediocre aesthetics, they would rather avoid it and choose an alternative product that meets their social desirability purpose.

The study has also found that more than 2% of consumers who prefer functionality to aesthetics if both of their product choices do not have a high level of sustainability, would change sides and swap functionality for aesthetics if both of their product choices achieve a high level of sustainability. This implies that they associate sustainability more with aesthetics than with functionality. Although these consumers are not many, they are neither negligible. When product designers develop a highly environmental friendly product, they are advised to also impose a correspondingly high level of beauty on the product because this can simulate more sales of the sustainability-focused product.

The study has also found that self-identity has a significant effect on consumers' decisions on trade-offs involving sustainability. Generally speaking, if a consumer scores high in self-identity, s/he is expected to prefer to a product with outstanding sustainability to a product with outstanding functionality or outstanding aesthetics. However, for the same consumer, the influence of self-identity will be greatly reduced when facing a trade-off between two products with both sustainability and one other aspect to be simultaneously considered. The greater complexity of the trade-off may have shut off the desired functioning of self-identity.

This study offers a number of possible explanations for the functioning of self-identity concept in some scenarios and non-functionality of the same concept in other scenarios. An in-depth qualitative study is recommended to gain more insights into the reasons for the functioning and non-functioning of self-identity concept in different situations. Similar trade-off studies can be conducted in another product case in order to find out whether the results of this study can be transferred to other products.

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