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Abstract

In the fields of innovation and product development, the dimensions of industrial design have not been focused upon. This paper proposes that the appearance and usability of products influence premium price and customer satisfaction, and these effects increase as products mature. The mobile phone industry in Japan was chosen as the market in which to test these hypotheses empirically. The results of this study indicate that the appearance and usability of products have no effects on premium price, but have positive effect on customer satisfaction. These effects increase with the maturing of the product.

Keywords: Innovation, Marketing, Industrial design

The effects of industrial design of products on premium price and customer satisfaction with maturing of products

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Introduction

Recently, Japanese electrical appliance companies have struggled to make their products, such as TV sets and TV games, highly functional and multifunctional. However, they have been unsuccessful in achieving differentiation from other firm's products and satisfactory performance. There are several reasons for their difficulty in differentiation and poor performance. This paper considers that these problems have arisen because they tend to place too much emphasis on the technical dimension of products and do not improve the emotional aspect, specifically, the industrial design of their products.

The dimensions of industrial design usually constitute competitive advantage because they are difficult to imitate. For example, Nintendo's Wii and Dyson's vacuum cleaner succeeded owing to their industrial design. It is important to pay attention to products' industrial designs. However, existing research has not focused on the dimension of products. Therefore, this paper will focus on industrial design and explain the effects of industrial design on premium price and satisfaction with products.

Hypotheses

Much research has been conducted in the fields of innovation and product development. Specifically, research involving the maturity of the industry, rate of innovation, and type of innovation in the market have impacted these fields (Abernathy and Utterback, 1978; Christensen, 1997).

One study demonstrated that in an industry's transition from a fluid to a specific stage, the rate of innovation changes (Abernathy and Utterback, 1978). In the fluid stage, the rate of product innovation is higher than that of process innovation. In the specific stage, the rate of product innovation decreases and becomes lower than that of process innovation.

Another study demonstrated that in the hard disc drives (HDD) industry, the shift of value of attribute came out through the hedonic pricing method which analyse the influences on the premium price (Christensen, 1997). By 1980, most HDD manufacturers in the industry had improved their HDD's areal recording density. However, in 1981 a disruptive technology change occurred that caused the size of HDDs to shrink. Because of this change, most established manufacturers defeated new manufacturers.

However, in the areas of innovation and product development, the industrial design of products has not been given enough weight. Some researchers have analyzed industrial design from the perspective of innovation and product development (Gemser and

Leenders, 2001; Gemser et al., 2006; Talke et al., 2009; Yamamoto and Lambert, 1994). Some studies argue that industrial design includes appearance and usability of products (Gemser et al., 2006) and that the appearance and usability of products contribute to product sales (Gemser and Leenders, 2001; Talke et al., 2009). However, studies that embrace the industrial design perspective do not consider the following points.

The effects of product appearance and usability on premium price and product satisfaction have not been studied, and the difference in these effects has also not been analyzed. In addition, longitudinal change of these effects on the appearance and usability of products has not been studied. These points should be considered in order to develop a correspondence relationship between existing research in the fields of innovation and product development (Abernathy and Utterback, 1978; Christensen, 1997).

Therefore, in this study, we first investigate how the design aspects of a product (appearance and usability) influence the premium price and satisfaction with the product. Then the impacts of these influences are analyzed with the increasing maturity of the product.

A hypothesis concerning the influences of appearance and usability on premium price is constructed. Christensen empirically shows the shift of value of an attribute through an analysis of the influences on premium price. The impact of appearance and usability on premium price would surely increase with the difficulty in differentiation of the products from the functional aspects, and shift the value of the attribute toward appearance and usability.

Second, the hypothesis on the influence of appearance and usability on customer satisfaction is developed. Existing research demonstrates the relationship between innovation and satisfaction with products (Langerak et al., 2004; Stock, 2011). The impact of appearance and usability on customer satisfaction would increase as is the case in premium price.

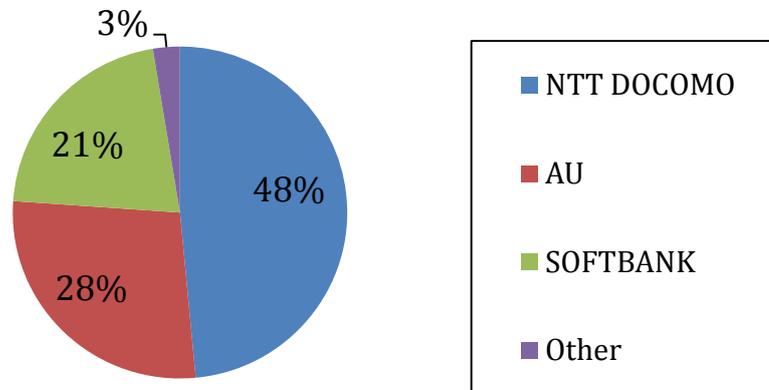
Therefore, this paper proposes four hypotheses to demonstrate that the appearance and usability of products have influence on premium price and customer satisfaction, and these effects increase as products mature. First, the positive effects of a product's appearance on premium price increase with the maturing of the product (H1a). Second, the positive effects of a product's usability on premium price increase with the maturing of the product (H1b). Third, the positive effects of a product's appearance on satisfaction with the product increase with the maturing of the product (H2a). Fourth, the positive effects of a product's usability on product satisfaction increase with the maturing of the product (H2b).

Method

The mobile phone industry in Japan was chosen as the market in which to test these hypotheses empirically. This choice was made because the mobile phone industry has many models of mobile phones and the speed of product evolution is high. The high speed of product revolution is very important in terms of investigating the maturing process of products (Fine, 1998).

First, we briefly review the Japanese mobile phone market. Mobile phones are widely diffused in Japanese society. The current number of mobile phone users is over 100 million, which shows that almost all citizens have mobile phones. The Japanese mobile

phone industry consists of telecommunications carriers and mobile phone manufacturers. NTT, Docomo, AU, and Softbank hold most of the market share.

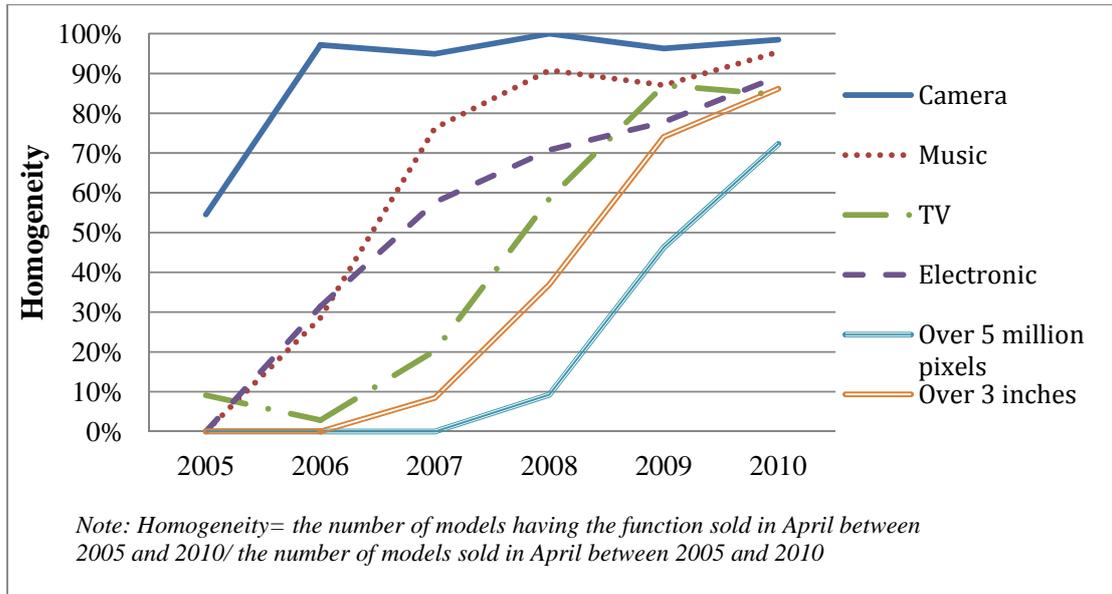


Source: Nikkei shijyou senyuritu 2012

Figure 1 – The market share of mobile telecommunications carriers in 2010

There is severe competition among several major mobile phone manufacturers such as Sharp, Panasonic, and Fujitsu. Unlike in other countries, in Japan, telecommunications carriers have considerable commitment and cooperation with mobile phone manufacturers in new product development, and both telecommunications carriers and mobile phone manufacturers are responsible for the development of the mobile phone.

Due to these distinctive characteristics of the industry, cutting-edge technologies have been introduced to the mobile industry (including cameras and electronic payment) with rapid market introductions occurring about three times per year. In 2010, over 50 different models were brought to market. However, by the late 2000s, most Japanese mobile phones could not be differentiated by functional aspects and were equipped with analogous features. In this paper, we further investigate the Japanese mobile phone market.



Source: *ke-tai hakusyo 2006-2012* and the Home page (HP) of each mobile telecommunications carriers.

Figure 2 – Trend of homogeneity

This paper analyzes the characteristics of mobile phones that were sold in April between 2005 and 2010. The period between 2005 and 2010 is divided into two sections to analyze the change in effects based upon the maturing of mobile phones. Section 1 ranges from 2005 to 2007, and Section 2 ranges from 2008 and 2010. One hundred and three and 185 types of mobile phones were available during Section 1 and Section 2, respectively.

To test the hypotheses, the model included appearance and usability of products as independent variables and premium price and satisfaction with products as dependent variables. In addition, model month (the number of months from each model's introduction to April each year), year when each model was released, career of each model released, and each model's functions (such as music and camera functions) were included as control variables.

Information about price was collected from the Japanese website 'Ke-tai watch'. This site records each model's price every week. Information regarding satisfaction with products and appearance and usability of products was collected from the Japanese website 'Kakaku.com' and was evaluated with a 5-point scale by users of each model. Information about control variables was collected from *Ke-tai hakusyo*, a Japanese mobile phone data book that has been published every year since 2005. Table 1 shows the variables for this study.

Table 1 – Variables for regression analysis

	Name	Variable detail	Data Collection
Dependent	Price	Price per April	From Ke-tai watch

variables	Satisfaction	Rating from 0 to 5 by users	From Kakaku.com
Independent variables	Appearance	Rating from 0 to 5 by users	From Kakaku.com
	Usability	Synthesis variable Rating from 0 to 5 by users regarding: button operation, response, character conversion, menu screen (Cronbach's alpha is over 0.8 at all year)	From Kakaku.com
Control variables	Camera (pixel)	Camera's pixel per models	From <i>Ke-tai hakusyo 2005-2011</i>
	Music (dummy)	Whether the model has music function	From the HP of each telecommunication carriers
	TV (dummy)	Whether the model has TV function	From <i>Ke-tai hakusyo 2005-2011</i>
	Electronic payment (dummy)	Whether the model has electronic payment function	From the HP of each telecommunication carriers
	Display size (inches)	Display size of models	From <i>Ke-tai hakusyo 2005-2011</i>
	Models' months old	The number of months from each model's introduction to April each year	From <i>Ke-tai hakusyo 2005-2011</i>
	au (dummy)	Models were released by au	From <i>Ke-tai hakusyo 2005-2011</i>
	Softbank (dummy)	Models were released by Softbank	From <i>Ke-tai hakusyo 2005-2011</i>
	2005 (dummy)	Models were released in 2005	From Ke-tai watch
	2006 (dummy)	Models were released in 2006.	From Ke-tai watch
	2008 (dummy)	Models were released in 2008.	From Ke-tai watch
	2009 (dummy)	Models were released in 2009.	From Ke-tai watch

To assess the effects of product appearance and usability on premium price and satisfaction with products, four multiple regression analysis models were built. The first model analyzes the effects of appearance and usability of products on premium price in Section 1. The second model analyzes the effects of appearance and usability of products on premium price in Section 2. The third model analyzes the effects of appearance and usability of products on satisfaction with products in Section 1. The fourth model analyzes the effects of appearance and usability of products on satisfaction with products in Section 2.

Findings

Table 1 and Table 2 show demonstrational results of the four models. In this section, these results were interpreted for implications (results of these models are robust even if control variables were eliminated).

Table 2 – Results of the regression analysis

		Model 1	Model 2	Model 3	Model 4
Independent variables	Appearance	0.003	0.125**	0.209***	0.262***
	Usability	-0.118	0.018	0.739***	0.778***
Control variables	Music	0.002	-0.018	0.189**	0.019
	Camera (pixel)	0.202*	0.359***	-0.183**	-0.08
	TV	0.245***	0.195***	0.099	0.069
	Electronic payment	-0.03	0.034	0.104	0.046
	Display Size (inches)	0.066	0.127**	-0.158**	-0.095*
	Softbank	-0.294***	0.479***	-0.136**	-0.038
	au	-0.276***	-0.321***	-0.0809	0.039
	Models' months old	-0.315***	-0.078*	0.039	-0.04
	2005	0.277***		0.233***	
	2006	0.264***		0.092	
	2008		0.178***		-0.011
	2009		0.094*		-0.036
Adjusted R ²		0.349	0.716	0.703	0.79
F-value		5.531***	39.810***	20.942***	58.684***
N		103	185	103	185

*p ≤ 0.1 **p ≤ 0.05 *** p ≤ 0.01

First, H1a and H1b were analysed. H1a and H1b were not supported. This means that a product's usability has no effect on premium price. A product's appearance has a positive effect on premium price in the second model, but it has no effect on premium price in the first model.

In contrast, the results supported H2a and H2b. The effects of appearance and usability of products on product satisfaction were statistically significant and highly positive in both the third model and fourth model, and their effects in the fourth model were higher than those in the third model. This means that these effects increased with the maturing of the product.

These results represent the characteristics of appearance and usability of products. There were no clear criteria to evaluate appearance and usability of products because these evaluations mainly depend on individual taste. This is why appearance and usability of products do not affect premium price, but do affect satisfaction with products. Most importantly, product usability is perceived after product use, so it has no effect on premium price but has a significant effect on product satisfaction.

The explanation for the increase in influence of appearance and usability on product satisfaction can be summarized as follows. For appearance, the influence on satisfaction with products increases in Section 2 because, compared to Section 1, people can choose from a larger variety of products with satisfactory functions. Compromising in usability can be seen in Section 1 due to the limited product functions. On the other hand, in Section 2, the difficulty in differentiating the products from the functional aspect led to higher expectation for product usability and a greater negative impact on product satisfaction when the user experience of the product was unsatisfactory.

The positive impact of appearance and usability on customer satisfaction would increase with the maturity of the products for the reasons mentioned above.

Conclusion

The results of this study indicate that product appearance and usability have no effect on premium price, but has positive effect on customer satisfaction. The effect on product satisfaction increases along with the maturity of the product. Existing research demonstrates that customer satisfaction has positive effects on market share and brand loyalty (Langerak et al., 2004; Stock, 2011). Indeed, Fujitsu may improve their shipment volume by improving their products' usability. In Section 2, Fujitsu's average usability of products is higher than that of mobile phones of other manufacturers.

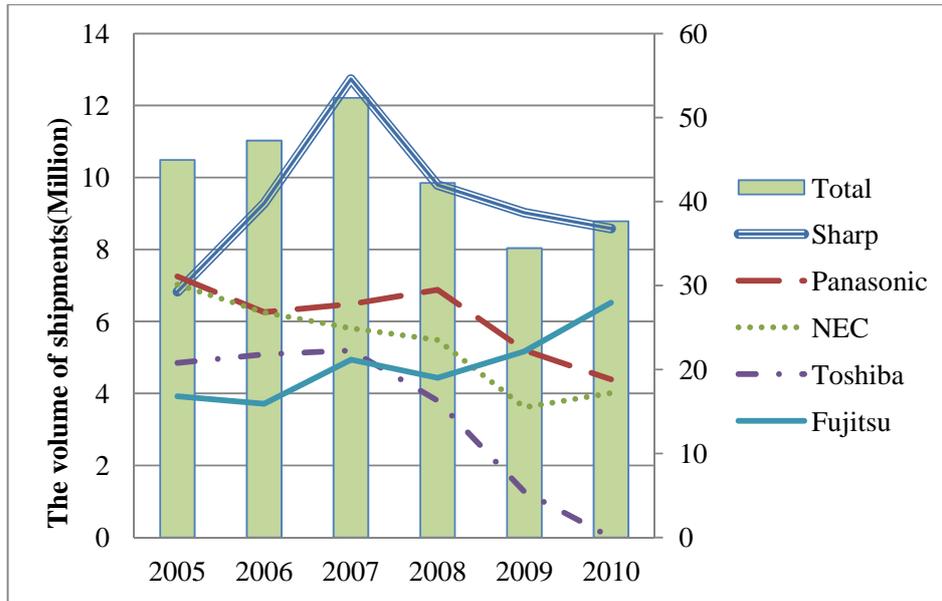


Figure 3 - The volume of shipments by mobile phone manufacturers
 Source: Nikkei shijyou senyuritu 2005-2012

These results indicate that, for appearance and usability of the product, Christensen's disruptive innovation framework is realized in the difficulty in differentiation of the products from functional aspects. However, these elements have positive effects on customer satisfaction, not premium price. This finding is one of the contributions provided by this paper. Existing research shows that the rate of product innovation decreases with the maturity of products. However, results of the current study indicate that the rate of product innovation from the industrial design perspective, as opposed to functionality, may improve. In fact, one study suggests the possibility of the existence of innovation in industrial design following functional innovation (Walsh, 1994).

This research also demonstrates that product usability contributes to a firm's competitiveness. Therefore, the present study has meaningful academic implications.

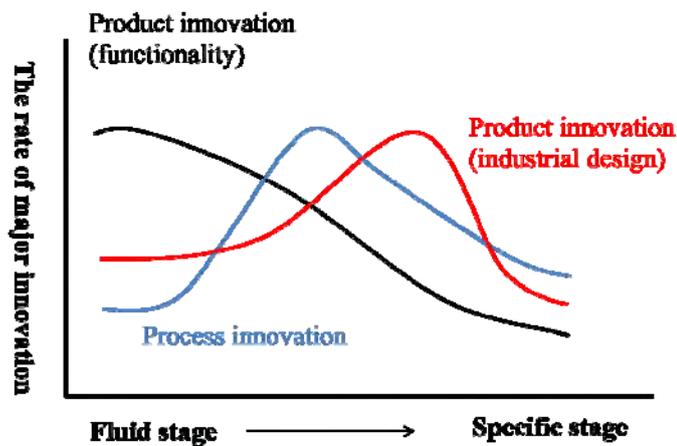


Illustration 1-New model of innovation considering the industrial design's dimension

For management practice, business managers should improve the appearance and usability of products, not for premium price but rather for user satisfaction, and continue to lay emphasis on maturing products. These results also show that firms should focus on appearance and usability and satisfaction with products.

There are some issues in this study resultant from data collection. For example, this research investigates only the mobile phone industry, the investigation period is short, and the reliability of the data is not very high. Future research should solve these problems and conduct a more generalized and precise demonstration. In addition, the present research does not focus on how firms develop products with superior industrial design. This theme is very important and should be analyzed. While analyzing how firms develop superior industrial design products, according to Clark and Fujimoto (1991) and Fujimoto (1991), we need further discussion regarding the role of product managers and integration of organisations to investigate the optimal product development for prominent design.

Finally, the contribution of the present study will become greater in the future because further emphasis on industrial design is expected.

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