

Analysis of Information Behavior in Determination of Product Specifications Based on a Conjoint Measurement Approach and Fusion Model

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ABSTRACT. This paper deals with the difficulties involved in analyzing and designing a management system to reduce the risks and improve the productivity of new product development. In this paper, a method is described to analyze user information and determine product specifications based on a stimulus-response model, the conjoint measurement of users' needs, and product characteristics deployment. The proposed method can analyze the effect of a partial price on the contribution ratio based on the order of preference of product profiles through a smaller number of product profiles. The strengths and weaknesses of this method are examined as the method is applied to the case study of a mobile computer intended for personal use.

Key Words: product development, stimulus-response model, fusion model, product specification, information behavior, conjoint measurement

1. INTRODUCTION

Most product innovations and improvements have been developed through trial and error by those in charge of research and development, and the evaluation of innovations has mainly focused on the success or failure of the results alone rather than on the causes and processes. Therefore, it is almost impossible to specify how to improve or redesign a management system for the purpose of product innovation (Muramatsu *et al.*, 1990). Based on the *fusion concept* (Holt, 1977), we have developed and proposed models and methods to analyze

information behavior in the assessment of users' needs. This concept aims to clarify the functions of the assessment of both users' needs and technology in connection with a new creative idea. *Users' needs assessment* refers to problem definitions derived from the users' perceived needs. *Technology assessment* involves the study of the possibility of solving problems as they arise in the process of new product development. The concept of *information behavior* includes the structure and operation of collecting information, using the information, and making decisions through the generation of ideas. The decision-making process can be

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analyzed from product strategy planning to the functional specifications and components of the product by using the proposed methods in combination with such methods as product characteristics deployment (Muramatsu *et al.*, 1990), listing of functions (Lawrence, 1961), product family-tree analysis (Ishii and Ichimura, 1992; Ishii *et al.*, 2000), and the conjoint measurement approach (Yoo *et al.*, 1994; Luce and Tukey, 1964).

This paper proposes a method to analyze information behavior and determine optimum product specifications. The method is combined with a stimulus-response model (Ishii and Ichimura, 2003) and the conjoint measurement of users' needs based on the fusion model. The strengths and weaknesses of this method are examined as it is applied to a case study, done in Japan, of a mobile computer intended for personal use.

2. APPROACH

2.1 A stimulus-response model

Figure 1 shows the stimulus-response model (Ishii *et al.*, 1987; Ishii *et al.*, 1999, 2003) that is the basis of this study of users' needs. In this model, the stimulus that effectively brings forth the users' needs is represented by various investigations done by means of questionnaires and interviews. Because the results obtained from the responses depend entirely on the stimuli, it is vital to generate effective stimuli when designing a study method. The responses can then be the bases for creating new and better stimuli. Shown in Figure 1 is a two-step stimulus-response model in which the first response regarding the weight of the merchandizing characteristics is targeted to induce an effective stimulus to determine users' needs for optimum product specifications.

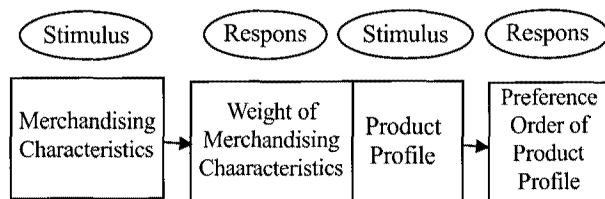


Figure 1. A stimulus-response model

2.2 Fusion model

The basic concept behind our research on needs assessment is fusion. In this concept, the assessment of users' needs and the assessment of available technology are fused into a new creative idea. Users' needs assessment is problem definitions derived from the users' perceived needs. Technology assessment consists of

studying the possibility of solving the problems arising in the process of developing a new product. The fusion of these two objectives is realized to facilitate the generation of new and effective ideas for the new product. This paper considers a procedure for the effective development of a new product or system using the innovative idea of the fusion concept as shown in Figure 2.

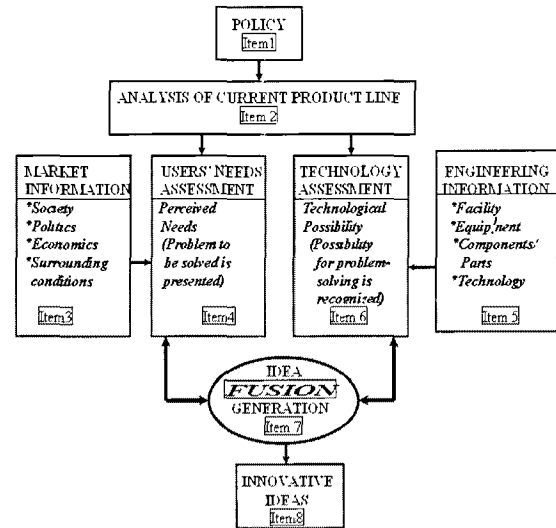


Figure 2. A fusion model for the development of a new product

2.3 Deployment of product characteristics

The fusion process of a fusion model consists of four significant characteristics of product merchandising: technical, manufacturing, and marketing characteristics, and deployment between the succeeding two characteristics of the four characteristics shown in Figure 3. Based on the results of the deployment process, activities such as development, design, process control, sales, and service are implemented. Results are evaluated, and maintenance/improvement activities are deployed. Figure 3 shows the relationships among the activities. To illustrate this deployment process, the matrix of product characteristics deployment will be utilized. This deployment matrix illustrates the four characteristics through the concept of levels (Muramatsu *et al.*, 1990). We have developed a method which combines product characteristics deployment and a product family tree in order to deploy the merchandizing characteristics to the manufacturing characteristics efficiently (Ishii and Ichimura, 1992).

Many studies have been done concerning quality function deployment, or QFD (Akao, 1993; QFD Institute, 2003). The concept of levels of product characteristics in our product characteristics deployment method seems similar to QFD, but our proposed method

aims to clarify a structure of the innovation process as information behavior. The content of the elements of product characteristics shown in Table 2 was derived from our many case studies of product development (Muramatsu *et al.*, 1990). Moreover, our product characteristics deployment method is just one method of analyzing information behavior in the innovation process. This method aims to analyze the conversion of the four product characteristics. In order to facilitate decision-making and creative effort, information behavior here is defined as the structure of and the activities involved in collecting, processing, and making decisions for which

- (1) a feasible target is established to accomplish the objective,
- (2) information is collected and its source selected,
- (3) research and experiments are performed and data collected, and
- (4) the obtained data are converted into the required information.

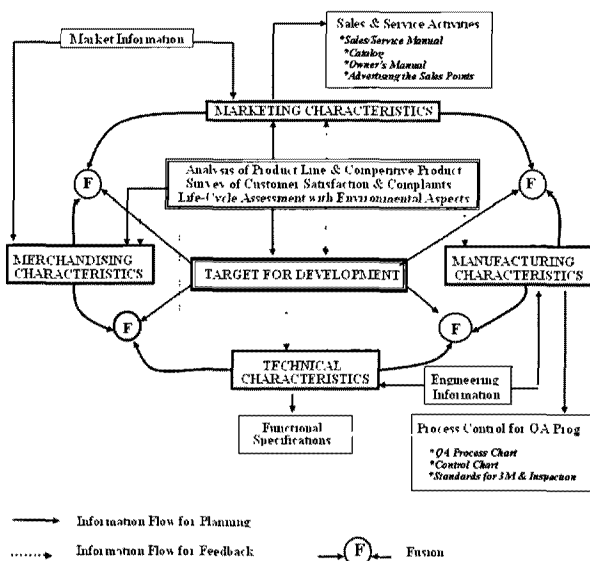


Figure 3. Model of information behavior based on the fusion concept

2.4 The proposed procedure for the determination of product specifications

Based on the model and method mentioned above, we have developed the following procedure to determine optimum product specifications based on users' needs:

- (1) Deployment of product characteristics.
- (2) Determination of the significant merchandizing characteristics and identification of the technical and marketing characteristics and components related to the significant characteristics.
- (3) Design of a product profile.
- (4) Determination of optimum specifications for a product.

3. CASE STUDY

3.1 Outline of the survey

For this study, a mobile personal computer was selected as a product sample, and a survey of users' needs was done using a questionnaire focusing mainly on those who use the computer for personal benefit. The questionnaire, which can be viewed at <http://www.kanazawa-it.ac.jp/jima/ishibaba/>, consists of the following three parts:

- (1) Characteristics of the respondents, including age, gender, occupation, online time, location of use, and purpose of purchase.
- (2) The significance level of the merchandizing characteristics selected from the results of product characteristics deployment.

For example, the following is an item from the questionnaire:

If you buy a mobile computer, how do you evaluate "The process of booting up the software does not take long?"

Please select from the following alternatives:

Not important At all (1)_____	Not important (2)_____	Important (3)_____	Very important (4)_____
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- (3) The product profiles, in order of preference, based on a conjoint measurement approach.

In the mobile computer case study, we designed eight profiles of a mobile computer as shown in Table 5. The respondent was asked to list his/her preferences in order from one to eight.

During the decision-making phase concerning product attributes, we interviewed people in charge of product planning at several computer companies about the current status of product planning. The 262 answers to questions about the significance of the merchandizing characteristics and the 192 answers about the preference order of product profiles had been collected from faculty members and students at Kanazawa Institute of Technology in 1998 and 1999. The responses regarding the significance level of the characteristics ranged from one to four.

3.2 Survey Results

Table 1 shows the survey results in terms of product characteristics deployed based upon the product features. The table also illustrates the results of deployment from merchandizing characteristics to technical characteristics as well as to family-tree analysis. The results of deployment from merchandizing characteristics to marketing characteristics are also given.

Table 1. product characteristics deployment list for a portable personal computer

Elem. of char.	Product Feature	Merchandizing Characteristics	Technical Char.	Product Family Tree(Components)	
Spec.	Thin, Light-Weight, All-in-One Model	Small body Light Weight Small Area Thin case	Weight (g)		
Efficiency	Full Expansion	Easy to upgrade Allows various functions Excellent compatibility	Time (s) Time (S)		
	Upgrade support	Easy to connect peripheral devices Easy to upgrade functions Can be connected with many peripheral devices Handles a lot of software A lot of software can be installed			
	Equipped with advanced functions	Quick boot process Fast internal processing Fast external data exchange shuttdown			
Reliability	Excellent Multimedia Functions	The process of booting up the software does not take long time Good Sound Quality Many types of sounds are available Large monitor Sharp color Smooth motion picture Internet capability File transferability Voice communication capability Fast communication speed	Failure rate (%) Failure rate (%) Failure rate (%)		
	Easy Internet	Clear monitor			Infrequent failure of body Infrequent failure of power cable Infrequent failure of liquid-crystal monitor
		Comfortable communication speed			Safe
		Infrequent failure			Easy cleaning Rarely stains Stains can be easily cleaned Operation procedure is clear Easy troubleshooting
Safety	Easy operation Various software makes your PC life more enjoyable	Easy operation Easy monitor adjustment Software ready to use A lot of pre-installed software			
		Power-Saving Function			Long-lasting battery Low power consumption
Ease of Operation	Advanced portability	Easy-to-move PC body Light weight Easy-to-carry body Small area dimension Thin case Easy-to-handle shape	Weight (g)		
		Smart design		Nice appearance Good design Good color Sense of reliability Corporate image	
Trans-portability	Feeling	Low PC price Low price of peripheral devices Low software price Satisfactory After-Service Service operator is nice Immediate repair	Cost (yen) Cost (yen) Cost (yen)		
		TLCC		Marketing Characteristics	
Guarantee	Beginner can enjoy full support	Computer Delivery Service			

Table 2 shows the average values of the survey results for the significance level of merchandizing characteristics. Thirty merchandizing characteristics were selected to clarify significant merchandizing characteristics from Table 1. In the selection of the 30 characteristics, we considered that a shorter questionnaire makes a better survey design and that the number of questions should be balanced among the elements of characteristics for effective information regarding product development.

Table 3 shows the product attributes which were chosen based on the deployed characteristics of products for which five merchandising characteristics were selected with reference to the highest level of significance as illustrated in Table 2. In identifying the product attributes, it was found that the failure rate, as a technical characteristic, could not be directly considered a product attribute but that delivery service, as a marketing characteristic when a computer breaks down, might be considered a repair service.

Table 4 shows the list of standards for product attributes which was used to design alternative product profiles for conjoint analysis. In this table, *partial price* means that the higher processing speed a CPU has, the more expensive the CPU is. Figure 4 shows a conceptual chart of the effect of partial price on the partial utility of a personal computer. In the figure, the difference between y_1 and y_2 is the partial effect of a CPU on the utility of a personal computer, while the difference between y_2 and y_3 is the partial effect of the partial price. The chart shows a trade-off relationship between price and quality based on the utility of a product. In addition, the weight depends upon internal or external disk-drive devices. The standards for product attributes such as weight, CPU, and basic price were selected according to the minimum and maximum specification levels of the products marked.

Based on Table 4, we designed eight product profiles as a whole-product specification, a combination of each standard for a product attribute, as shown in Table 5.

Table 2. Product characteristics and significance level for mobile personal computers(Survey done 1998 and 1999. Sample size: 262)

Elements of Characteristics	Merchandizing Characteristics	Average Value
Specification	Computer is small enough to fit in a bag	3.473
	Body is thin and takes up little space	3.492
	Body weight is light for ease of transportation	3.641**
Efficiency	Multiple functions, such as voice recognition and others	2.981
	Quick software start-up, processing, and shutdown	3.626**
	Peripheral devices and files are compatible	3.317
	Can play music	2.298
	Visual display is clear	3.420
	Response speed is comfortable	3.324
Reliability	Frequency of main body failure is low	3.702*
	Frequency of power cable failure is low	3.408
	Visual display is stable	3.359
Safety	No physical damage	3.134
Maintainability	Stains and dirt do not stick easily	2.802
	Stains and dirt can be cleaned easily	2.592
	Easy and simple operation of software for maintenance	3.458
	Troubleshooting can be done by user	3.328
Ease of Operation	Use of keys, switch and mouse is easy and simple	3.347
	Monitor adjustment is easy	3.118
	Much software is preinstalled	3.061
Transportability	Power consumption is low	3.397
	Shape of body makes computer easy to handle	2.462
Feeling	Body shape is pleasing	2.756
	Body color is pleasing	2.714
	Corporate brand is excellent	2.588
Total Life Cycle Cost	Price of the computer is low	3.599**
	Price of peripheral device is low	3.340
	Price of software is low	3.244
Guarantee	Questions about service can be answered over the phone	3.145
	Repair is immediate when computer is broken	3.626**

*Maximal average value.

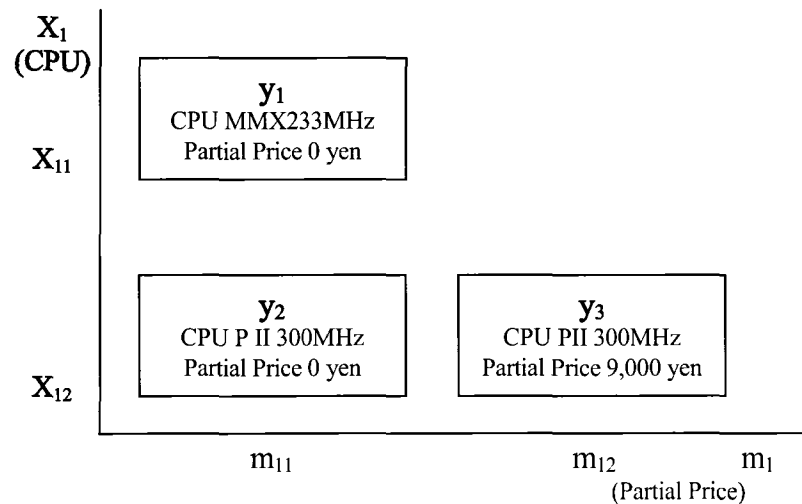
**The average value has no difference between the maximal average with a 5% level significance

Table 3. specification attributes determined by the significance levels of characteristics

Significant Merchandizing Characteristics		Technical Characteristics	Marketing Characteristics	Product Family Tree (Components)	Product Attributes
Element of Characteristics	Contents				
Specification	Body weight is light for ease of transportation	Weight			Weight
Efficiency	Quick software start-up, processing, and shutdown	Time		CPU	CPU Time
Reliability	Frequency of main body failure is low	Failure Rate			—
TLCC	Price of the computer is low	Cost			Price
Guarantee	Repair is immediate when computer is broken	—	Delivery Service		Delivery Service

Table 4. List of standards for product attributes for conjoint analysis

Product Attributes	Standard 1	Standard 2
Weight Internal/External	3Kg Internal FFD,CD-ROM	1Kg External FFD,CD-ROM
CPU Partial Price	MMX233MHz 0 yen	P II 300MHz 90,000 yen
Basis Price	280,000 yen	230,000 yen
Delivery Service	Not included	Included

**Figure 4.** conceptual chart of effect of partial price**Table 5.** Product profiles designed for conjoint analysis

Profile No.	Weight(Int./Ext.)		CPU(Partial price)		Basic Price		Delivery Service	
	3Kg(Ext.)	1Kg(Int.)	233MHz	300MHz	¥280000	¥230000	Not included	Included
1	1	0	1	0	1	0	1	0
2	1	0	0	1	1	0	0	1
3	1	0	1	0	0	1	0	1
4	1	0	0	1	0	1	1	0
5	0	1	1	0	1	0	1	0
6	0	1	0	1	1	0	0	1
7	0	1	1	0	0	1	0	1
8	0	1	0	1	0	1	1	0

3.3 Result of conjoint analysis and proposal of optimum product specifications

A conjoint analysis of the survey responses regarding the order of preference for eight product profiles allows us to provide an optimum product specification proposal as shown in Tables 6 and 7.

Table 6 gives the following information:

- (1) The most effective product attribute of a mobile computer is the delivery service.
- (2) The partial effect of the partial price is greater than the effect of the CPU in this product standard case.

Table 7 shows that the optimum specification for delivery service and basic price is the same independent

of the segment of users, but weight and CPU depend on the category of the segment of users.

3.4 Discussion of the results of the case study

The validity and problems of the proposed method have been analyzed by applying this method in a case study of a mobile computer. The conclusions are listed below:

- 1. From the results of the deployment of product characteristics and the survey of the significance level of merchandizing characteristics, we clarified four product attributes to design an effective product profile of the efficient determination of optimum specifications of a mobile computer.

Table 6. Conjoint analysis results in consideration of partial price(users who use a computer for communication 1 hour or longer/day)

Product Attributes	Standards	Degree of Effectiveness	Contribution Ratio
Weight (Internal/External)	1kg /External	0.027	8.09
	3kg/Internal	-0.027	
CPU (Partial Price)	MMX233MHz	0.018	3.60
	P II 300MHz (+90,000yen)	-0.018	
Basis Price	280,000yen	-0.060	39.96
	230,000yen	0.060	
Delivery Service	Included	0.066	48.35
	Not included	-0.066	

Table 7. List of optimum product specifications for a portable PC

Segment	Category	Product Attributes and their Standards				
		Delivery Service	Weight, FDD-CD-ROM Internal/External	Basic Price (yen)	CPU(Partial Price, yen)	Sales Price (yen)
Gender	Male	Included	1Kg both external	230,000	Pentium II 300MHz(90,000)	320,000
	Female		3Kg both internal		MMX233MHz	230,000
Age	20s or younger		1Kg both external		Pentium II 300MHz(90,000)	320,000
	30-40s				MMX233MHz	
	50s or older				Pentium II 300MHz(90,000)	320,000
Occupation	Faculty		3Kg both internal		MMX233MHz	230,000
	Office Clark				Pentium II 300MHz (90,000)	320,000
	Student				MMX233MHz	230,000
Online Time	Almost none		1Kg both external		Pentium II 300MHz (90,000)	320,000
	Less than 1hr./day				MMX233MHz	230,000
	1hr./day or more					
Personal PC	Owned		3Kg both internal		Pentium II 300MHz (90,000)	320,000
	Not owned					
Location of Use	Home		1Kg both external		MMX233MHz	230,000
	School, Office				Pentium II 300MHz (90,000)	320,000
	Not specified					
Purpose of Purchase	Word processing	3Kg both internal	Pentium II 300MHz (90,000)	320,000		
	Spreadsheet		MMX233MHz	230,000		
	Game					
	Design					
	Communication					

2. With a product profile based on the four product attributes, we were able to determine the optimum specifications based on the contribution ratio of each product attribute and the possibility of the partial utility that each attribute standard may have. It was clarified from the results that CPU's differ in their optimum product specifications depending on the segment of online-communication time spent due to the partial price.
3. Among significant merchandizing characteristics, the product attribute of "non-frequent computer failure" was not clarified because the after-service of "repair immediately after failure," classified as delivery service, supplemented the undeveloped design standard of technical characteristics.
4. Upon determination of the optimum specifications, we considered their partial price impact on the CPU level alone; however, it will be necessary to study and clarify their impact on the weight of the computer and the cost of repairs.

4. CONCLUSIONS

In this paper, a method has been proposed to analyze the information behavior of decision-making for optimum product specifications in product development based on the fusion model. In this method, product characteristics deployment can be combined with product family-tree analysis to identify the product attributes that effectively satisfy users' needs. The method is combined with the conjoint measurement approach and the stimulus-response model as a two-stage model. The application of the proposed method to a mobile computer allowed the identification of optimum product specifications depending upon a target user, considering the effect of a partial price.

To improve the proposed method, a dynamic change in users' needs such as the levels of significance of merchandizing characteristics and the partial utility of a product attribute should be analyzed in future research.

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