A Study on User Satisfaction with an Entire Operation Including Indefinite-Length Response Time

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Abstract:
Recent years have seen progress in multi-functioning through information and communication equipment, such as personal computers and multi-function printers. Consumers are increasingly using multi-functional devices. One of the most vital aspects of the communication function is response time (RT). The length of the RT may be indefinite because it depends on the situation in which the communication occurs. Therefore, there is a possibility that user complaints may arise. Thus, user satisfaction in this regard is important. Companies that make information and communication equipment must improve usability by considering users’ Kansei, that is, the perceptions or feelings of human beings.

RT can be considered in two ways. One way is to devise the display content to prevent users from getting bored, such as animation. The other way is to make a good impression throughout the entire operation, such as through a "smooth" and "comfortable" user experience. However, the question remains: how may RT be used to provide a good impression?

First, this study divided the operational process into two parts: “pressing a button” and “waiting during the RT.” Problematic operational processes were cleared by tracing users’ emotional ups and downs. Such problematic operational processes were improved upon by understanding the Kansei evaluation structure, which is a network model representing the cause–effect relationship between each evaluation word based on users’ evaluations.

Next, language-related data on user requirements were grasped through an interview on the usability of the entire operation and each operational process. The Kansei evaluation words (i.e., words used by users to express their feelings/perceptions) for the entire process, such as “comfortable throughout the entire process,” and for each operational process, such as “the first wait is too long,” were selected. A survey on the semantic differential method using the Kansei evaluation words was conducted. Then, the Kansei evaluation structure related to the entire process was determined. Our analysis enables us to understand how to use the function of RT to provide satisfactory user experience.

Keywords
Information and Communication Equipment, Indefinite-Length Response Time, Kansei Quality, Operational Process, Usability Requirement

1. Introduction

In recent years, the use of information and communication equipment providing numerous functions, such as personal computers, smartphones, and multi-function printers, has increased rapidly. Thus, it is important that users perceive a sense of satisfaction while using such equipment. However, there may be a response time (RT) of indefinite length while the user waits for certain functions to be completed. As the RT is a part and parcel of all operational processes, its length and frequency are important.

In this paper, we analyze user requirements and suggest methods for improving functions involving indefinite-length RT. In particular, the analysis focuses on the direct scan function in the multi-function printer.
This function is directly connected to the storage service of the multi-function printer and enables scanned data to be stored without using a personal computer.

2. Previous Studies and Approach

2.1 Previous Studies on the Development of a Kansei Evaluation Structure

According to Munechika (1999) and Hanyuda (1996), attempts to develop a Kansei evaluation structure have involved listing evaluation words on the basis of preliminary investigations in four phases. Phase 1 entails interviewing consumers regarding their evaluations of certain products. Phase 2 entails selecting evaluation words and classifying them into four hierarchical levels using the perception-recognition model. Phase 3 involves segmenting consumers in terms of their different personal viewpoints derived from a primary investigation in which consumers use selected evaluation words to appraise products using the semantic differential method. Phase 4 uses graphical modeling to understand the Kansei evaluation structures of each segmented group. A Kansei evaluation structure is a network model based on consumers’ evaluation processes, and the model represents the causal relationship between different evaluation words used by consumers to appraise a product on the basis of their Kansei.

A recognition-recognition model describes the human process that leads from perception to action, and the process of perception, recognition, memory checking, emotional response, and action. Munechika (1999) suggested that evaluation words in Kansei investigations have a hierarchical structure that comprises single sense, combined sense, psychological response, and the overall Kansei, each of which corresponds to a construct in the recognition-recognition model.

In this study, we used the Kansei evaluation structure of previous studies to clarify the factors that strongly affect information and communication usability regarding RT.

2.2 Previous Studies on Reducing Dissatisfaction with Waiting RT by Waiting Animation

Myers (1985) suggested that percent-done progress indicators could reduce the dissatisfaction with RT. He proposed that such indicators help when the RT is more than 10 seconds. Nakanishi (2011) posited that a dynamic and an iterative and unpredictable waiting animation appearing at the end of the RT could reduce dissatisfaction when the RT is about 2 seconds. However, we do not know what kind of waiting animation is more effective for an indefinite-length RT, although percent-done progress indicators are effective.

2.3 Previous Studies on the Customer Journey Map

Sato (2013) investigated the emotional ups and downs of a car drive assistance system. He used a simulation that assumed a scenario for the use of such a system. He then related the users’ emotional ups and downs and the mechanism of providing the service by creating a customer journey map. Further, he clarified a problematic mechanism using this map; he found that the RT can be divided into multiple stages, as shown in Figure 1.

![Figure 1. An example of dividing the RT](image)

Thus, it is not enough to improve waiting animation. Moreover, it is unclear as which of the two categorizations of RTs is better: a few long RTs or many short RTs. This question has not been answered by previous studies. Therefore, if the function contains an RT, we need to not only improve the dissatisfaction associated while waiting because of the RT but also provide a good impression of the product.

2.4 Previous Studies on Usability Task Analysis

Since the conventional methods are intended to improve the usability of individual operations, Tsukuda (2010) suggested that such methods may not generate user satisfaction pertaining to the entire operation.
Therefore, using a high vision recorder remote control as the object of her study, she determined the operational process and user requirements affecting user satisfaction throughout the operation through the usability task analysis.

An example of the usability task analysis appears in Table 1. First, major tasks appear in rows, while the products to be evaluated are arranged in columns. Users are requested to evaluate each product in terms of the task being performed on a 5-point scale. For each task, users need to provide one good point and one bad point, to enable a comprehensive evaluation of each product.

Table 1. Example of a survey sheet for usability task analysis

| Scene | Product (1) | Product (2) | Product (3) | Product (N) |
|-------|-------------|-------------|-------------|-------------|
| Task (1) | Points | Good Point | Bad Point | | | | | |
| Task (2) | Points | Good Point | Bad Point | | | | | |
| Task (n) | Points | Good Point | Bad Point | | | | | |
| Overall Evaluation | Points | Good Point | Bad Point | | | | | |

The objective variable in this comprehensive evaluation is the score of each task, which is considered as the explanatory variable in a multiple regression analysis. Then, we calculate the importance of each task for an individual product.

While conducting the cross-evaluations at the task level, Tsukuda (2010) added items to the usability task analysis. These items were “usefulness (good features, robustness),” “convenience (ease of pressing and holding the key, ease of finding the key, and ease of operating the key),” and “attractiveness (pleasant design and luxurious).” Moreover, each product was numbered and scored. Performing a multiple regression analysis using the cross-evaluation items from the usability task analysis allows us to understand which cross-evaluation items have a considerable influence on a particular task, and thus, on the comprehensive evaluation.

Thus, we intend to understand the impression created by the product in the users’ minds and identify problematic operational processes. However, if there are RTs in the function, the sequence of the operational process also becomes important because it is unclear as to whether a long or a short RT is preferable earlier or later in the operational process. As mentioned previously, as there is no way to answer this question at the present time, we must consider the sequence of the operational process.

2.5 Approach Used in This Study

There are two approaches. One approach is to understand and develop the dissatisfaction process. The other approach is to create a good impression throughout the process, to understand which is better: a few long RTs, many short RTs, or one long RT earlier or later in the operational process.

We studied the direct scan function of a multi-function printer to understand the two types of Kansei evaluation structures, one for the entire process and the other for the dissatisfaction process. First, we separated the operational process into steps: “pressing a button” and “waiting (RT).” Then, we evaluated the satisfaction of each operational process and the entire process using a 7-point scale. Grasping the users’ emotional ups and downs enabled us to understand the dissatisfaction process. Using the Kansei evaluation words for this process helped us study the Kansei evaluation structure, thus giving indications for subsequent improvements to the process. We have explained this exercise in more detail below.

We analyzed the Kansei evaluation words for the entire operation. A grading of less than 4 indicates that the process or overall evaluation is dissatisfactory. Users were also requested to provide the reasons for the dissatisfaction. A grading of 5 or more indicates satisfaction, and users were also asked to list the reasons for their satisfactory perceptions. Thus, we assessed users’ emotional ups and downs and collated the Kansei evaluation words. Next, the Kansei evaluation structure for the entire process was created using the Kansei evaluation words for the same. Our analysis shed light on how functions with indefinite-length RT may be designed and improved to increase user satisfaction.
3. Identification and Improvement of Problematic Operational Processes

3.1 Identification of Problematic Operational Processes

By understanding users’ emotional perceptions, we can analyze problematic operational processes. This required conducting surveys on touch panel usability. In addition, to extract the evaluation terms from a variety of viewpoints, we used three functions: direct scan, direct print from a printer, and direct print from a smartphone. The function is directly associated with the storage service of the multi-function printer or smartphone, and its prints data from these storage services without using a personal computer. The outline of our investigation is described below. In addition, as we considered an indefinite-length RT, we conducted these surveys in a difficult communication environment.

Research function: (1) Direct print from the printer
    (2) Direct scan from the printer
    (3) Direct print from the smartphone

Respondents: (1) 25 respondents (20–50 years old)
    (2) 38 respondents (20–50 years old)
    (3) 13 respondents (20–50 years old)

Samples: (1) Two multi-function printers
    (2) Three multi-function printers
    (3) Three smartphone apps

Communication environment: Difficult (RT tends to be longer)

Method: Questionnaire and interview

Semantic differential method (7-point scale)

Items: Satisfaction with each operational process

Overall evaluation

Question: If the operational process or the overall evaluation was graded less than 4 points, we inquired about the reason for the dissatisfaction. Additionally, if the operational process or overall evaluation was graded higher than 4 points, we inquired about the reason behind the satisfactory evaluation.

First, a description was provided for each operational process of each printer. As an example, the operational process involved in a direct scan from the printer is shown in Table 2.

Table 2. The operational process involved in a direct scan for each printer

| Operational Process Number | Printer X | Operation Process of each Printer | Printer Y | Printer Z |
|---------------------------|-----------|----------------------------------|-----------|-----------|
| 1                         | Selecting “Cloud Computing” Button | Pressing “Scan” icon | Pressing “Scan” icon |
| 2                         | Waiting (about 30 seconds) | Selecting the “Attached to an E-mail” | Pressing “E-mail” icon |
| 3                         | Selecting Types of Cloud Computing | Waiting (about 20 seconds) | Waiting (about 10 seconds) |
| 4                         | Waiting (about 1 second) | Selecting Types of Cloud Computing | Pressing “OK” button |
| 5                         | Choosing an Account | Pressing “OK” button | Waiting (about 3 seconds) |
| 6                         | Waiting (about 1 second) | Waiting (about 30 seconds) | Pressing “Document” button |
| 7                         | Selecting “Direct Scan” button | Checking the completion | Waiting (about 3 seconds) |
| 8                         | Waiting (about 1 second) | | |
| 9                         | Pressing “PDF” button | | |
| 10                        | Waiting (about 1 second) | | |
| 11                        | Confirming setting and | Pressing “OK” button | |
| 12                        | Pressing “OK” button | | |
| 13                        | Waiting (about 1 second) | | |
| 14                        | Pressing “OK” button | | |
| 15                        | Choosing No More Scan | | |
| 16                        | Waiting (about 5 seconds) | | |
| 17                        | Checking the completion | | |

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All the operational processes and overall satisfaction were evaluated for each printer. This exercise helped us understand users’ emotional positive and negative experiences and extract the Kansei evaluation words. The latter are shown in Section 4.1. One result of users’ emotional experiences for the direct scan is illustrated in Figure 2. The vertical axis and horizontal axis indicate the average satisfaction for each operational process respectively. The sample size in this case is 38.

![Figure 2](https://example.com/figure2.png)

**Figure 2.** Users’ emotional ups and downs with regard to the direct scan (38 respondents)

Figure 2 represents the average satisfaction level for the operational process. Printer X is the improvement target printer, and Figure 2 indicates that the average satisfaction level for the operational process from 1 to 3 is less than 4 points in printer X. Moreover, some answers indicate that the overall dissatisfaction is caused by these problematic operational processes. Thus, we determined that we must improve these operational processes.

### 3.2 Understanding the Method to Improve Problematic Operational Processes

#### 3.2.1 Understanding Kansei Evaluation Words for Indefinite-length RTs

In Figure 2, operational processes 1 and 3 represent “flick and tap a button,” which can be improved using Mariko’s (2013) result. Mariko (2013) referred to improvements in the usability of a touch panel. Thus, we should devise ways to improve operational process 2, which is the waiting operational process with an indefinite-length RT. Then, surveys were conducted on RTs of various indefinite lengths in order to collate the Kansei evaluation words for them.

**Samples:** 6 types of waiting animations (10 seconds and 60 seconds)

**Respondents:** 15 (18–24 years old)

**Question:** Describe your impression about each animation

We provide two examples of waiting animations used in our survey (Figure 3).

![Waiting Animations](https://example.com/wa.png)

**Figure 3.** Two examples of waiting animations used in our survey
We asked respondents to indicate whether they viewed each waiting animation as either good or bad, and the reasons for the same. Based on their answers, we selected the Kansei evaluation words for the indefinite-length RTs using the method provided by Munechika (1999). Table 3 presents these results. Notably, the same Kansei evaluation words were provided by the users for the RTs of 10 seconds and 60 seconds.

Table 3. Kansei evaluation words for the indefinite-length RTs

| Hierarchical Levels   | Kansei Evaluation Words                                      |
|-----------------------|---------------------------------------------------------------|
| Single Sense          | Smooth animation                                             |
|                       | Complexity of the animation                                   |
|                       | Speed of animation                                            |
|                       | Size of animation                                             |
|                       | Size of the waiting reason                                    |
|                       | Good position of the waiting reason                           |
|                       | Regularity of animation                                       |
|                       | Novelty of animation                                          |
| Combined Sense        | Breadth of the range to go with eye                           |
|                       | Feel faster                                                   |
|                       | Meaningful animation                                          |
|                       | Eye-catching animation                                        |
|                       | Progressed feeling                                            |
|                       | Understandability of waiting reason                           |
| Psychological Response| Enjoyable feeling                                             |
|                       | Not boring                                                    |
|                       | Comfortable                                                   |
|                       | Safe feeling                                                  |
| Overall Evaluation    | Satisfaction                                                  |

Using these evaluation words, we utilize the semantic differential method and determine the Kansei evaluation structure. Additional information in this regard is provided in Section 3.2.2.

3.2.2 Understanding Kansei Evaluation Structures for 10- and 60-second RTs

To improve user satisfaction regarding indefinite-length RTs, we investigated the Kansei evaluation structure for waiting animations. The length of the RT in this process depends on the communication environment. We need to assess how user dissatisfaction may be reduced for long and short RTs. Thus, we conducted surveys on 10- and 60-second RTs. It should be noted that the samples used in the survey were the same as those in Section 3.2.1.

Samples: 6 types of waiting animations
Set RTs: 10 seconds and 60 seconds
Respondents: 41 respondents (10 seconds), 37 respondents (60 seconds)
Methods: Questionnaire
   Semantic differential method (7-point scale)
Items: Evaluation words
   (19 words, selected in Section 3.2)

Based on these results, we modeled the Kansei evaluation structure to identify possible improvements. This model is based on Munechika (1999) and is graphical in form. Figures 4 and 5 show the Kansei evaluation structures for the 10-second RT and the 60-second RT, respectively.
The numerical values near the lines in Figures 4 and 5 represent partial correlation coefficients. These coefficients help us ascertain the evaluation words that strongly affect users' preferences concerning the wait screen. For example, in Figure 4, we understand that “comfortable” affects the preference regarding the wait screen, and “eye-catching animation” affects “comfortable.” Further, “size of animation” and “speed of animation” affect “eye-catching animation.” Thus, the size and speed of the animation affects preference. Similarly, we identified the factors affecting the preferences for the wait screen. Table 4 shows the results of the factors affecting users’ preferences.

Table 4. Preference factors for the 10- and 60-second RTs

| Single Sense                     | 10 seconds | 60 seconds | Desitron for applying |
|----------------------------------|------------|------------|-----------------------|
| Speed of animation               | +          | +          |                       |
| Size of animation                | +          | +          |                       |
| A large display of waiting reason| +          |            |                       |
| Novelty of animation             | –          | △          | ×                     |
| Smooth animation                 | +          |            |                       |
| Complexity of the animation      |            | +          |                       |
| A good position of waiting reason|            | +          |                       |
In Table 4, “+” or “-” denotes single-sense evaluation words that affect user satisfaction in processes with 10- or 60-second-long RTs. For example, if the speed of animation becomes faster, the evaluation of satisfaction will increase for both the 10- and the 60-second RTs. Indeed, this was confirmed by the Kansei evaluation structure. Moreover, “Δ” was used to depict single-sense evaluation words that refer to trade-offs while evaluating satisfaction. For example, Figure 5 shows that if the waiting animation is altered to the new one, it will become “progressed feeling” and “meaningful.” However, the evaluation for “eye catching” will decrease. Thus, the evaluation of satisfaction, on the whole, will not improve. Therefore, single-sense evaluation words, which convey a good impression for both the 10- and 60-second RTs, are of particular importance with regard to our study. These words are indicated by “O” in the column to the far right. Applying these factors to the design will help increase user satisfaction despite indefinite-length RTs.

4. Assessing Satisfaction for the Entire Operation

4.1 Selecting Kansei Evaluation Words for the Entire Operation

The results of our investigation in Section 3.1 shed light on users’ perceptions about each operational process and the entire operation. Using the method devised by Munechika (1999) and the findings presented in Section 3.1, we selected Kansei evaluation words for the entire process. Table 5 summarizes our results.

| Hierarchical Levels | Kansei Evaluation Words |
|---------------------|-------------------------|
|                     | The number of times users have to wait |
|                     | Position of the long wait |
|                     | Goodness of the operation sensitivity |
|                     | The number of buttons |
|                     | Brightness of button and icon colors |
|                     | Switching motion of the screen |
|                     | Multitude of colors |
|                     | The number of times to press the button |
|                     | Sound when you press the button |
|                     | The size of the shining range users press the button |
|                     | The amount of the character of the operation screen |
|                     | The number of times to flick |
|                     | Progressed feeling |
|                     | Goodness of tempo |
|                     | Not boring |
|                     | Beautiful of the design |
|                     | Understandability of pressing the button |
|                     | Few of your own movement |
|                     | Find Ease of button |
|                     | Less hassle feeling |
|                     | Feeling shorter |
|                     | Smooth feeling |
|                     | Intuitive feeling |
|                     | Comfort feeling |
|                     | Pleasant feeling |
|                     | Secure feeling |
|                     | Cool feeling |
|                     | Pretty feeling |
|                     | Difficulty mistake |
| Overall Evaluation  | Satisfaction |

The evaluation words seen in Table 5 were applied to the semantic differential method and helped us determine the Kansei evaluation structure. Additional information is provided in Section 4.2. Further, we used [DOI : 10.17929/tqs.2.70] Copyright © 2015 Journal of the Japanese Society for Quality Control. All rights reserved.
“Number of times users have to wait” as a specific single-sense Kansei evaluation word in this study. The use of these Kansei evaluation words made it possible for us to assess how a good impression may be created on users throughout the operation.

4.2 Understanding the Kansei Evaluation Structure for the Entire Operation

Using the evaluation words listed in Section 4.1, we attempted to understand the Kansei evaluation structure for the entire process, as outlined below.

![Figure 6. Kansei evaluation structure of the entire operation](image)

Similar to Figures 4 and 5, the numerical values near the lines in Figure 6 represent partial correlation coefficients. Therefore, we ascertained the evaluation words that strongly affect user preference for the entire process using these correlations. For example, we understood that “smooth touch,” “feeling shorter,” and “comfortable” are important user preferences for the entire process. Next, “easy to use buttons,” “goodness of tempo,” and “appealing design” also affect users. “Number of characters,” “The number of times users have to wait,” “operationally sensitive,” “The size of the shining range users press the button,” and “brightness of button and icon colors” are additional user preferences. Thus, we clarified the factors affecting user preferences for the entire process. Combining the results of sections 3.2.2 and 4.2 helped us understand how we may use the functions satisfactorily with regard to indefinite-length RTs.

5. Discussion

In recent years, improvement of user evaluation for the entire operation has become more important than bettering individual functions. Conventionally, following the flow of the operational experience can help us identify problematic operational processes and user impressions for the same. However, if the function contains indefinite RTs, we should not only attempt to improve the problematic operational processes but also user impression of the function. This is because RTs can be divided, and it is unclear whether a long RT earlier or
later in the operational process is preferable. Thus, there is a need to study how user impression may be improved if the function contains an indefinite-length RT.

This study considered eliminating a problematic operational process by identifying the factors affecting user satisfaction with regard to indefinite-length RTs. By understanding the Kansei evaluation structure of the entire operation, we could pinpoint how we may improve user experience with regard to the RT’s position in the function and its frequency. The findings indicate that it is possible to improve user satisfaction throughout the operation even if it contains an indefinite-length RT.

6. Conclusion and Future Research

In this study, we clarified the factors affecting user evaluation of problematic operational processes as well as the entire process. Further study is needed to complete the surveys and review the design value of the sample in detail. Moreover, we need to verify the effectiveness of the proposed method.

References:

Hanyuda, K., (1996), “A Study on an Evaluation Method of Kansei Quality Considering Individual Differences”, Master’s thesis of Waseda University.

Mariko, T. and Munechika, M., (2013), “A Study on Understanding Factors Affecting Usability of Touch Panel”, The 13th ANQ Congress.

Munechika, M. and Miwa, T., (1999), “A Guideline for Selection of Evaluation Words used in Questionnaire of Kansei Quality”, Quality 30(4), 96–108.

Myers, B.A(1985): The importance of percent-done progress indicators for computer-human interfaces, Proceeding. Proc. ACM CHI ’85 Conf. (San Francisco, CA, 14-18 April), 11-17.

Nakanishi, M. and Oyama, F. and Iwanaga, K., (2011): “How Dose Users’ Waiting Time Perception Change Depending on Types of GUI Elements? : Evaluation with Point of Subjective Equality (PSE)”, BULLETIN OF JSSD, 58(1), 25-30, 2011-05-31

Sato, K. and Nakatani, T., (2013), “Multi-layered Scenario Analysis for the Driver’s Satisfaction Evaluation of the Operation Support System”, Digital Practice 4(2), 161–168, 2013-04-15

Tsukuda Satsuki, Yamaoka Toshihiko “Proposed Methods for Extracting and Analyzing User Requirements by Usability Task Analysis”, Bulletin of Japan for the Science of Design 56(6), 37-46, 2010-03-31

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[DOI : 10.17929/tqs.2.70]

Received March 2, 2015
Revised November 30, 2015
Accepted May 11, 2016