



Redefinition of Benefits of Inconvenience

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Abstract. A new design methodology for a human-machine system, which is called *Benefits of Inconvenience (BI)*, has attracted lots of attention, especially from the people who worry about the harmful effects of too convenient products and systems. Nevertheless, the definitions of “*inconvenience*” and “*benefits*” of inconvenience differ not only among the researchers and the general public but also among the researchers. Therefore, the present manuscript clarifies the reasons why the misunderstandings of the above-mentioned definitions occur, and it redefines the BI by separation of effort and benefits into two types; objective ones and subjective ones. Moreover, the present manuscript analyzes some BI examples from the viewpoint of the new BI definition.

Keywords: Benefits of inconvenience ·
Design guidelines for human-machine systems · Redefinition ·
Objective and subjective effort · Objective and subjective benefits ·
Cognitive disuse atrophy

1 Introduction

The previous study [1] named the utilities obtained from inconvenience as “Benefits of Inconvenience (BI¹)”, and also defined a system that provides BI to users as a BI system. We proposed design guidelines for the BI and support tools for designing of the BI system [2, 3]. By using the guidelines and the tools, some BI researchers perform a field-based learning (FBL) or/and a problem-based learning (PBL) under the theme of designing the BI system. At the beginning of FBL/PBL, they explain the definition of the BI with plain expressions in order to promote easy understandings by the participants gathered not only from university students but also the general public. However, the participants’ understandings of the BI are sometimes different from the original definition proposed by the BI researchers. This seems to be due to the fact that the definition of “inconvenience” in the BI is just a little part of conventional meanings commonly used in the Japanese general public.

¹ Please note that the BI is not “Basic Income” in this manuscript.

Furthermore, the differences in the understandings of the BI definition exist not only among the BI researchers and the general public but also among the BI researchers. Hence, this study provides a redefinition of the BI in order to clear up the misunderstandings, especially among the BI researchers.

The present section described the background and purposes of this study. Section 2 explains conventional definitions of inconvenience and the BI in the general public and the past BI researches. Section 3 discusses misunderstandings of the BI, and therefore Sect. 4 proposes the redefinition of the BI. Section 5 shows six different types of the BI definition based on the combinations of the BI elements, and also analyzes the BI examples from the viewpoint of the combinations of the BI elements. Finally, Sect. 6 mentions some concluding remarks and future works.

2 Conventional Definition

2.1 Conventional Meaning of Convenience and Inconvenience

A Cambridge Dictionary [4] explains meanings of “*convenient*” as follows:

- suitable for your purposes and needs and causing the least difficulty. Ex.: *a bike’s a very convenient way of getting around.*
- near or easy to get to or use. Ex.: *a very convenient bus service.*

The meanings of convenient in Japanese dictionary are almost the same as the above definitions. And a meaning of “*convenience*” is described as

- the state of being convenient.

On the other hand, a meaning of “*inconvenient*” is described as

- causing problems or difficulties. Ex.: *It will be very inconvenient for me to have no car.*

And a meaning of “*inconvenience*” is described as

- a state or an example of problems or trouble, often causing a delay or loss of comfort.

Consequently, the word “*inconvenience*” has negative meanings implicitly in general meaning.

2.2 Definitions of Convenience and Inconvenience for Former BI Researches

In the previous BI researches, convenient and inconvenient have been originally defined as follows [1]:

- **Convenient:** Saving labor to attain a specific task.

- **Inconvenient:** Not convenient. To require labor in order to attain a specific task.

The labor² can be classified into two types; physical one and mental one. The physical labor requires physical body movement, and the mental labor requires thinking with consuming mental resources. Comparison of this definition with the above-mentioned conventional definition found that the definition of “*inconvenience*” in the previous BI researches is narrower than that used commonly in our daily life. The definition gap can be thought to be one of the causes to produce misunderstandings of the BI.

2.3 Former Definition of BI

Four Types of Systems. Figure 1 shows that an X-axis represents Inconvenience/Convenience and a Y-axis represents Harms/Benefits. The combination of the two axes yields four types of systems [2]; *Harms of Inconvenience*, *Benefits of Inconvenience*, *Harms of Convenience*, and *Benefits of Convenience*.

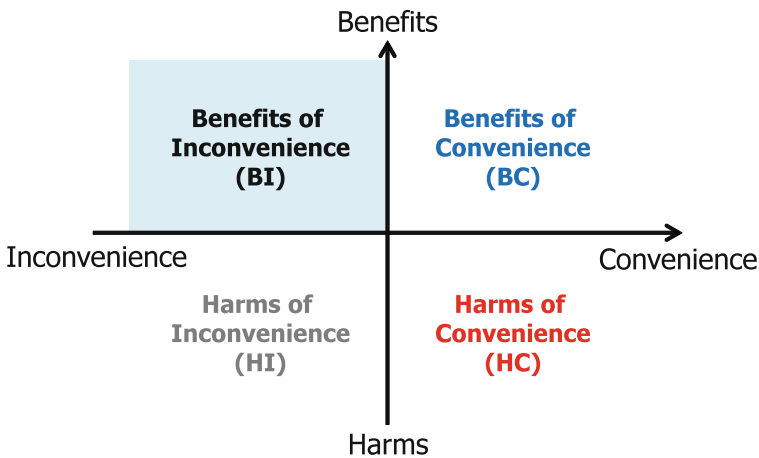


Fig. 1. Former definition of the BI based on two-axes

From the viewpoint of a human-machine system design, the harms of inconvenience (HI) system is obviously considered out of the question and the benefits of convenience (BC) system is the best for users if possible. Here, let us consider the harms of convenience (HC) system. It is widely known that the human being has developed plenty of convenient systems which can reduce user’s labor

² The meanings of “*labor*” or “*inconvenience*” are almost same as “*effort*” in the present manuscript. Hence, a redefinition of the BI in Sect. 4 uses “*effort*”.

and therefore the tasks become easy to be accomplished efficiently. On the other hand, the HC systems have negative aspects such as cognitive disuse atrophy [5,6], as mentioned-below. It means that convenience does not always enrich our lives. Accordingly, in order to solve the problems of the HC, we redesign the HC system by intentional additions of certain kinds of “inconvenience”. The redesigned system is called the BI system in which the users can take more effort to achieve the tasks, and therefore they can obtain benefits.

Two Types of Benefits. Based on the definition of inconvenience as mentioned in Sect.2.2, the BI means the utilities derived from inconvenient. The BI researches mentioned that the benefits, which are equivalent to the utilities, include objective ones and subjective ones. The previous studies [2,3] proposed eight types of “benefit cards” as shown in Fig.2, and they can be separated into the two types of benefits as follows:

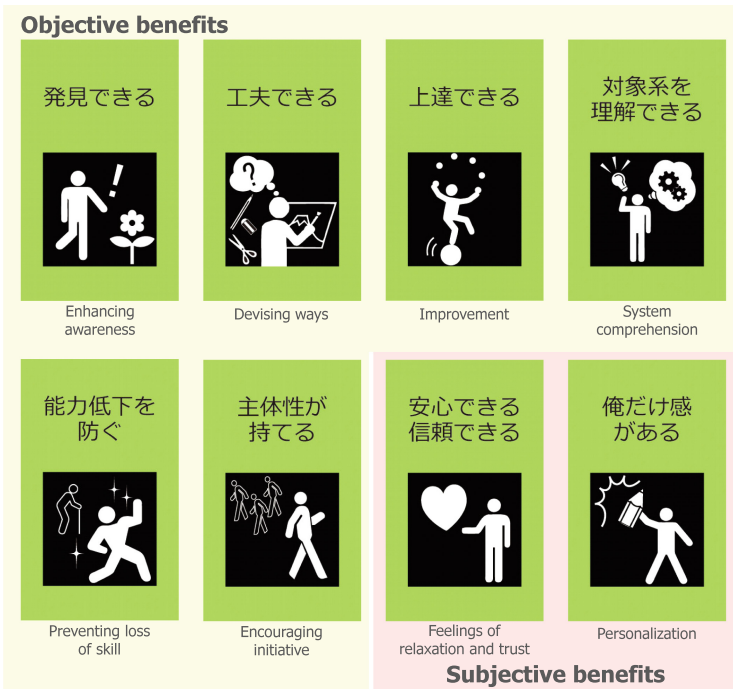


Fig. 2. Eight types of benefit cards (six objective benefit cards and two subjective benefit cards)

Objective benefits: “enhancing awareness”, “devising ways”, “improvement”, “system comprehension”, “preventing loss of skill”, and “encouraging initiative”.

Subjective benefits: “feelings of relaxation and trust”, and “personalization”.

In addition to the two subjective benefits as shown in the benefit cards, three types of subjective benefits such as “self-affirmation”, “motivation”, and “delight” also exist.

Cognitive Disuse Atrophy. The objective benefit “preventing loss of skill” is intimately related to cognitive disuse atrophy [5,6]. As it is generally known, body sites tend to atrophy if they are not used, and some researchers have pointed out that the same phenomena can happen for human cognitive functions. Not to use his/her brain by using the tools is considered convenient in a short term, but it might bring potential risk to decrease the capability of think in the longer term. For example, the people who usually use a car navigation system tend not to memorize routes, and also the people who do not write characters manually because of the usage of a personal computer or a smartphone will become difficult to remember and write characters. The phenomenon will happen especially in the case of Kanji characters.

3 Misunderstandings of BI

Misunderstandings with respect to the BI can be summarized into the following three types: misunderstandings of “inconvenience”, misunderstandings of “benefits” of inconvenience, and ideological misunderstandings.

3.1 Misunderstandings of “Inconvenience”

As mentioned above, the definition of “inconvenience” in the previous BI researches is narrower than that in the general public. The definition in the BI researches means that it takes more effort to achieve tasks, that is, it takes time and labor. Nevertheless, many people tend to consider “inconvenience” just as “unsuitable thing/event for his/her purposes” or “useless thing/event”. The meaning gap might produce the misunderstandings of the BI among the BI researchers and the general public.

3.2 Misunderstandings of “Benefits” of Inconvenience

Not all the utilities of inconvenient systems become “Benefits of Inconvenience”. Some users incorrectly recognize ‘the inconvenience which has no correlation with user effort’ as BI. For example, the benefits which the user obtains because of others’ inconvenience are not BI. The compromise to accept inconvenience where the user must enter passwords for security reason is also not BI.

As shown in Sect. 2.3, there are two types of benefits in the BI; objective benefits and subjective benefits. Nevertheless, in the past BI researches, we have not referred whether one of them should be acquired or both benefits are necessary.

3.3 Ideological Misunderstandings

People who have the ideology to criticize modern civilization sometime borrow the concept of BI in order to justify their ideology. They tend to misunderstand the BI researches as a nostalgic design theory, but it is completely wrong. We think that we should better analyze past events/things which brought BI to users, although the concept of BI is not a nostalgia where people yearn to go back to good old days.

One of the goals in the BI researches is an attempt to recover the lost benefits because of no room for users to make effort, by redesign the system to allow users to lavish labors.

4 Redefinition of BI

4.1 Detailed Definition of BI Based on Five BI Elements

The present section proposes the redefinition of the BI. The right part of Fig. 3 describes a main part to regulate the definition of the BI, and it shows that the present study classifies effort and benefits from the viewpoint of objective or subjective. The right part consists of five elements; objective effort, subjective effort, results of effort (=accomplishment of main task), objective benefits (=accomplishment of sub task, improvement of skill, etc.), and subjective benefits.

The left part of Fig. 3 describes objective and subjective cues which are design factors for the BI system. The users can be encouraged to make objective efforts effectively when the cues are well-designed.

4.2 Process to Obtain BI

Here, let us explain the process where the user obtains the BI by his/her effort on the assumption that he/she has the main task to accomplish.

Step 1: Against the target system, the user moves his/her body sites or uses his/her brain. At that time, if the effort increases compared to the case when the user deals with other systems, it means that it is defined as “inconvenient” relatively.

Step 2: The user accomplishes the main task by his/her effort.

Step 3: The user acquires objective benefits such as “improvement of his/her skill” and “enhancing awareness” other than the accomplishment of the main task. The benefits are just secondary.

Step 4: The user recognizes the fact that he/she took objective effort at Step 2.

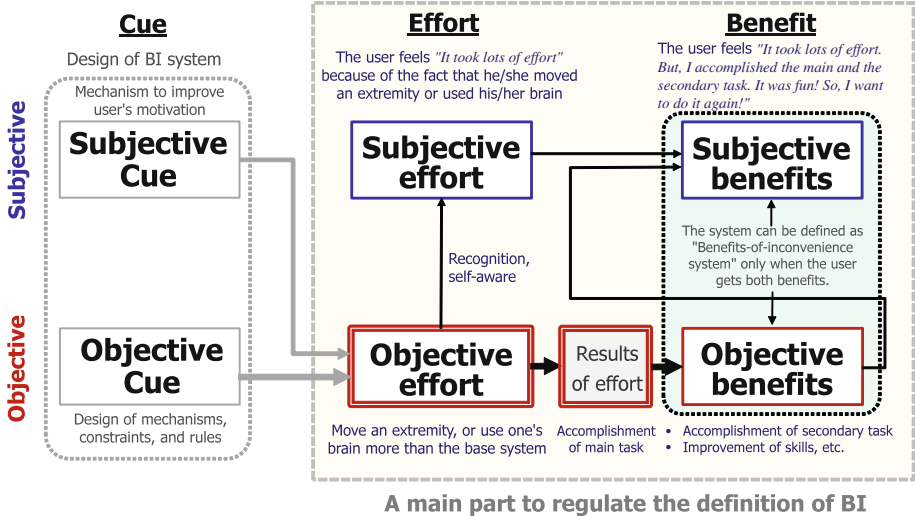


Fig. 3. Redefinition of Benefits of Inconvenience (BI)

Step 5: The user recognizes his/her effort, and then he/she recognizes that he/she acquired the objective benefits secondarily in addition to the accomplishment of the main task. Accordingly, he/she acquires subjective benefits such as “delightful!”, “fun!”, and “want to do/use more!”.

In this process, it is assumed that the user obtains the “Benefits of Inconvenience” only when the user obtains both of the objective benefits at Step 3 and the subjective benefits at Step 5.

5 Analysis of BI Examples

The process described in Sect. 4 is the strictest redefinition of the BI, but some BI researchers advocate that the definition is too narrow. In other words, the BI researchers have to discuss how many of the five elements must be required for the establishment of the BI.

The main part of regulate the definition of the BI consists of five elements; objective effort, subjective effort, results of effort (=accomplishment of the main task), objective benefits (=accomplishment of sub task, improvement of skill, etc.), and subjective benefits.

It is no wonder that the minimum requirement for establishment of the BI is to satisfy the following two elements; the objective effort and the accomplishment of the main task. Consequently, the present section discusses six types of the BI based on the combinations of three BI elements; subjective effort, objective benefits, and subjective benefits. Table 1 describes the six types of BI.

Type I to III meet the requirement of subjective effort, and Type IV to VI do not meet it. The three types of combinations of objective benefits and subjective benefits define Type I to III and Type IV to VI respectively.

Table 1. Combinations of the BI elements

	Effort		Accomplishment of main-task	Benefits	
	Objective	Subjective		Objective	Subjective
Type I: OS-OS	✓	✓	✓	✓	✓
Type II: OS-O	✓	✓	✓	✓	
Type III: OS-S	✓	✓	✓		✓
Type IV: O-OS	✓		✓	✓	✓
Type V: O-O	✓		✓	✓	
Type VI: O-S	✓		✓		✓

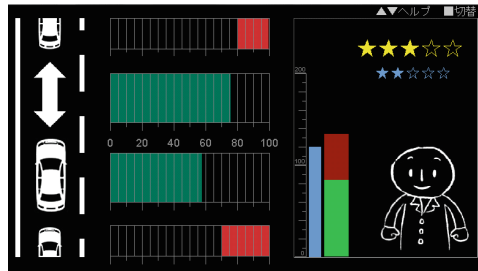
5.1 Type I: OS-OS

Type I includes all of the five constituent elements in the redefinition of the BI, and it is expressed by ‘OS-OS’ which means both efforts and both benefits are required. This means that the Type I is the strictest definition of the BI.

We found that there are lots of BI examples in this Type I. The present subsection introduces two representative examples such as a COGY and an SDES (Fig. 4 (a), (b)).



(a) COGY [7]



(b) SDES (Safe Driving Evaluation System) [8]

Fig. 4. Examples of Type I (OS-OS) BI system

COGY. Figure 4(a) is a wheelchair, called COGY [7]. It is designed specially for the half-paralyzed people who can move left or right leg. This study considers an electric wheelchair or an autonomous wheelchair as the HC (Harms of Convenience) system, against the COGY as the BI system. The user moves the COGY by pedaling with his/her healthy leg, and therefore the disabled leg is moved passively. The pedaling is an objective effort for the user, and the user recognizes that the user took lots of effort. By his/her effort, the user can move by using the COGY. Moreover, the user becomes to move faster according to the proficiency in how to use the COGY. It means that the main task ‘moving’ was accomplished by his/her effort. In addition to the accomplishment of the main task, the disabled leg can be recovered by using the COGY, because the usage of the COGY can be considered as not only physical rehabilitation but also rehabilitation for brain function. It is equivalent to the interpretation that the user secondarily acquires objective benefits which are different from the accomplishment of the main task. Consequently, the user will feel that the moving with the COGY is lots of fun although the pedaling only by the healthy leg is not easy. This is an example of the subjective benefits which the user obtains.

SDES (Safe Driving Evaluation System). Figure 4(b) shows a visual interface of a safe driving evaluation system (SDES) proposed in the previous study [8]. The SDES does not assist in driving operation by controls of vehicle motion. It just provides the scores of the drivers’ safe driving behavior to encourage the drivers to perform safe driving spontaneously. The SDES can be considered as the BI system compared to the automated driving system or the advanced driver-assistance systems such as an adaptive cruise control (ACC) or a lane-keeping assist system (LKAS). When the driver uses the SDES, the main task is to perform safe driving and one of the secondary tasks is to improve his/her driving skill. And, the driver using the SDES might feel that the manual safe driving is enjoyable although it requires more time and effort, compared to the ACC and the LKAS which is considered as the HC system.

Other BI Examples of Type I. Not only the above-mentioned examples, but there are also various BI systems of the Type I. The following examples are parts of them;

- a cellular manufacturing system. (\leftrightarrow a line production system.)
- a mountain climbing by his/her own foot. (\leftrightarrow by using a ropeway gondola, a helicopter.)
- a rehabilitation house for the elderly people called ‘*Yume-no-Mizuumi Mura*’, where there are many types of physical and cognitive barriers and the residents must make their daily plan and perform all aspects of their daily life by themselves. (\leftrightarrow a barrier-free rehabilitation house for the elderly people where care workers make all of the care programs for the residents.)

5.2 Type II: OS-O

Unlike the Type I mentioned above, the Type II does not include subjective benefits. It means that the Type II system does not give the user positive feelings such as delight, fun, and so on but provides just secondary objective benefits.



(a) Degrading navigation system (left: a normal map without degradation which is displayed at the beginning, right: a map where the driven route was whitened.)

歳 歳

(b) Examples of correctly shaped characters (left) and incorrectly shaped characters (right) used in G-IM (Gestalt Imprinting Method) [9]

Fig. 5. Examples of Type-2 (OS-O) BI system

Degrading Navigation System. The driver usually uses a car navigation system when he/she goes to an inexperienced destination. The driver can certainly arrive at the destination by following the navigation guidance, however, in that case, there is a harmful effect that they do not memorize the route. It is thought to be one of the cognitive disuse atrophies and then the conventional car navigation system can be considered the HC system. Therefore, in order to solve this problem, Kitagawa et al. proposed ‘a degrading navigation system’ [10] which has

the following features; (1) it displays a normal map at the beginning, and (2) the system degrades the map by whitening of the driven route inversely proportional to the moving speed (Fig. 5(a)). Field experiments showed that a more detailed cognitive map is formed when using the degrading navigation system compared to when using the conventional navigation system whose map is not degraded. The user of the degrading navigation system can obtain secondary benefits of forming a detailed cognitive map in his/her brain while he/she accomplishes the main task of arriving at the destination. The user will recognize that it takes more time and effort when using the degrading navigation than when he/she follows voice guidance and visual guidance on a navigation screen. In other words, the BI elements other than the subjective benefits are satisfied when using the degrading navigation system.

G-IM (Gestalt Imprinting Method). As a consequence of an increase in opportunity to type the sentences by using a personal computer and a smart-phone, the number of Japanese people and Chinese people who cannot recall Kanji character shapes increases and it becomes one of the social problems. The phenomenon is called ‘*Character amnesia*’, and it is considered one of the cognitive disuse atrophy. In order to solve the problem, Nishimoto et al. [9] developed a novel input method called G-IM (Gestalt Imprinting Method) for a personal computer. The system displays incorrect character shapes (Fig. 5(b)). It forces users to pay close attention to the character shapes because the document cannot be saved when the incorrect characters exist in it. Therefore, the system strengthens retention and recall of the character shapes. The experiments confirmed that the G-IM improves the retention and recall of the character shapes as compared to the conventional input method. Although the G-IM improves the ability to recall and write Kanji characters, the user will not want to use the G-IM more frequently because the confirmation of character shape is thought to be burdensome. It means that the G-IM user will not gain the subjective benefits.

5.3 Type III: OS-S

In the case when using the Type III system, the main task is accomplished by the user’s effort, and the user acquires only the subjective benefits while he/she does not obtain the objective benefits. The followings are representative examples of Type III; (1) hobbies (a TV game, a puzzle, a Tamagotchi, construction of a plastic model, etc.), (2) sports not for the purpose of improving the health, and (3) a system which can give Eureka effect to the user.

5.4 Type IV: O-OS

The main task is accomplished by using the Type IV system and the user acquires the secondary objective benefits, although he/she does not recognize that it took time and effort. A silver film camera is a representative example of the Type IV

system. Here, we assume that a digital camera is defined as the target system because it can save too many photos and the user can confirm the photo just after taking a picture. The user presses the shutter button with considering when and what he/she takes a photo under a constraint of the number of films. The main task is to take photos by using all of the films. The secondary objective benefit is to remain photos in the users' memory, and the subjective benefit is to have an emotional attachment to the photos.

5.5 Type V: O-O

The user accomplishes the main task by his/her effort and obtains the secondary objective benefits. However, he/she does not recognize that it took time and effort and does not obtain the subjective benefits such as delight. The representative Type V systems are experienced skills such as a behavior of a Japanese lady who makes an original duster by manual stitching and as machining of a skilled worker in a small factory. The comparisons are to use a sewing machine or purchase of a ready-made duster and to use NC machine tools.

The skilled person moves his/her hands unconsciously and therefore accomplishes the main task. The secondary objective benefits include making things that cannot be processed by machines, being able to suppress the decline in operating skills of the machine tools and so on.

IDAF-drum. Nishimoto et al. [11] proposed a training system of the extensor muscles in everyday drum practice (Fig. 6), and it is called "iDAF-drum". The "iDAF" means that an acronym of "insignificantly Delayed Auditory Feedback". The user cannot perceive the slight delay. The experimental results showed that the iDAF-drum users raised the drumsticks higher than usual without cognition of the delay and an unusual feeling. After the training using the iDAF-drum, the user could play the drum better than before the training. However, the user does not feel delightful because he/she does not recognize the delayed auditory feedback and the improvement of the drumming skill.

5.6 Type VI: O-S

The user using the Type VI system accomplishes the main task by his/her effort. He/she also obtains the subjective benefits. On the other hand, he/she does not obtain the secondary objective benefits and also does not recognize that he/she took time and effort.

Talking-Ally. Talking-Ally [12,13] is a communication robot which has an utterance generation mechanism by considering the state of the listener and by using mutual interactive adjustments (Fig. 7). The utterance of the Talking-Ally is disfluent so that the listener pay more attention to hear the utterance. Therefore, the interaction between the robot and the user becomes well-organized and

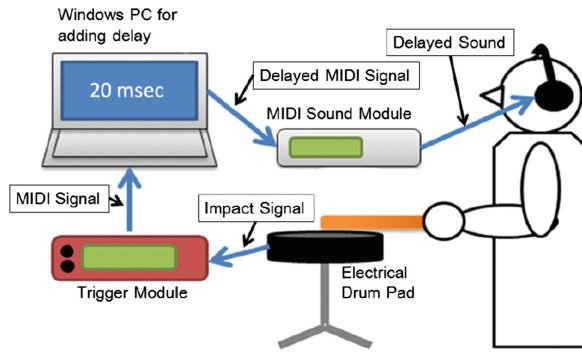


Fig. 6. Example of Type-5 (O-O) BI system (iDAF-drum) [11]

the user feels that the interaction is delightful. The main task is communication between the user and the robot, and the subjective benefits are to have an emotional attachment to the robot and to feel that the interaction is joyful.



Fig. 7. Example of Type-6 (O-S) BI system (Talking-Ally) [12]

6 Conclusions

The present manuscript redefined the benefits of inconvenience (BI) based on the five elements; objective effort, subjective effort, the accomplishment of the main task, objective benefits, and subjective benefits. Next, it described a process that the user obtains the BI when using the BI system. In addition to the redefinition, we defined the six different types of BI by combinations of four elements with respect to effort and benefits.

The BI researchers have to discuss which types can be considered as the BI as for Type II to Type VI, although the Type I is the narrowest definition of the BI. Moreover, in the near future, we try to classify all of the BI examples which we already have into the six types.

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