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Development of a web-based user experience evaluation system for home appliances

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ABSTRACT

Although the home appliance industry is globally growing, there are many cases where the companies do not have user experience (UX) specialists enough to cover all their product lineups, and often the costs are too high for external referrals. The objective of the study is to provide a system to evaluate user experience (UX) for home appliance enterprises. The goal of the proposed system is to provide professional diagnosis and feedback to improve UX with home appliances, based on the usability, affect, and user value principles. A questionnaire composed of 109 items was developed for UX evaluation of home appliances by considering design elements and design principles together. A web-based UX evaluation system was developed by using the questionnaire items, and its usability as well as face validity were evaluated by nine domain experts and nine product designers as acceptable.

Relevance to Industry: The proposed system is expected to provide useful information for design improvement in the product planning and design phases of home appliance enterprises.

1. Introduction

Home appliances are consumer products that help users perform household jobs. The worldwide annual sales of home appliances increased from 580 million units in 2013 to 700 million units in 2017 (Statista, 2017). Companies are struggling to achieve competitive edge in the home appliance market. One of the well-known strategies for achieving competitive edge is to provide superior user experience (UX) by exploiting Information Technology (IT), the Internet of Things (IoT), and Artificial Intelligence (AI). The home appliance industry is being affected by UX design trends that started with the introduction of smart devices such as smart phones, smart tablets, and wearable devices. Many enterprises are trying to consider not only the functionality of products, but also the experiences that they can provide to users.

The concept of UX has become one of the most important factors for enterprises to achieve competitive edge in the market. Large corporations, such as Comcast, Google, and GE, are trying to use several approaches such as constructing online hubs for know-how sharing, or for building task force coaching teams to accelerate organizational innovation and to increase their UX capability (Fabricant, 2013). However, many enterprises still do not know how to systematically improve UX. Although some tools have been developed to evaluate UX, most of them are difficult to apply, and have limitations. First, existing techniques require expert analysts to apply the methods to collect evaluation data from the products of interest, and to draw meaningful inferences from the collected data (Nielsen, 1993, 1994; Jaspers, 2009; Vermeeren et al., 2010). For example, usability-inspection techniques require expertise in usability to customize the existing tools to the target product. An advance would be to provide a tool that helps the enterprises to develop their own evaluation methods and to analyze the result of the UX evaluation systematically. Secondly, existing techniques require the evaluators to considerable devote time and effort to plan, develop, apply, and analyze the UX evaluation iteratively.

The recent trend in industry is a shift from mass production to mass customization. The home appliance enterprises must hasten the product development process and minimize the effort of product development. Because of these requirements, iterative in-depth UX analysis of each product may not be an option, although the iterative design is still necessary to reduce flaws in the design of a product (Gould and Lewis, 1985). Unsystematic UX evaluation may overlook severe design flaws

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that could reduce quality and impose a cost for product redesign. Therefore, we suggest that an efficient UX evaluation tool would benefit developers of home appliances.

The objective of the study is to provide a UX evaluation system that can help enterprises to improve their products throughout the development cycle. The system is intended to include features including development of questionnaires, conduct of surveys, and interpretation of the evaluation result. The usability and validity of the proposed system were evaluated by consulting domain experts and UX designers.

2. UX evaluation

2.1. User experience

UX can be defined as a consideration of all aspects of users' interactions with a product, system or service (Park et al., 2013; Vermeeren et al., 2010). Aspects that influence satisfactory UX vary among application domains and academic fields. However, usability, affect, and user value are considered to be important criteria for UX evaluation (Davis, 1989; Igbaria et al., 1994; Venkatesh, 2000; Heijden, 2003; Hong and Tam, 2006; Hassenzahl and Roto, 2007; Park et al., 2013). Usability covers the effectiveness, efficiency, and satisfaction with the user interface that enables users to achieve specified goals in particular environments (Hix and Hartson, 1993; ISO, 1998; Park et al., 2013). Affect is considered as an image or emotion that is evoked by interaction with a product or service (Park et al., 2013). Many studies reported that value provided by the product is an important factor that influences UX satisfaction. Researchers have used several terms such as 'utility' (Hassenzahl and Roto, 2007), 'usefulness' (Davis, 1989; Igbaria et al., 1994; Venkatesh, 2000; Heijden, 2003; Hong and Tam, 2006), and 'user value' (Park et al., 2013) to describe the value-related aspects of UX. In this paper, these aspects of UX are referred to as 'user value'. A few researchers claim that brand (Rotfeld, 2008; Lin, 2009; Krishnan and Hartline, 2001) and social influence (Hong and Tam, 2006; Kuniavsky, 2007; Koivumäki et al., 2008) are important aspects of UX. However, these factors were excluded from the scope of this study, due to their low relevance to product design.

2.2. UX evaluation techniques

The purpose of UX evaluation is to increase the UX satisfaction of users by identifying flaws during the design and development phase. UX evaluation techniques can be used in the iterative redesign process (Jaspers, 2009; Bastien, 2010). Many techniques have been introduced to evaluate different aspects of UX.

For usability, inspection techniques can be used to identify design flaws (Vermeeren et al., 2010). However, these techniques usually require expert analysts (Nielsen, 1993, 1994; Jaspers, 2009), because extracting meaningful results from qualitative data is difficult for someone without expertise in the UX domain (Vermeeren et al., 2010). Researchers suggested questionnaire methods to evaluate the usability of a specific product in a quantitative manner such as System Usability Scale (SUS) (Brooke, 1996), Questionnaires for User Interaction Satisfaction (QUIS) (Chin et al., 1988) and Post Study System Usability Questionnaire (PSSUQ) (Lewis, 1995).

For affect and emotional appraisals of the users, a few techniques can be applied to assess specific products. Most methods to assess emotional state are based on the Circumplex model (Russell, 1980; Posner et al., 2005) or PAD model (Mehrabian and Russell, 1974; Russell and Mehrabian, 1977) of human emotional states. Representative pictorial assessment tools are Self-Assessment Manikin (SAM) (Bradley and Lang, 1994), Emocard (Desmet et al., 2001), and Product Emotion Measurement Tool (Premo). Another approach is Kansei engineering, which can be used to extract and define the aesthetic characteristics of products as representative ("Kansei") words (Nagamachi, 1995). The Kansei engineering approach assesses psychological feeling of the users toward the product with semantic differentials based on these Kansei words (Nagamachi, 1995, 2002).

Although several existing methods provide questionnaires for UX evaluation, the process of developing questions for specific application domains is still difficult for designers who are not experts in UX. For example, Naeini and Mostowfi (2015) extended QUIS to develop a questionnaire to evaluate user satisfaction, which includes customer experience with a vending machine. To customize QUIS for evaluation of the vending machine, the researchers analyzed the users' experiences by conducting a literature review, in-depth interviews, and principal component analysis. Researchers at Mitsubishi Electric Corporation and Keio University also proposed a method to collect good experiences about vacuum cleaners and quantify those UXs based on interaction modes and UX evaluation criteria (Miyahara et al., 2015). However, the method still requires that the analyst be a UX expert, because further quantification requires that the collected experiences be categorized according to interaction forms and UX types.

3. Design of UX evaluation system

The following three steps were conducted to develop a UX evaluation system: 1) defining target home appliance, 2) developing a UX evaluation method, 3) implementing the UX evaluation system (Fig. 1).

3.1. Definition of target home appliances

The home appliance industry covers a vast expanse of the electronic appliance categories that support housework. Korea Electronics Association (2013) assigned home appliances into eight categories and 84 sub-categories based on the product categories of 21 online shopping malls. For this study, six categories and 27 sub-categories of home appliances were selected as the targets (Table 1). Several electronic devices were excluded from the target home appliance, such as medical device (Blood glucose meter, blood pressure meter, etc.) due to their low relevance to housework.

3.2. Development of UX evaluation method

The objective of this study is to provide a tool that helps the home appliance designers in industry. Questionnaire items and a survey analysis method were proposed to minimize the unnecessary effort of the designers for efficient user survey. The questionnaire items and the

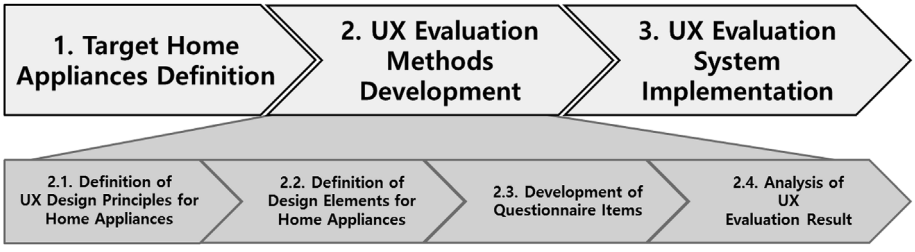

Fig. 1. Design process of the UX evaluation system.