Anticipating Soft Problems with Consumer Electronic Products

How do soft problems interact with
user characteristics and product properties?

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Anticipating Soft Problems with Consumer Electronic Products

How do soft problems interact with
user characteristics and product properties?

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We know that only the technical means of artistic achievement can be taught, not art itself .... but art is always present when a person lives sincerely and healthily.

Walter Gropius

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PART B THE INTERACTION BETWEEN USER CHARACTERISTICS, PRODUCT PROPERTIES AND SOFT PROBLEMS

“The loose power dial! It works but I hate the loose feeling”

Age 43 | Female | Delft, Netherlands

CHAPTER 1 INTRODUCTION

1.1 General introduction

Most product developing professionals know very well the importance of user-centred design, and understand the high stakes involved. If a product fails to embrace users' expectations, generally speaking the project fails. The importance of good user centred design can be the difference between product acceptance and rejection in the marketplace. In order to optimize user centred design a systematic approach to the design process is required. But, to ensure optimum satisfaction of users, several user participatory tests are conducted, most of them at the end of the design process when prototypes are evaluated. These empirical trials allow ingenuous users to tell about what does work as expected and what does not work. Based on the results, an adjustment has been made. In most of cases, naïve users in that phase are not a representative target group whom companies aim at. Nevertheless, a product is regarded as optimized user centred design. Although there are well-designed consumer products from company' s perspective, many still have little user-friendliness. One of the causes could have been the rapid economic growth and, consequently, the time-to-market pressure. Many companies put priority on direct costs and profits. As a consequence they are facing increasing difficulties to obtain an acceptable level of consumer satisfaction and to guarantee the success of new products when released on the market. The same holds for the market of electronic products. Previous research (den Ouden *et al.*, 2005) has demonstrated the increasing number of consumer complaints on new products in consumer electronic products industry. Manufacturers of these products are too much involved in developing new electronic products without identifying increasing customer complaints. At the same time, consumer electronic products service centres are triggered by an increasing number of products returned by users who probably didn' t inform themselves about the operational qualities of the product before buying. It is common in consumer electronic industries that customer complaints are dealt with by call centres in case consumers try to contact the manufacturer directly. These call centres hardly have direct links with the product development departments. Furthermore, the root causes of non-technical customer complaints are unknown based on field feedback data from service centres or from call centres (Petkova, 2003).

A significant portion of the product returns shows complaints for which a technical problem was not found (Brombacher, 2005). It was defined as soft reliability problems, i.e. problems with an " in-specification" product that require adaptive redesign of the product; " out-of-spec" problems are classified as " hard" reliability problems that can be resolved by

replacement or repair of defective parts (Geudens *et al.*, 2005). Analysis of the complaints even indicates that to an increasing degree the cause of the complaint cannot be retrieved (see Figure 1). Den Ouden et al. (2006) found that from 48% of the products that were returned by consumers no technical fault could be detected. These ' no-failure-found' problems, described as ' soft reliability problems' (Brombacher, 2005) have been estimated to be 68% of returned electronic consumer products, and the cost for product returns for 2007 in the US market alone was estimated at $13.8 billion (Steger et al., 2007). Products being returned even though technically speaking they are not broken, probably result in an unexpected gap between actual product use and intended use by the manufacturer. Fighting this unprecedented phenomenon must be challenging for companies, being aware of the fact that they might lose a large amount of profit from product returns. Therefore, improving the usability of products is seen as one of the strategies to deal with (Steger, et al., 2007).

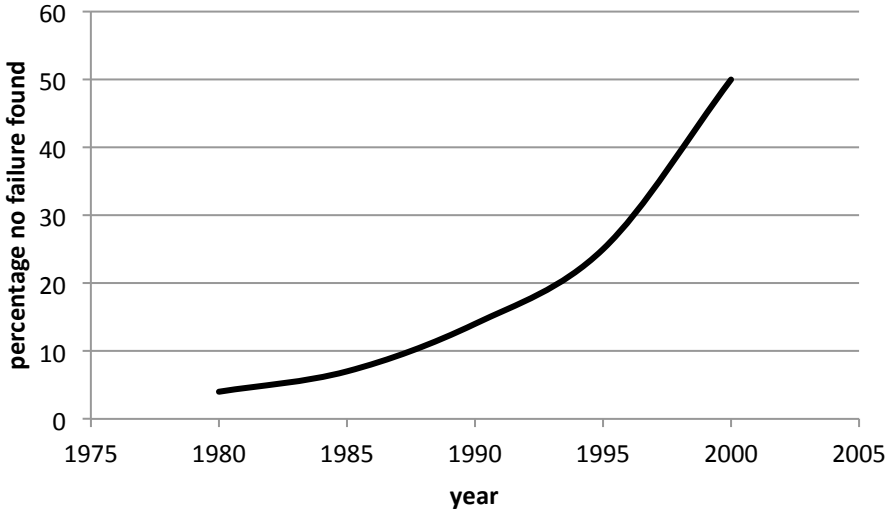

Figure 1 Percentage of No-Failure-Found (NFF) in modern high-volume consumer electronic products (Brombacher, 2002)

Considering the phenomenon mentioned above, insufficient insight into the use of a product will lead to product malfunctioning, user complaints, and market loss, resulting in slowed-down innovation processes and high costs for costumer service and redesign. Hence, companies need to realize how usability is critical to their survival in the global market. Under these circumstances the project ' Design for Usability' (hereafter referred to as DfU project) began. The project forms part of the so-called IOP-IPCR Programme. The governmental IOP programme by the Agentschap NL of the Ministry of Economic Affairs, Agriculture and Innovation, is engaged in the development of generic methods and means that support designers in the manufacturing industry. Several developments have made current methods and support tools obsolete, according to the Ministry. Many of these methods/tools fail in dealing with preliminary and uncertain information. Improvement can

only be achieved by collaboration between industry and knowledge institutes. The focus is on the designing of complex products with a high degree of innovation IPCR (Integral product Creation and Realisation) is part of IOP (Agentschap NL, 2008).

Partners in the DfU project are (1) the knowledge institutes Delft University of Technology, Eindhoven University of Technology and the University of Twente, and (2) the companies Philips, Océ Technologies, Thales Nederland and Indes, the last one a design agency. Funding for the project was coming from the aforementioned governmental programme and from the three companies.

The goal of this research was to reduce use problems with consumer electronic products by developing and offering companies a coherent design methodology to identify needs and expectations of users on the one hand, and product effects on use practices on the other. The integral approach will focus on (i) user problems as a consequence of a mismatch between user and designer expectations about the product (ii) the user characteristics in relation to types of products and use-situations; (iii) product impact on user behaviour; (iv) company processes including product development and after-sales service; and (v) design methodology, expanding the existing approach of scenario-based design to incorporate the interaction between product design, user characteristics, and user behaviour. The design methodology (including methods and techniques), which supports the design of products with a high level of usability, will be developed, implemented and followed by an evaluation (See Figure 2 for the five subprojects). The project team consisted of five PhD students as well as seven researchers of the same universities involved, five of them being the supervisors of the PhD' s.

This dissertation is part of this integral project and focuses on the user and his/her use problems from a usability perspective: an in-depth understanding of the interaction between use problems, user characteristics and product characteristics.

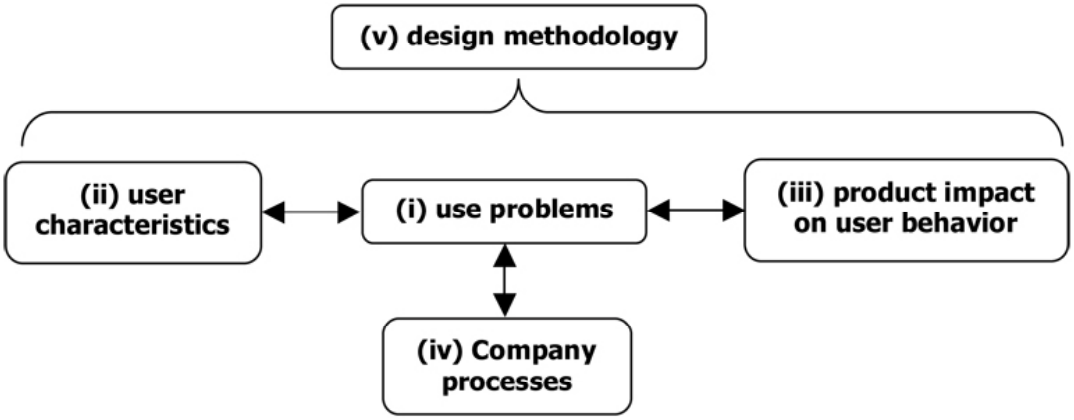

Figure 2 Design for Usability Project Scheme

1.2 Research goals

Within the general goal of the DfU project the specific goal of this subproject is to discover how and what user characteristics are related to use problems and types of products. A user centred approach in product development processes asks for a deeper understanding of user characteristics related to (a) the (unexpected) problems users face when interacting with products and services, (b) the interaction with specific products in specific use-situations, and (c) user wishes and needs regarding product functions, interface and user-friendliness. Based on these, research questions are formulated as follows:

Research question 1

What unexpected problems have users faced in interacting with consumer electronic products and services?

Research question 2

Which product properties are involved in user-product interactions that lead to dissatisfactory usability?

Research question 3

Which user characteristics are involved in user-product interactions that lead to dissatisfactory usability?

Research question 4

In what way do user characteristics and product properties interact when looking at unsuccessful user-product interaction?

Research question 5

What is the optimal way, in terms of methods and techniques, to bring in knowledge of the interaction model into the design process?

These user characteristics encompass sensorial, mental and physical capacities and limitations coupled to differences in age, gender and cultural aspects. The study will lead to an interaction model that, together with the data from use problems will provide a complete picture of the influence of user characteristics on product-user interaction in operating electronic products. As the ultimate aim to support designers the design methodology (including methods and techniques), which supports the design of products with a high level of usability, will be developed, implemented and followed by an evaluation.

1.3 Problem definitions

As individuals, companies, and society are becoming more and more dependent on increasingly complex technical systems, reliability of products and systems has become crucial importance for society (Brombacher, 2005). These changes seem to have a great

influence especially to new product development in the consumer electronic products industry since reliability is directly linked to product quality and reliability problems could directly lead to consumer dissatisfaction. Four major trends in the industry that may affect product quality have been identified: increasingly complex product due to new technology becoming more rapidly available at lower prices, strong pressure on time-to-market, increasingly global economy, and decreasing tolerance of end-users for quality and reliability problems (den Ouden, et al., 2006). See Figure 3.

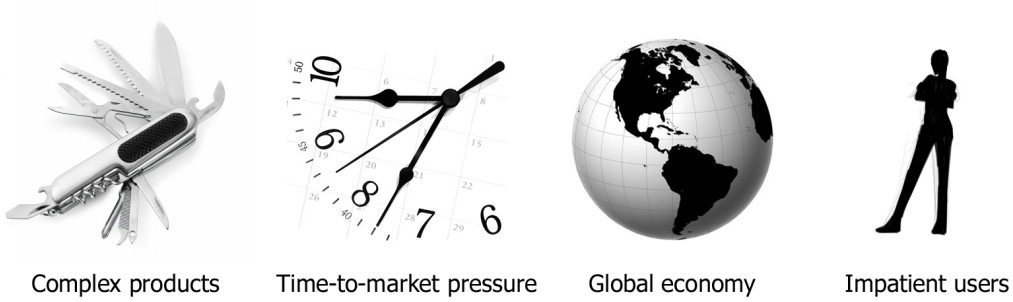

Figure 3 Four trends that may affect product quality

Under these circumstances, the number of product returns has been on the rise (Brombacher, 2005). Despite increasing consumer dissatisfaction with electronic products caused by soft reliability problems, there are only a few studies to identify what soft reliability problems consumers experienced. Den Ouden et al. (2006) investigated new product development projects to figure out the reasons behind the growing number of consumer complaints. However, no soft reliability problems were specified in detail in the study. Lu et al. (2007) proposed an enhanced framework to structurally analyse unexpected user-product interactions involving different moments of use. Their study focuses on the relationship between four-levels of users (technovators, supplemental experts, core experts and novice users) and experience in a three-level use process (install, configure, and first use). However, soft reliability problems were not seriously dealt with in the study. Geudens et al. (2008) suggested a model to avoid soft reliability problems especially for high innovative consumer products. Although five different types of soft reliability problems based on characteristics that determine the rate of adopting products were distinguished, these do not show actual soft reliability problems experienced by users. Because the word ‘ Reliability’ in the definition is not clear, and we are looking for problems with usability, from here on we use the term “ Soft Usability Problems”, shortly “ Soft Problems”.

At present there is also a lack of information on the causes of such soft problems. It is assumed that user characteristics and product properties play an important role in the occurrence of soft problem, which represent user diversity and changing concept of electronic products respectively. Soft problems have been studied mostly in the field of soft reliability engineering. Although they have emphasized the importance of user

characteristics, they have been not systematically taken into account in their studies. For instance, Lu et al. (2007) considered the user classification only from Saaksjarvi (2003) that deals with segmenting user groups based on knowledge and compatibility. Indeed, user characteristics are mainly dealt with in the study of consumer complaining behaviour. However, the focus is on why people complain and not on the reasons for complaining: the product. The studies are even limited to marketing and service recovery. Therefore, this study tries to find out the correlation between user characteristics representing user diversity, product characteristics representing changing concept of electronic products and soft problems experienced by users. By identifying the relationships between the factors, the influence of user characteristics and product characteristics to consumer satisfaction can be better understood. These findings will be used to formulate an interaction model that enables product designers to easily recognize the characteristics of their target user in terms of soft problem and product characteristics. Furthermore, the outcome of this study can be used in the process of product development to define a target group, which will lead to ease-to-use and end up with consumer satisfaction.

1.4 Thesis outline

This thesis is divided into three main parts: (1) usability seen from the perspective of use problems, (2) the interaction between user characteristics, product characteristics and soft problem, and (3) an interaction model, method and its validation (see Figure 4). Part A consists of theoretical findings and an explorative survey related to consumer dissatisfaction in product use. Part B is composed of surveys and experiments dealing with the relationships between user characteristics, product characteristics, and soft problem. Part C consists of an interaction model, a method and its validation with companies. For those who may want to restrict their readings to a particular topic of interest to them, the introduction to each chapter briefly summarizes the major conclusions and discussions of the preceding chapters.

Part A – Usability seen from the perspective of use problems

Chapter 2 employs theoretical background of this study concerning definition of usability, use problems, user characteristics, and product properties, and a conceptual framework for the project is considered. Chapter 3 presents an explorative survey. In the chapter one of the research questions is to be answered: “ What kind of use problems have users experienced in using household electronic products?” These use problems are defined as soft problems and a categorization of soft problems is present. Partly, it also explores what product characteristics are related to soft problems among consumer electronic products people complain about” . The first objective of this project to figure out the causes of soft problems is dealt with and understanding of the causes provide starting points for

revealing the interaction between user characteristics, product properties and soft problems.

Part B – The interaction between user characteristics, product characteristics and soft problems

In Chapter 4 an explorative survey is described with a new categorization of soft problems. The aim of the survey is to (1) see if user characteristics and product properties are related to particular soft problems (the second research question), and (2) filter out insignificant user characteristics for further study. Chapter 5 describes an experiment in which two household electronic products are tested (in-depth study related to the third research question). This experiment concerns the interaction between user characteristics, product properties and soft problems in actual product use. Other aspects such as user expectation and complaining behaviour in relation to soft problems are considered. In Chapter 6, a survey is described in which a much larger sample size is involved than the explorative study in Chapter 4 in order to increase reliability of the study and validate the previous findings (the third research question).

Part C – An interaction model, method and its validation

In Chapter 7, the empirical findings in Chapter 4, 5 and 6 are compared and discussed, which leads to an interaction model, called PIP (Persona-Interaction-Product) model, showing a overall picture of the interaction between user characteristics, product properties and soft problems. This chapter answers the last research question, “How do the interactions between user characteristics, product properties, and use problems contribute to the product development process?” A framework of an interactive tool and a workshop as a method based the model are created and validation of the workshop with companies is described.

Finally, Chapter 8 presents answers to the research questions and main conclusions of this research. A final discussion of the research project and the implications of the research described in the previous chapters are considered.

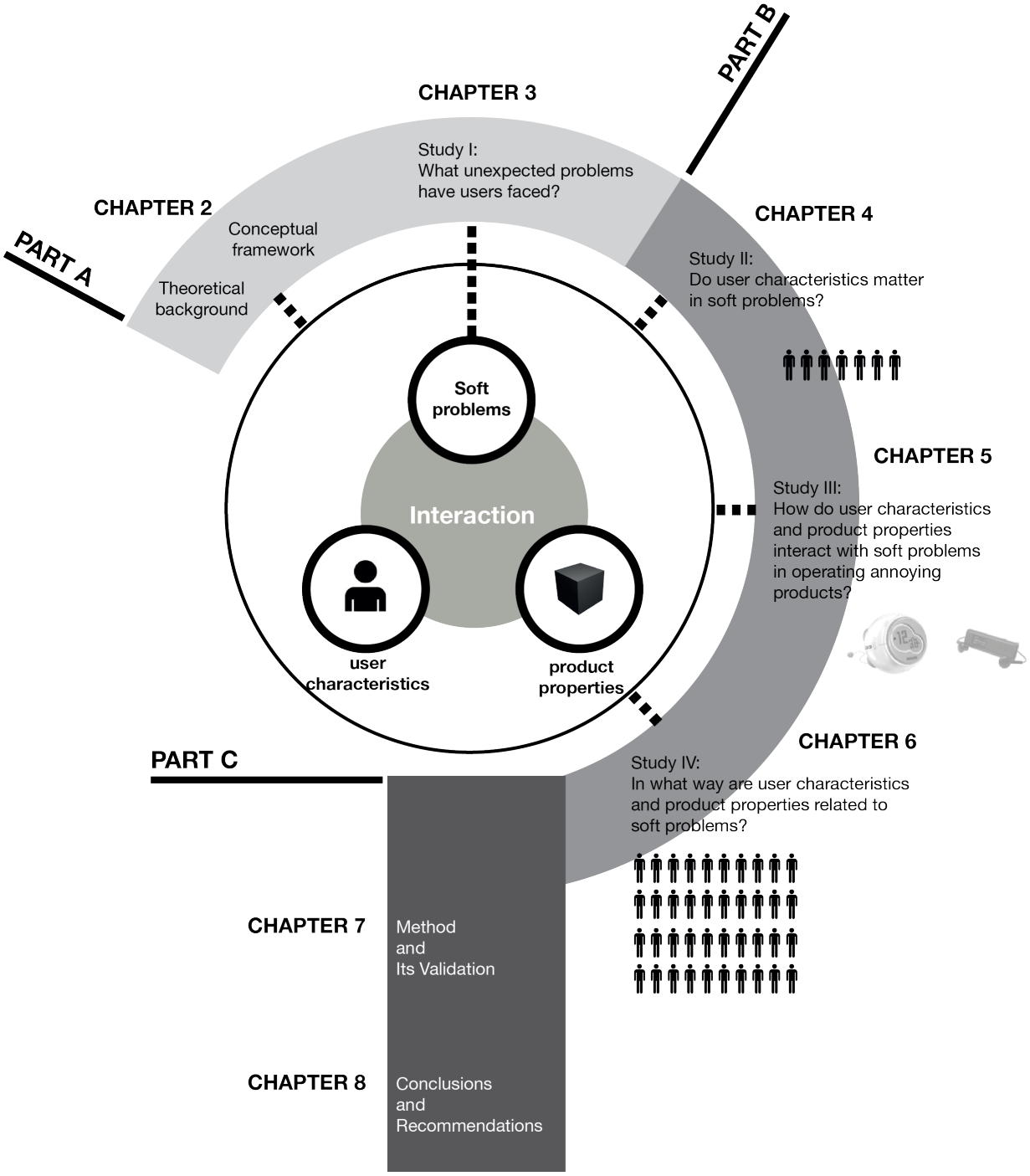

Figure 4 Visualization of the thesis outline

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PART A

USABILITY SEEN FROM
THE PERSPECTIVE
OF USE PROBLEMS

ABSTRACT

This chapter describes the theoretical background of this study concerning definition of usability, use problems, user characteristics, product properties and situations in human-product interaction. Finally based on the theoretical background a conceptual framework for the project is constructed and illustrated.

CHAPTER 2 THEORETICAL BACKGROUNDS

Product design has been increasingly becoming a determinant of consumer as the technology gaps between companies become smaller and they produce similar products with respect to functions, quality, and costs. User diversity and changing product characteristics were blamed for increasing ' no failure found' problems, as was stated in the previous chapter. These NFF problems presumably result from a discrepancy between intended usability by designers and actual experienced usability by users. Users' complaints about the use of their electronic products are the outcome of the interaction between user and product characteristics as well as – sometimes - with context features. The usability of a car' s operation features will depend on the quality and structure of these features, but also differ for a novice compared to an experienced driver, and for a stressful versus relaxed situation. It is worthwhile to study how these three factors are related to usability of consumer electronic products. Before going deeper into those aspects, there is a need for first defining usability to see if those NFF problems have to do with usability. In practice, a new consumer electronic product is developed either for a particular user group or for all. This depends on how product development teams position their new products in the market at the very first stage. In case an electronic product is developed for a specific user group, knowledge about the characteristics and behaviour of that group is critical. This understanding can be acquired by identifying the relationship between user characteristics and the degree in which a product or product features are experienced as user-friendly or not. However, in case of an undefined user group, specific usability issues are difficult to observe and too costly as it would be recommendable to test a representative sample of people.

By identifying the interaction between product characteristics and usability, taking the context into account, a product can be developed in a way to decrease usability problems. To understand the characteristics of complainers and draw a complete picture of user-product interaction in usability problems, it is useful to figure out how user-related characteristics influence their complaining behaviour. Therefore, in this chapter the goal is to define usability in this research context, explore user-product interaction in usability problems and complaining behaviour. This chapter will end up with a conceptual framework for the study that presents the roadmap to set up this study.

2.1 Usability

In this paragraph the concept of usability will be addressed and the key issues that are dealt with in the various usability definitions in literature. Finally, based on these discussions usability in this thesis will be defined as we use it in this thesis.

2.1.1 Defining usability

As electronic products evolve along with technology development, they come closer and closer to our daily life. People, who watched a football game on TV in the living room, are watching it on the move with their mobile phones or laptops. And at the same time traditional electronic products are still in use on a daily basis such as a vacuum cleaner, a shaver, a hairdryer, a watch, and so on. But even these products will sooner or later be replaced by more advanced systems in which technology plays a major role. These changes in the interaction between user and product are meant to lead to an ' easier' life and thus to pleasant use experiences. However, daily practice shows that they could produce unpleasant use experience too as electronic products are getting complex. Under this circumstance, usability is more and more receiving attention. If so, what is usability? To answer this question, the existing concepts of usability are reviewed. Four models of usability were chosen, which are widely accepted by academia as well as by industry: i.e. those of Shackel (1986), Nielsen (1993), Eason (1984) and Norman (2004).

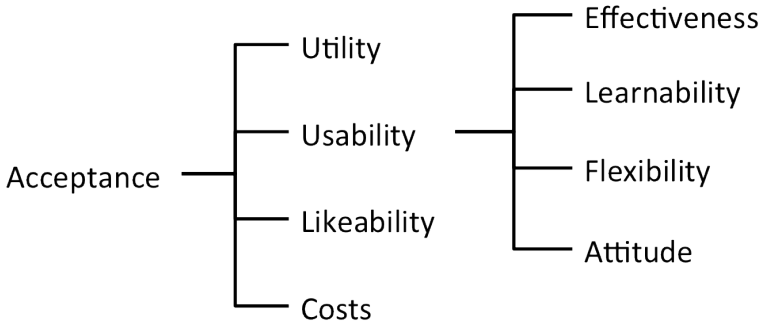

Figure 5 Shackel's Model of Usability (1986)

Shackel' s Model of Usability consists of four dimensions: effectiveness, learnability, flexibility (adaptation to variation in tasks and environments) and attitude (personal traits) (Shackel, 1986) (Figure 5). He emphasizes that each of these dimensions depends on the context of use in which specific users interact with a specific product to achieve a specific goal (task) in a specified environment. This means, the extent to which a product is usable is determined by the interaction between user, product, task and environment.

In Nielsen' s model (1993), usability is composed of five dimensions: easy to learn, efficient to use, easy to remember, few errors, and participant pleasing. These dimensions look similar to those of Shackel' s model: i.e. ' easy to learn' and ' easy to remember' are related to learnability, ' efficient to use' and ' few errors' are related to ' effectiveness' ,

and ‘ participant pleasing’ to attitude (Figure 6). However, his model does not include flexibility shown in Shackel’ s model.

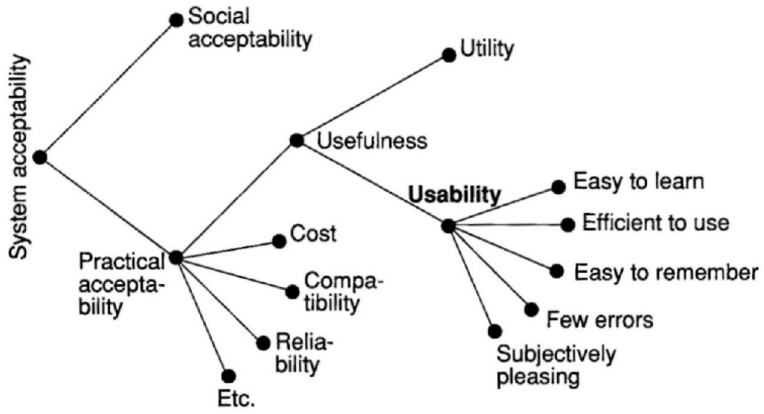

Figure 6 Nielsen's model (1993)

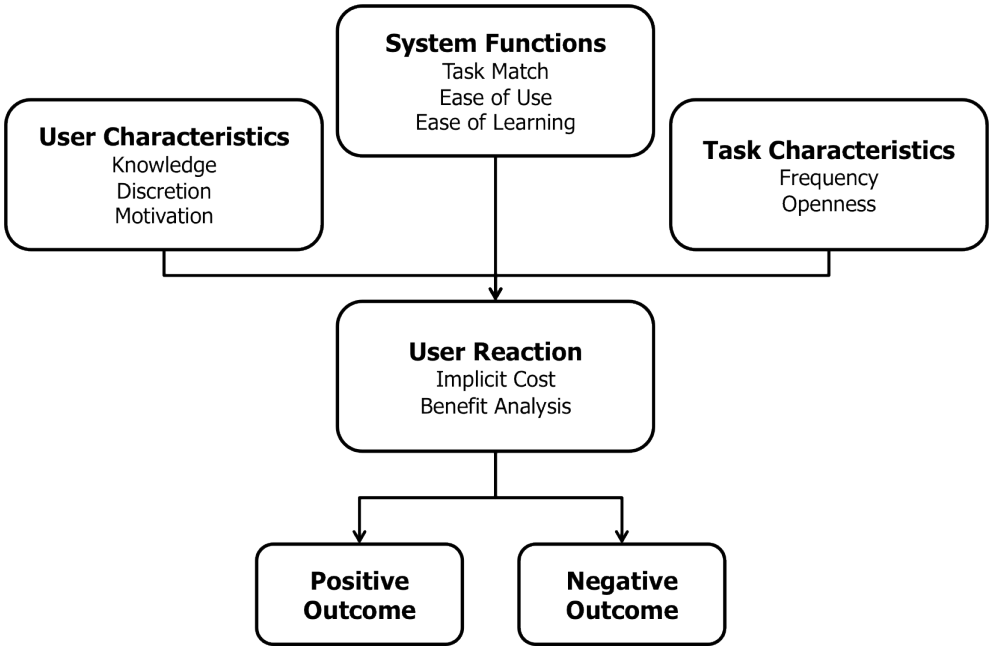

Figure 7 Eason's model (1984)

Eason (1984) defines the usability of a system as ease of learning, ease of use, and task match (Figure 7). Furthermore, he emphasizes that usability is determined by task characteristics (e.g. frequency) and user characteristics (e.g. knowledge). Unlike the previous models, he takes user and task characteristics into account, providing detailed input factors and clear outputs on usability.

Finally, Norman (2004) in his studies on emotion presented three levels of how people

process information from the environment and react on it: visceral level, behavioural level, and reflective level. Each level is related to a different style of design. The visceral level is automatic and prewired by making quick judgments based on whether it is good or bad, and safe or dangerous. According to Norman, this is the start of affective processing. The behavioural level contains brain processes that control everyday behaviour. The reflective level contains the contemplative part of the brain. See Figure 8. We can apply his processing levels on how everyday products are experienced. The usability of a product belongs mainly to the behavioural level where performance, function, and understandability are related, while the visceral level interprets form, colour, touch and sound. The reflective level refers here to the meaning and message expressed by the product, self-image, and brand. So, the three levels are entangled and they interact with each other. Therefore, usability of a product cannot be separated from both the visceral and the reflective level. The environmental factors and user characteristics, however, are not seriously taken into consideration in his model.

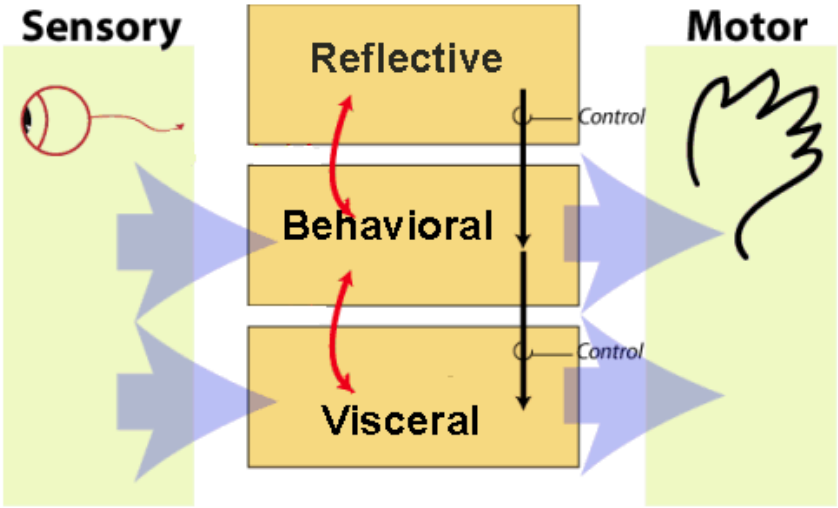

Figure 8 Norman's three levels of processing (2004)

Other authors have added other dimensions of usability. According to Kurosu and Kashimura (1995) there are apparent usability and inherent usability. Apparent usability literally refers to the usability (ease to use) recognized by looking at a product, while Inherent usability is an indicator for the usability experienced while using a product. They measured how participants experience aesthetic and functional aspects of several Automatic Teller Machines (ATMs) in an experiment. It turned out that there was a close relationship between beauty and apparent usability. Moreover, they found out that apparent usability was higher correlated with apparent beauty than with inherent usability. However, the way they measured inherent usability is doubtful since the participants actually did not use the ATMs: inherent usability was measured based on determinants that interface designers thought influence inherent usability without taking other studies into account.

Tractinsky (1997) replicated the experiment of Kurosu and Kashimura to prove the correlations between interface aesthetics and usability involving cultural difference between Japan and Israel. Although no cultural difference between two countries was found, they found out that there was a very high correlation between the interface aesthetics and perceived usability of the machines, which is one of the basic findings by Kurosu and Kashimura. They drew a conclusion that aesthetics could influence system acceptability considering that aesthetics are closely associated with apparent usability. Besides postulating that objective measures of usability may not be enough to predict system acceptability, they emphasized a more holistic approach to get a better understanding of user experience.

Tractinsky et al. (2000) conducted another experiment elaborately dealing with these concepts. With working ATM designs run by a computer simulation, the participants were asked about their perceptions of the interface design both before and after they used the machine. They found out that there were high correlations between the perceived interface aesthetics and its perceived ease to use before and after the participants used the system. The perceived aesthetics of the interface before use influenced the perceptions of both aesthetics and usability after use. However, the actual usability experience was not influential at all. They concluded that the aesthetic aspects play an important role not only in usability but also in other design dimensions.

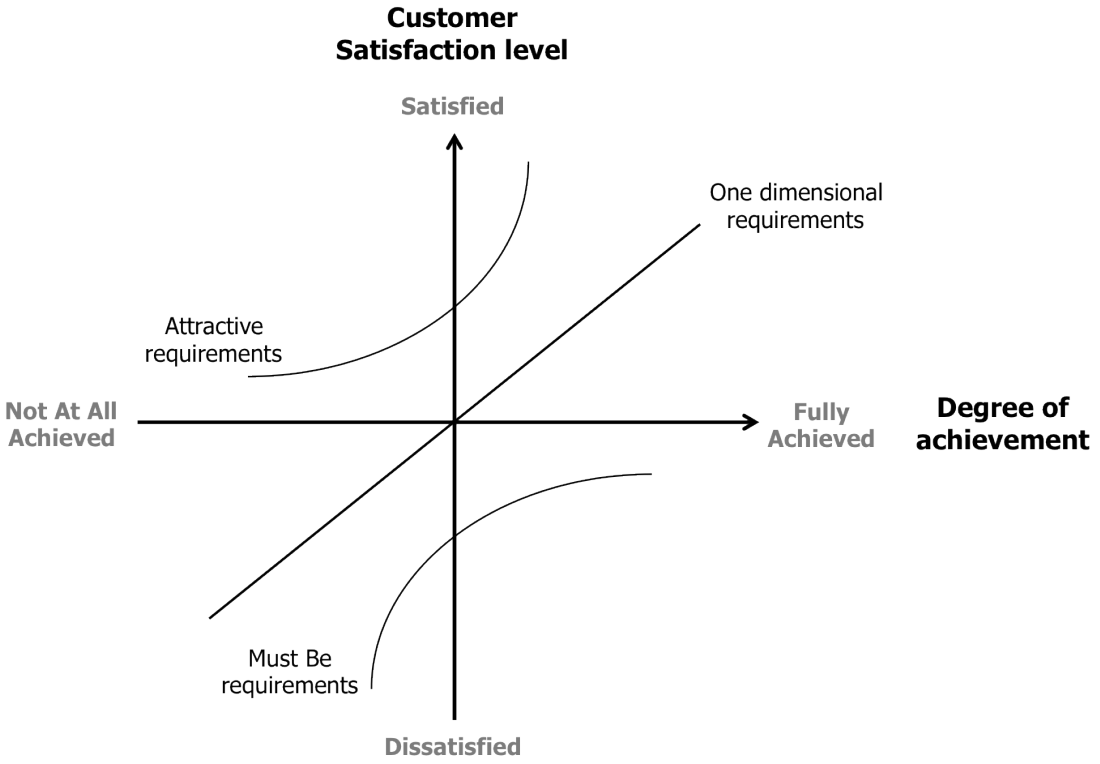

Figure 9 Kano's quality model (Matzler, 1998)

According to Jokela (2004), usability consists of three categories: must-have usability, more-is-better usability, and attractive usability referring to Kano' s quality model (Figure 9) in which different categories of product qualities are identified. Must-have usability literally represents the quality that customers expect from a product. More-is-better usability refers to improvements in the existing usability features of the product. Lastly, attractive usability refers to greatly easier to use with different ways to achieve the goals of the users. The absence of must-have usability will lead to customer dissatisfaction but meeting the must-have usability is not enough for attaining customer satisfaction. He argued that attractive usability is required in addition to these other factors to achieve dramatic impact on the satisfaction of customers. However, more-is-better and attractive factors turn into must-have qualities over the course of time. He concludes that continuous usability improvements could have a positive impact on customer satisfaction. Negative must-have usability directly leads to consumer dissatisfaction while increased consumer satisfaction can be achieved through more-is-better and attractive usability.

In sum, the models all agree that usability of a product or system is influenced by the characteristics of its user and the task. Three models also have ease-of-learning and ease-of-use in common. But there are also differences. Nielsen regards usability as an element of larger system, whereas Eason considers usability as the outcome of the interaction between several variables. In that way there is no single definition of usability. However, the concepts in these two models were created in the context of software engineering and its user interface. Since our study deals with consumer electronic products which consist of a physical part as well as software-based interface part, it is necessary to review what more is known about usability in the context these physical products.

2.1.2 Usability in product design

In the previous section usability concepts were reviewed whose roots are mainly from software engineering. This section reviews how usability is defined in the field of product design since this project deals with physical consumer electronic products. In the first publications about usability the concept was almost exclusively related to ' ease of use' , which could be objectively measured. However, recently its definition became as broad as including satisfaction, feelings about and image of product, which are difficult to be quantitatively measured. For instance, Han et al. (2000) defines usability as both objective performance and subjective image and impression. Their definition encompasses the subjectivity of users, emphasizing that subjective feelings resulting from poor or bad design are closely linked to the performance problems. They underlined that subjective feelings should be considered as equally important as the performance aspect. In this way the usability concept was expanded changing from quality of use to quality of experience (McNamara & Kirakowski, 2005). According to them when evaluating a product, subjective aspects of technology usage such as engagement, pleasure, presence, and fun are receiving more attention. Logan (1994) supports their observation dividing measurements

of usability into two levels such as behavioural usability, which refers to the ability to complete some goal-directed task, and emotional usability, which refers to the degree to which a product is desirable. Jordan (2002) confirms these concepts as well by saying that usability is inherently limited by placing too much emphasis on cognitive issues. He suggested a three-level hierarchy of consumer goods based on Maslow' s hierarchy of needs. His model maintains that the pleasure-based approach to design provides a holistic view of the user associated with subjective satisfaction to use. Considering these arguments, it becomes evident that subjective aspects in the evaluation of consumer products are increasingly catching the attention of both academia and industry.

2.1.3 Definition of usability in this thesis

Originally, the concept of product usability was concerned with performance and effectiveness. Since then, it has been encompassing experience defined by a diversity of users, of tasks which users aim at and of situations where a product is experienced. User experience varies accordingly. This is supported by Leventhal & Barnes (2007). They focused attention on the changing context such as diversity in users, rapidly changing environments, and multiple applications in products and services. Environments surrounding users and products are changing fast. For instance, people have become more sensitive to fashion and trend. All information is easily accessible as the Internet becomes increasingly popular. As an example, telephones are being replaced by mobile phones. More diverse applications are available compared to the past when the number of applications was often limited to a single task. Some activities users do today can be done in many different ways with their electronic products. For instance, they can go shopping online, can listen to music, and watch videos on the move with a digital device. These changes are involved in the quality of user experience. Therefore, it would not be relevant to stick to traditional approaches to usability anymore, taking these changes today into account in which users, tasks, and environments in which a product is used are emphasized more than its performance. The ISO organization provides the best-integrated summary of the models and changes on the definition of usability today: " Usability of a product is the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in specific situations" (ISO 1998). In addition to that, it is obvious that quality of use is not all about usability anymore. Quality of experience is emphasized in the recent concept of usability. Although these are two different things, it is unnecessary to separate the latter from the concept of usability, but rather what Jordan suggested, to see it as another level of usability such as pleasure.

In our study usability is defined, from a macro perspective, as the sum of both quality of use and quality of experience in this study. From a micro perspective, the definition can be rephrased again for a scientific research, pinpointing user, situations, and products: the term usability is defined as effectiveness, efficiency, and satisfaction in terms of the interaction between users characteristics, situational factors, and product properties.

Situational factors are not deeply taken into account in the study. The main focus is on the interaction between user characteristics and product properties (see figure 10).

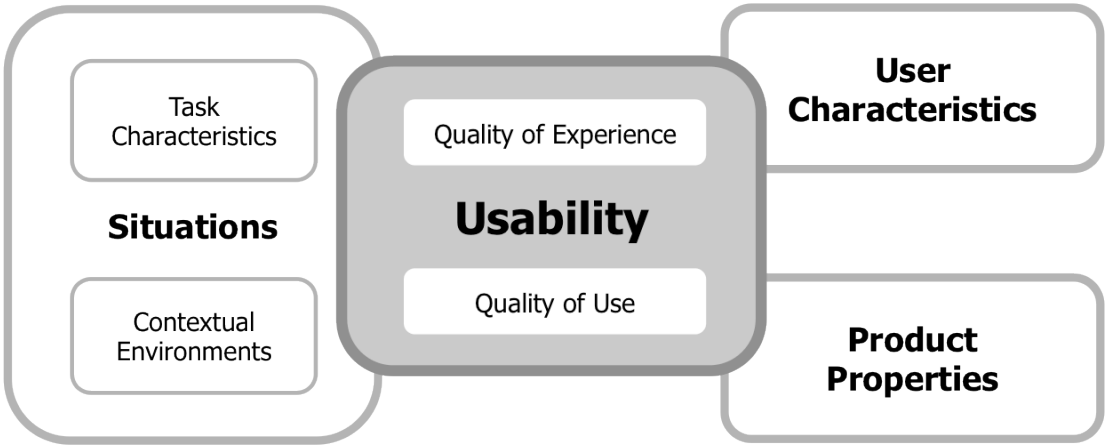

Figure 10 The usability model for this project

2.2 Usability and consumer (dis)satisfaction

In the previous section, the concepts of usability were reviewed and a working definition of usability was defined in the study. In this section we analyse how usability plays a role in consumer satisfaction and dissatisfaction, a factor which is seen here as key in understanding user problems. Consumer dissatisfaction in electronic products results from the gap between intended use experience and actual use experience, as literature shows. This might lead to market failure of the product, which is a direct threat to the company. In order to make it more concrete the literature review will be supplemented with some examples.

2.2.1 Effects of usability in consumer (dis)satisfaction

Only technical excellence of products is not enough to satisfy consumers as these days most electronic products have been absorbing the technological progresses resulting in larger complexity in terms of its characteristics and functionality (De Melo & Gontijo, 2000). Accordingly, products with technical excellence should be ease-to-use, and fit in the context of use to avoid loss of business for the manufacturer. Under these circumstances, product usability is now recognized as a critical dimension of product quality more than ever before (Ram & Jung, 1991; Babbar et al., 2002). Recognizing the importance of product usability, some researchers (Ram & Jung, 1991; Khalid, 2006) studied the relationship between product usage and dissatisfaction, and found out that product usability affects consumer satisfaction as is manifest in their complaining behaviour. These complaints vary depending on the phase of the purchasing process s/he is in. As soon as they start to interact with products usability matters. And next, people will meet usability problems in the phase of extended use after the out-of-the-box phase, when the product

doesn' t meet their expectations (den Ouden, et al., 2006). For instance, consumers are likely to be attracted by the number of features when buying or customizing a product for their needs. Once consumers have actually worked with a product, however, usability starts to matter to them (Rust et al.2006).

As a conclusion, usability certainly gives influence on consumer (dis)satisfaction but usability experience is mainly visible not in purchasing situations but in extended use after the out-of-the-box phase.

2.2.2 Usability problems

In previous sections, it was addressed that usability experience is measured by both objective aspects, such as performance, effectiveness and efficiency, as well as subjective aspects, such as satisfaction. Although in the consumer electronic product market objectively measured performance aspects were long seen as the most critical factors in evaluating user experience, nowadays the importance of this factor drops because electronic products mostly perform well according to their technical specifications. Therefore, subjective aspects are being dealt with more and more seriously in user evaluations. One of the few studies on product reliability supports this argument. According to den Ouden (2006), companies have faced an increasing number of product returns in the consumer electronic market while these products did not have any technical problems. Moreover, the reasons of product return could not always be identified because of its subjective character. In Han' s study (2001) for instance 48 detailed usability dimensions were observed to explain problems with consumer electronic products. These dimensions range from simplicity, consistency and controllability (performance dimension) to shape, elegance and comfort (image/impression dimension). According to the results, all the dimensions have the possibility to become usability problems to consumers because of subjective feelings. In their follow-up study, Yun et al. (2003) evaluated the design of 50 different mobile telephones in terms of luxuriousness, simplicity, attractiveness, colourfulness, texture, delicacy, harmoniousness, salience, and rigidity, focusing on subjective image and impression characteristics in usability. They found out that such design variables were perceived as important for user satisfaction in product usability. Babber et al. (2002) mapped categories of product usability aiming at helping product development managers to design products that better meet the needs of their customers. The categories consist of insufficient information for use, incompatibility, missing and dysfunctional features, needs to be constantly reset, insufficient control, lack of durability, and difficulty to access. Recently, usability issues have been underlined in the HCI field as Internet is becoming increasingly popular with its users being very diverse. For instance, Janda et al. (2002) identified five dimensions important to consumers in their usability assessment of the quality of Internet retailers, which are: performance, access, security, sensation, and information. Kim et al. (1999) identified that style, character and image on screen, browsing and navigating style, screen layout, and ease of learning as usability

features in a web design. Sutcliffe et al. (2000) also indicated many causes of usability problems in the study of a HCI usability evaluation method, which were: user task error, task compatibility error, hidden/missing functionality, cue/prompt/metaphor error, hidden effect-mode error, motor-action error, user error, absent/inadequate feedback, and manipulation precision error. All these variables and dimensions would involve usability problems to consumers and some problems with operating the Web are applicable to 3D products as well. Overall can be concluded that a majority of the usability issues can be considered as a subjectively experienced phenomenon. Therefore, usability problems today are not because of technical problems but rather because of subjective dissatisfaction among diverse users with diverse preferences. Whether these usability dimensions are problematic or not depends on who the user is and what type of product she or he uses. In the next sections, these characteristics of users and products are examined.

2.3 User characteristics in human-product interaction

This section describes the role of user characteristics in human-product interaction. For this, a literature study was conducted focusing on the fields of product development, product design, ergonomics, product development, marketing, and consumer behaviour. This investigation led to a review about which similarities and differences exist between people related to usability problems. Next, we will have a look into how and which user characteristics are related with usability problems, such as cognition, preferences, product use, and complaining behaviour.

2.3.1 User commonalities

There are several ways to describe human beings in relation to usability. One can take the view of their physicality to improve human product interaction, as is mainly the case in the field of physical ergonomics. The aspects in this field consist of biomechanical, physiological and anthropometric data. With most of the current electronic products these physical aspects are only part of the question how to adapt a product to human beings. The interaction with such products rather asks for mental abilities: people have to understand the information in the manual, to understand and learn how to operate a product, to store it in memory for a next use, to insert data in the product, etcetera. In that interaction input and output of information goes through all the senses to our memory functions. As many electronic products become more and more like black boxes, the learnability and understandability ask for more cognitive load; particularly so when the product is unfamiliar to the user. In order to understand what is going on in the human mind when interacting with a product we will describe several important aspects related to information processing, such as sensory perception, human memory, mental representation, user fixation, and so on. But first, we start with a review of literature on physical commonalities.

Physical aspects

Physical ergonomic principles in the literature deal with common aspects of humans. These commonalities cover about 95 per cent of the population because we have more similarities than differences in terms of physical characteristics. However, it is hard to apply them to the other 5 per cent of the users: for instance, exceptionally short or tall, excessively overweight, very old, and very young, or physically impaired. Customized ergonomic measures are required for those special groups of people. Except for the extreme cases, there are many physical ergonomic principles ranging from posture, carrying to operating equipment, which are generally applicable. Anthropometric, physiological and biomechanical aspects can be considered significant to address the use of consumer electronic products. They focus on how to reduce stress on muscles and joints, and ultimately aim to reach physical comfort in using a system or a product (Dul & Weerdmeester, 2001). Our muscles and joints are involved in taking postures, accomplishing movements and applying forces. Physical discomfort and fatigue result from local mechanical stress, to which poor posture and movement can lead. The best ways to reduce stress are simply speaking to have proper posture and movement. Dul and Weerdmeester (2001) suggested many ways to avoid discomfort and fatigue from biomechanical, physiology, and anthropometry perspectives. In biomechanics, some of the principles seem interesting in using consumer electronic products, considering they are increasingly close to our everyday life. For instance, prolonged bending over for long periods should be avoided, sudden movements and forces produce peak stresses, any continuous muscular effort is limited, and more frequent short breaks are better than a single long one. In physiology, the energy demands on the heart and lungs are discussed, which are caused by muscular effort during movement. They claim that light activities do not necessarily ask for breaks such as typing, assembling small materials, and operating devices. This is different for heavy tasks. Although using electronic products belongs to relatively light activities, breaks are necessary in case of long time use.

In anthropometry, physical dimensions of human body such as the size and propositions are concerned. According to the principles of anthropometry, body dimensions of the population are diverse, and thus designers have to bear in mind differences in body dimensions of the target users. Especially in portable electronic products operating buttons is a common way of interaction (Figure 11), and thus are motoric skills and the size and strength of hand and fingers critical which have to be taken into account. Considering globalization and internationalization of the consumer electronic market, with different anthropometrics in different cultures this aspect is getting more critical.

Cognitive aspects

Everyday we are using a large number of consumer products. The usage of our everyday consumer products is not always successful. Ideally, a product should be intuitively operated if the designer of the product successfully took the use of the product into

account. However, the designer' s insights on which this could be based are insufficient, which have to do with cognitive aspects of users. In the following section the different aspects of cognition in product use will shortly be addressed.

Figure 11 An example picture of operating buttons of a mobile phone

Sensory perception

The process of perception begins with an object in our real world. Users first perceive the information of a system or a product through their senses such as vision, hearing, olfactory, touch, and taste. The information is transformed into neural activity. Users obtain understanding of the information by organizing and interpreting the sensory information. At this stage, sensory perception influences people' s experience. Experience in return effects the interpretation of the information and people can learn to make finer perceptual distinctions. For example, a particular classical music appreciation can be explained by the influence of experience. While all our senses can be used as receptors of information, here we focus on visual, audio and haptic perceptions because they play an important role in the field of product design. Perception of information is best achieved through our vision, the eyes, which make visual perception the most important source of information. Over the past few years many theories have been developed to give an explanation of the process by which the physical information through our sensory organs forms the basis of perceptual experience. These theories range from Gestalt theory that tries to explain how

people innately perceive objects as organized patterns and objects, to David Marr's idea about the generation by the visual system of a sequence of increasingly symbolic representations of a scene, progressing from a 'primal sketch' of the retinal image, through a '2.5D sketch' to simplified 3D models of objects (Marr, 1982); and after the influential and controversial theory of direct perception by James Gibson in which the concept of affordances plays an important role as being cues in the environment that aid perception (Gibson, 1979).

In audio perception, our hearing can screen the sources of interest among sounds from multiple sources and directions, and identify where they come from and even what they are (Moore, 2009).

Haptic perception is involved in recognition of objects though our sense of touch. The sense of touch provides accurate and rapid identification of three-dimensional objects (Klatzky *et al.*, 1985). An interesting fact in this kind of perception is that when we use a tool, for example chopsticks, the perceptual experience is transparently transferred to the end of the tool (Simpson, 1972): we can feel the end of the chopsticks as if they were our fingertips (Figure 12).

Figure 12 An example picture of using chopsticks

In order to effectively accommodate this perception in product design general principles have been proposed in ergonomics (Dul & Weerdmeester, 2001) For visual information, the use of familiar typefaces is recommended because plain characters without decoration are the most legible. Diagrams are an efficient way to support text or as a substitute for

text. However, they should be made in such a way to be understood by everyone. In this sense, pictograms need to be made with care because they are not bound to a specific language or culture and are understood by many people from different languages. In addition to that, numbers best represent exact information. Although we can distinguish between a large number of colours, using more than five colours is not recommended, especially in user interface. For auditory perception, if our eyes are overworked in a certain task the ears can help people perceive the environment. Considering pleasant sounds turn to noise in the end, repetition of auditory signals should be avoided. Sound has to be taken for warning signals since sounds come from all directions. For haptic perception, temperature should only be used to signal alarm conditions. The sense of touch can be involved in feedback on the location of controls. The identifying mark on the ' F' and ' J' of a keyboard is a good example (Figure 13).

Figure 13 An example picture of the mark on the ' J' key

However, in case of alarms, a mixture of simultaneous sensory alarms is more effective than a single one. An alarm is a good example, coupled with a light signal. Perception can be triggered by usecues, conceived as meanings given by users to product characteristics in terms of what functionalities a product has and how these functionalities can be activated (Kanis et al., 2000). External product features such as appearance, colour, texture, and graphics as well as functional factors such as noise and movement represent typical usecues in the field of product design. Affordance as a concept has much in common with the term usecue in the context of human-product interaction. It is defined as a quality of an object or an environment to induce or invite a user to perform an action. Norman (1988) defines the concept of affordance relational rather than subjective or intrinsic. This occurs at the very beginning of perceiving an object or an environment. Gaver

(1991) divided affordances into three categories: perceptible, hidden and false affordances.

No given information of pushing or pulling the door is a good example of missing (hidden) affordances (see the left picture in Figure 14). The floor numbers in the elevator are not buttons to be pushed but the black ones next to them are the buttons to be pressed (see the right picture in Figure 14). This is a typical example of false affordances. These hidden and false affordances should be avoided by the designer since users do not perceive hidden affordances and perceive false affordances as possibilities for action. They lead to mistakes and misunderstandings in using products. On the contrary, perceptible affordances offer a direct association between perception and action. User perception of symbolic, ergonomic and aesthetic values is influenced by visual information such as colour and form (Murdoch & Flurscheim, 1983; Whitfield & Wiltshire, 1983; Schmitt & Simonson, 1997; Muller, 2001). For instance, forms with many edges are related to dynamism and masculinity, while those with much roundness elicits softness and femininity (Schmitt & Simonson, 1997). The form in which the information is presented must suit as many people as possible. Norman called this kind of experience ‘ visceral level’ . This level refers to an initial impact to its appearance which is closely related to a sensorial response.

Figure 14 Examples of hidden affordances (left) and false affordances (right)

Aesthetics also has to do with usability. Users initially judge visually attractive (aesthetically beautiful) products or interfaces to be more usable. Whether a product is aesthetically

attractive or not is judged by this initial sensory perception. Hekkert (2006) mentions some common characteristics of human perception suggesting four general principles of aesthetic pleasure. The first one is maximum effect for minimal means. Human sensory systems function as economically as possible. If we can perceive something with less effort or faster through our senses, we will easily take it over the more demanding other possibility. The second principle is about unity in variety and it relates to making things grouped, contrasted, closed, and isolated. This is closely related to the gestalt theory of form. Our sensory systems have to perceive unity in variety or order in chaos so as to identify what is bad or harmful or what is good or contributes to our survival. The third one is that humans choose the most typical examples of a category, the ones to which we get used by being repeatedly exposed. We prefer familiar things because they lead to safer choices rather than risking the unknown decision. Simultaneously, we are easily attracted by things unfamiliar so as to get the better of saturation and boredom. People prefer products that are balanced in both the originality of a design and its typicality. The last one is about congruency. Products are simultaneously involved in various human senses. Like ease of identification plays an important role in our survival, we are likely to prefer products that deliver identical messages to all our senses. These sensory perceptions can anticipate and explain human' s aesthetic responses. To make a satisfactory use experience, this belief, however, should be accompanied by easy-to-use experience (Dillon, 2006).

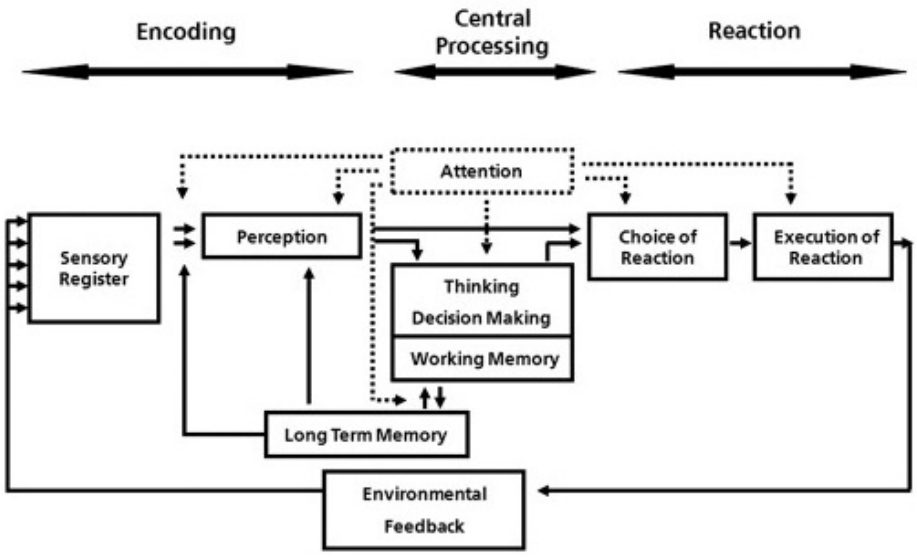

Figure 15 Information processing model (Wickens & Hollands, 2000)

Memory storage

Information perceived through our senses is first encoded and stored in our memory. Whenever the information is necessary, memory retrieval is triggered. However, we cannot always get back the information we need. There are three types of memory according to

the time it lasts in our body: sensory memory, short-term memory (STM), and long-term memory (LTM) (Atkinson & Shiffrin, 1968); see Figure 15. The sensory memory records information from our senses and it lasts for no longer than a half-second for visual information and 3 or 4 seconds for auditory information. If this information does not need to be memorized, it disappears quickly. On the other hand, STM contains only a small amount of information actually temporarily used. The information in STM is so fragile that it can be lost about within 20 to 30 seconds and can hold only about 7 chunks of information. If memories in STM are repeated, they pass from STM to long-term memory (LTM). This LTM is large and have a relatively permanent character. In product use, STM is closely related to intuitive operation of a product user experience since STM makes it possible for people to operate without constant referral to long-term memory which is much more complicated and laborious.

Nielsen proposed ten general principles for user interface design and some of them are related to STM limitations of human beings. For instance, a system should always keep users informed about what is going on, through appropriate feedback within reasonable time. Additionally, it should lessen the memory load of user by making objects, actions and options visually explicit (recognition rather than recall). Information for how to use the system should be visible or easily retrievable wherever it is necessary. On the other hand, disruptive data such as conversation, noise, motion, or worst of all, a combination of all three is likely to totally erase STM. Due to these limitations of STM, STM overload or disruption causes low performance, high error rate and stress. Thus, products or systems should be designed to minimize user' s memory load: especially STM and not to be disrupted by external factors. There are principles about how to reduce memory load. According to Wickens (2004) , a user should not need to keep hold of important information simply in working memory or to retrieve it from LTM. For example, visual information such as a menu or a checklist can help the user to ease the use of their memory. In addition, proactive actions are also usually more effective than reactive actions. This means that in display design users should be able to not only focus on current conditions but also think about possible future conditions. He also suggested that displays should be designed in a consistent manner that old habits will easily transfer to support processing of new displays. In this case, LTM plays a role in triggering actions. In product design, use of STM should be encouraged but also controlled in terms of capacity and disruption. Furthermore, when a new product is designed, it would be better to keep the interactions people are familiar with rather than completely new interactions. It is because LTM could help people to easily understand the new product.

Mental representation

Mental representations seem to underlie our thought processes in interacting with the real world. They help the brain to absorb and process the abundance of information and to rapidly take decisions. Representations can range from concrete, such as the recognition

and operation of a product to abstract, such as the structure of a system. These representations are also referred to as mental models. Norman (in Gentner & Stevens (1983), p. 7) describes them as follows: "In interacting with the environment, with others, and with the artifacts of technology, people form internal, mental models of themselves and of the things with which they are interacting." These models provide explanatory and predictive power for making sense of the interaction. They are concerned with our behaviour of recognition, reasoning, and making decisions, A mental model is not always clearly understood by the other formulation and the process of interpretation can be done in many different ways. On the one hand, this is because mental models are often founded on incomplete or obscure facts. On the other hand, our memory capacity is very limited to use them as sources of information (Ford & Sterman, 1997). Furthermore, mental models are constrained by user' s knowledge background, prior experiences with similar products or systems, and by the structure of the human information processing system. Nonetheless, for the same reasons people also share similar mental models as expressed in similar behaviour. For instance, users tend to assume causal relationships when one event immediately follows another (Norman, 1988). People' s ability to run their mental models is, however, very limited. For instance, people forget the detailed functions of the product they are using, especially when those functions have not been used for some period. The more a mental model consists of only vague representations the less firm boundaries they have. This intends that people easily get confused with operating similar devices that require different ways of operation. Their understanding of electronic products is surprisingly poor as well as full of inconsistencies. We also maintain superstitious behaviour patterns even though we know that they are unneeded. This is because of our behaviour to trade off extra physical action against reduced mental complexity. In graphic interface design, users tend to create anthropomorphic mental models when interacting with software (Cooper, 1995). Usability experience is dependent on the extent to which a user' s mental model matches the action of a system such as mapping and visual representation. Considering the character of the mental model, the best way is to design anything like the one that everyone has been familiar with. For instance, a calculator program on the computer is the same as the physical hand-held calculators on the desk. However, this is not always easy because the technical capabilities of a system increasingly have no resemblance to objects in the real world. These gaps lead to errors in using a product or a system. Designers have difficulty in capturing users' expectations, which is represented as mental model, and implementing them into design as well. Nevertheless, Preece (1994) suggested common design methods employed to support and influence users' mental models: simplicity, familiarity, availability, flexibility, feedback, safety and affordances. Apparently, products should be designed in the way that users' mental models are most effectively reflected into based on simplicity and familiarity. On the other hand, considering that their mental models have no firm boundaries and are even inconsistent, it is also important to help users understand how to use and so, take availability, flexibility, feedback, safety and affordance into account when designing

products. Otherwise, the products would be hard to use because they are simply not understood by their users.

Action control in operating products

Human cognition includes attention, memory, association, understanding, and making decisions and is deeply involved in operating consumer electronic products, especially with those that have multiple functions. Although there are no theories or models that are directly related to the operation of (electronic) products, the classification of Rasmussen (1983) is very useful. He developed a model for human thinking in supervisory control. His model provides a framework to help designers combine information requirements for a product and aspects of users' cognition (See Figure 16)

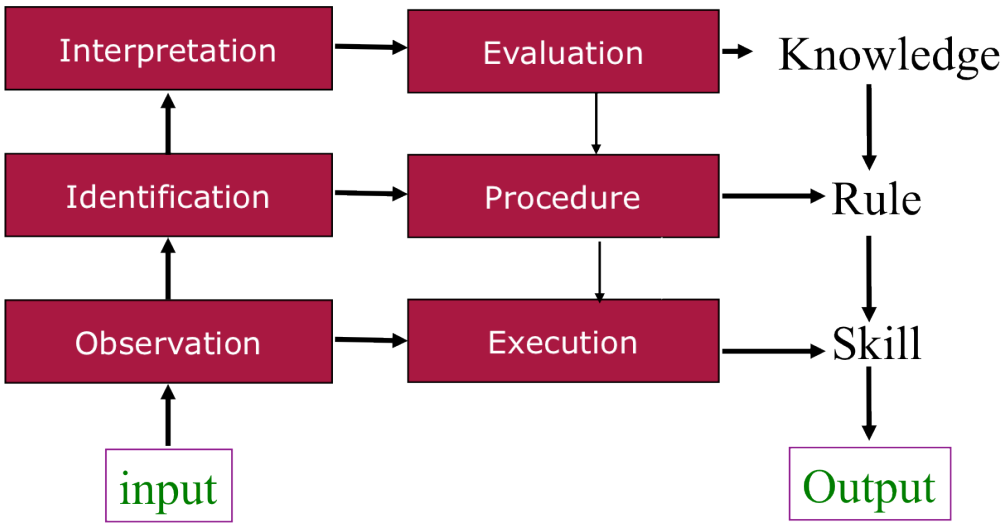

Figure 16 Rasmussen's action model

According to Rasmussen (1983), we try to reduce cognitive effort with operating everyday things. He therefore distinguishes three levels on which interaction is undertaken. The three levels essentially explain the possible ways in which information from a human-product interaction is extracted and understood. At the skill-based level, responses are automatic and easy, due to an acquired skill. People will become proficient enough to perform the actions without the need of instructions or even the mediation of the brain. Nonetheless, some interaction requires higher cognitive level for an action. At the rule-based level, action involves matching the context and problem currently facing the user. These rules can be based on prior experience, explicit instructions, etc. Namely, people are not required to know the underlying principles of a product to perform this rule level. This processing comes to play when an automatic skill fails and the user needs to fall back upon a set of explicit instructions or rules. Finally, people rely on knowledge-based processing if rules-based processing does not work out the problem, and hence they must fall back on reasoning from first principles, for instance, when we meet unfamiliar

situations. Without such reasoning, this becomes very difficult work. Due to the tendency to keep down cognitive effort people will try to scale down all actions to an automatic, skill-based level. Therefore, products should be designed in such a way as to reduce high-level cognitive capacity to transfer product usage into automated processes on a low cognitive level considering efficient performance in human product interaction. The Rasmussen model resembles what Anderson (1980) describes about the acquisition of procedural knowledge. Anderson hypothesized that knowledge representation of procedural skills occurs in three stages: cognitive, associative and autonomous. The cognitive stage of learning is to learn how to operate an object. During the associative stage, people repeatedly practice and are used to the procedure. In the long run, this repetition reaches the autonomous stage where people do not need to think about the procedure at all. Each stage corresponds to the levels of the Rasmussen model: the cognitive stage is the knowledge level, the procedural the rule level, and the autonomous level the skill level. In general, this kind of mental processing involves the processing of symbolic information. For example, the proper use of symbols in operating products can reduce the user' s cognitive effort. In human product interaction, mistakes or errors made by users stem from cognitive breakdowns: actions go as planned but the plan was poor.

User expectations

User expectations refer to the consistency that users expect from the behaviour of other people and of products while personal and situational factors are crucial. Expectations play an important role in consumer satisfaction/dissatisfaction. Consumer dissatisfaction in using products has been explained by the relationship between disconfirmation and satisfaction. This means that consumers compare product performance with their expectations in the post-usage process and when the expectations do not match with the actual product performance consumers feel some degree of tension. This tension leads to either satisfaction or dissatisfaction, making adjustments either in expectations or in the perception of the product' s actual performance. According to Peyton et al. (2003) there are four theoretical approaches to explain this consumer behaviour: assimilation theory, contrast theory, assimilation-contrast theory, and negativity theory. According to assimilation theory, consumers seek to minimize the discrepancy between expectation and actual performance (Olson & Dover, 1979). Thus, they distort expectations or minimize the relative importance of the disconfirmation in order to reduce the tension. Like assimilation theory, contrast theory holds that consumers also seek to minimize the discrepancy between prior expectations and actual product performance but that is done by shifting their evaluations away from the expectations (Cardozo, 1965). Assimilation-contrast theory argues that consumer satisfaction depends on the magnitude of the discrepancy between anticipated and perceived performance (Hovland et al., 1957). In other words, if there is a relatively small discrepancy between expectations and actual performance, consumers adjust differences in perceptions about product performance. If the discrepancy is large,

consumers magnify the perceived difference. According to negative theory, consumers respond negatively to any disconfirmation when their expectations are strongly held (Anderson, 1973). These four theoretical backgrounds state that satisfaction or dissatisfaction in using products in the post-usage process involves prior expectations but the disparity between expectations and perceived product performance does not always lead to dissatisfaction. Therefore, dissatisfaction can be measured by the degree of mismatch between expected use and actual use (Anderson & Jolson, 1973; Chen-Yu et al., 2001; Chen-Yu & Hong, 2002; den Ouden, et al., 2006).

If consumer expectations are related to consumer satisfaction/dissatisfaction, how are such expectations formed? Prior experience with a similar product influences the formation of expectations of product performance before the post-usage phase (Jokela, 2004). These expectations are also created through exaggerated promotional information in the pre-sales and point-of-sales phases (Anderson & Jolson, 1973). This exaggerated promotional information influences the expectations of the consumer regarding the product, including quality, price, variety of choice, uniqueness, convenience, reliability, service, performance, information and excitement.

Use fixation

In their interaction with products, users are strongly inclined to utilize the automatic operations of pre-established processing units (Reason, 1990). As we have seen, this skill-based behaviour is essential in information processing. However, in some situations confidence in prior knowledge and experience can have a detrimental effect. In those cases we speak of ‘ fixation’ , a term used in relation to hindrances in our creative thought processes, and also in using everyday products. Particularly, in using unfamiliar products fixation to particular action patterns is often observed regardless of whether it leads to success or not. In this way, users repeat and repeat their own solutions sticking to an ineffective hypothesis (Standaert, 2004). Gelderblom (2001) defines fixation in this context as the state in which a user cannot find solutions while information provided by the product is contradictory or insufficient to guide the user to the proper operation. Experiments by both authors with apparently familiar products (a can-opener, an overhead projector and a radio alarm clock), but with an unfamiliar operating procedure, clearly presented these fixation effects. The results also made clear that fixation can exist on different levels: (1) on the level of the rules applied, and (2) on a higher abstraction level dealing with the problem-solving strategy. Both user-related and product-related aspects influence the occurrence of fixation. Designers should be aware of the fixation effects caused by interface errors and poor feedback. They should also realise that the type of problem (static versus dynamic problem; number of variables; the length of the use-sequence) has an impact on the way users deal with unfamiliar products.

Emotional aspects

The ' user experience' literature commonly deals with the distinction between the hedonic and utilitarian qualities. Although nowadays these hedonic qualities seem to get priority in design, the relationship with usability in product design has hardly been studied. Most literature regarding this relationship can be found in the domain of computing system interfaces. The HUMAINE (Human-Machine Interaction Network on Emotion) organization for exploring the possibilities for defining standards in emotion-oriented computing gave an overview of literature in this area. Originally most studies took the ISO definition as a starting point, limiting affective responses to satisfaction and frustration. The overview indicated that situational variables such as importance of task, time to fix and time lost, effected specific incident frustration (Bessiere et al., 2006). However, the constructs of satisfaction and frustration provide only a limited description of the affective product or system.

In recent years researchers and system developers have taken a broader view of users' affective experiences, but again data about it is mainly about interacting with computer systems. An increase in the users' opportunity to select between products and systems brings about such broader view. Consumer products such as mobile phones, TV' s, vacuum cleaners etc. compete in the stores, and brands try to transfer their superiority in affective experience. This broader view on affective experiences was clearly presented in a review by Hornbæk (2006) of 180 studies of computing system usability, published in core HCI journals and proceedings between 1999 and 2002. In his self-report study, 70 measures of specific users attitudes were identified (see Table 1). 13 of these measures explicitly address negative emotional or physical and emotional states.

Table 1 Measures of specific attitudes towards the interface (Hornbæk, 2006)

Measure	n	Explanation
Annoyance	7	Measures of annoyance, frustration, distraction, and irritation
Anxiety	3	Users' anxiety when using the interface
Complexity	3	Users' perceptions of interface complexity
Control	7	Users' sense of control and attitude towards the level of interactivity
Engagement	4	Users' experience of engagement, involvement and motivation
Flexibility	3	Users' perception of flexibility in the interface
Fun	14	Users' feeling of fun, entertainment, and enjoyment
Intuitive	3	Users' perception of the intuitiveness of the interface
Learnability	5	Users' attitude toward how easy it was to learn to use the interface
Liking	15	Users' liking of the interfaces
Physical discomfort	3	Users' experience of physical discomfort in using the interface
Want to use again	3	Users' attitude towards using the interface again

In general, it has been indicated that emotional responses can unconsciously influence people' s behaviour (Berridge & Winkelman, 2003), which also holds for the behaviour regarding user product interaction. Jordan in his book about designing for pleasurability of the user, stated a hierarchy of needs for a computing system: functionality as the most basic, then usability, and finally, pleasure. Norman (2004) argued that emotion plays a central role in our interaction and appreciation of the (computing) devices we use. He reported in his book about research that makes clear that attractive products were easier to use. Support for this finding can be found in the earlier in this chapter mentioned research by Tractinsky et al. (2000) who found close relationships between the perception of the interface aesthetics and perceived usability of the system. They also found that aesthetic preferences are culturally dependent.

User's preferences

User' s preferences are closely linked to the success of a product because successful products in the market are dependent on an understanding of consumer preferences (Baxter, 1995; Swift, 1997). There is a variety of preference definitions and it varies depending on disciplines. The most relevant definition in the field of product design is the perspective that preference is an evaluative judgment in the sense of liking or disliking an object (Scherer, 2005). It also could change over time and certain preferences are made in either an unconscious or conscious way (Coppin et al., 2010).

Basically, humans have innate preferences acquired early in life (Lewalski, 1988). However, it is not easy to transfer user' s preferences into design specifications since they are the results of multidimensional psychological interaction between perceptive, affective, and behavioural dimensions. With regard to the perceptual level, product appearance plays a key role in affecting user' s preferences. The form and colour of a The visual appearance of a product such as form and colour can be involved in the process of consumer product evaluations and choice in various ways. According to Meyers-Levy and Tybout (1989) products that differ a little from the design users have in mind are judged more positively than products that are either very common or very uncommon. In the affective level, the symbolic value that products deliver plays a key role in affecting user' s preference. The symbolic value can represent social interaction such as social status. Intrinsic brand preferences have a much bigger effect on the performance of the brand than the inclusive value which reflect model level prices, product attributes, and the length of the brand' s product line (Sriram et al., 2006). Furthermore, consumers use products to express their (ideal) self-image to themselves and to others (London, 1974; Sirgy, 1982; Solomon, 1983; Belk, 1988). In the behavioural dimension, usability plays an important role in affecting the preferences of users. However, only ease to use of a product is not sufficient to affect the preference of consumer positively. Consumers need to perceive how the product is easy to use as well. However, considering that consumers are not able to try out products in a shop or when consumers buy products on the Internet or they

simply and shortly try out the product in an electronic shop, the product appearance will be used to judge how the product is valuable from ergonomic point of view (Bloch, 1995). For example, a few buttons make a device look easy to use (Norman, 1988). This implies that simple operation will play a more primary role in sales than variety of functional features (Nussbaum, 1988; Hammer, 1995). Ease to use is especially of great importance to functionally complex electronic products such as mobile phone. Many electronic products are so complex that they look like a black box design, and as its result many consumers are the more intimidated by the more high-tech products (Feldman, 1995). This study also showed that not only product parts such as displays and buttons but also the appearance such as structure and size affect the perceived ease to use. These facets are related to the indirect consequences of use such as the physical space required by the product (e.g., whether or not it fits on a kitchen), the ease of controlling the product, or the ease of management such as maintenance or cleaning. Therefore, when investigating the usability of a product is investigated, attention should be paid not only to the perceived operational qualities but also to these secondary significances of use, since they play an important role in product choice. Based on this first perception, consumers may discard the product or not. Nevertheless, in a decision-making situation, people do not seriously weigh usability related to product attributes. The low explanatory power of usability relates dimensions in relation to product preference (Keinonen, 1997). The low explanatory power of usability in regard to preference may be due to lacking motivation to search for product information, reliance on the quality of interface design, inability to detect differences due to fuzzy mental models, etc. However, in reality any single dimension of the three - perceptive, affective, and behavioural - cannot have an absolute power to user' s preferences. Preferences result from the interaction between the three dimensions. The appearance of a product plays an important role in user' s preferences: it has aesthetic, symbolic, functional and ergonomic values for consumers. It can also draw attention and can influence the perception of categorizing the product. For example, a more bulky product looks more a bigger product looks more rigid, bright colours may decrease an impression about the quality, and many buttons on the interface diminish the impression of usability (Norman, 1988). However, individual preferences are at large influenced by cultural context and consumer characteristics such as experience and personality. A good example to explain this argument is the preference difference between novice and expert users. Novices search non-functional attributes like brand and price, and only experts within a category are considered to search using a bottom up approach on a technical basis (Solomon, 2006).

Complaining behaviour

The consumer complaining behaviour can be triggered by feelings or emotions of perceived dissatisfaction (Day & Landon, 1977). Consumer complaining behaviour responses generally are considered to fit into two broad categories, behavioural and non-

behavioural. Behavioural responses, which traditionally have been the focus of complaint behaviour studies, constitute of any or all consumer actions that convey an "expression of dissatisfaction" (Landon, 1980). These responses are not limited to those directed toward the seller (i.e., manufacturer, retailer, etc.). Complaints towards third parties (e.g. consumer organizations, legal actions, etc.) or friends and relatives (e.g., negative word-of-mouth communication) are also regarded as belonging to the category of behavioural responses (Richins, 1983; Day, 1984). The first level distinguishes behavioural from non-behavioural responses. The second level represents the distinction between public and private action. Public actions include seeking redress or refund from the seller, complaining to a consumer organization, and legal actions. Some typical examples of private actions are word-of-mouth communication to friends and relatives and ceasing to patronize a store. Whereas the no-action or action distinction follows directly from the conceptualization of consumer complaining behaviour, both Day and Landon seem to justify the public or private dichotomy on the grounds of the nature and importance of the product involved in the dissatisfaction. That is, for complex and expensive products (e.g., durable goods), consumers are expected to engage more often in public actions. Empirical support for the validity of the preceding distinction is limited, however. For instance, Day and Ash (1979) report some typical findings for complaint behaviours in the case of non-durable and durable goods. After dissatisfaction with durable goods, 32.5% of the respondents reported warning family and friends (i.e., private action). For non-durable goods, the comparable value was reported to be 33.3%. In contrast, the percentage of respondents who complained to the seller for a replacement or a refund (i.e., public action) was 48.8% and 57.9% for durable and non-durable goods respectively. Namely, as the product complexity increased (mostly shown in durable products), the extent of private actions remained about the same but public actions actually decreased. This finding is inconsistent with the hypothesis of Day and Landon (1977).

The three concepts (voice, exit, and royal) make a variety of effects on companies: “ Voice” such as negative words-of-mouth creates negative attitudes towards the company and motivate search for other alternatives. “ Exit” such as redress or product return result in loss of the dissatisfied consumer as well as potential buyers that leads to reduced sales and profits. And “ Loyal” creates the transmission of the dissatisfaction related to lack of improvement done by the company. According to Gronhaug (1977), many dissatisfied consumers remained loyal probably because of lack of relevant alternatives, lack of courage, or lack of relevant information and knowledge. Another explanation might be found in one of the aforementioned assimilation theories regarding the discrepancy between expectations and real performance.

2.3.2 Scope of user characteristics

User characteristics are mainly taken into consideration in the field of human computer interaction as individual differences and customization have been recently underscored in

that field. These individual differences were shown mainly in studies on consumer complaining behaviour, consumer (dis)satisfaction and usability. In our study user characteristics were collected from literature and divided into four categories, demographic factors, socio-economic aspect, cognitive aspects, and personality. Furthermore, the areas in which these characteristics play a role are taken from the directly observable reactions by consumers and subdivided into three categories: Consumer complaints behaviour, dissatisfaction and usability. See Table 2.

Table 2 Summary of literature on user characteristics. Names in bold means the variables were empirically tested

Factor	Consumer complaining behaviour	Consumer (dis)satisfaction	Usability
Demographic factor			
Age	**Keng & Liu (1997)** Older people select group-oriented values and group-oriented consumers take private actions	**Martin (1996)** Younger consumers are more tolerant of other's behaviour **Zinkhan & Wallendorf (1985)** Younger people tend to be more dissatisfied than older people with the services which they patronize	**Chou & Hsiao (2007)** Younger age learners show lower anxiety and hold more positive attitudes toward computer learning than the older-aged ones **Burton-Jones & Hubona (2005)** Older workers found the systems harder to use but appeared not to find them less useful for their jobs **Kim et al. (1999)** For older group, the screen layout is important element of interaction style **Schneiderman (2000)** **Aykin & Aykin (1991)**
Gender	**Keng & Liu (1997)** Gender makes no difference Manikas & Shea (1997)	**Chen-Yu & Seock (2002)** Significant differences were found between genders in shopping **Leventhal et al. (1996)** Women prefer interfaces rated high on an accessibility factor and dislike complex layouts more than men **Martin (1996)** Male consumers are more tolerant of other's behaviour Sheth (1977)	**Chou & Hsiao (2007)** More males than females were found to exhibit the phenomenon of computer phobia. **Kim et al. (1999)** Females prefer menu style but males prefer graphical interaction style Borgman (1986) Schneiderman (2000) Aykin & Aykin (1991)

Education	**Keng & Liu (1997)** Highly educated people are self-oriented, and they take public actions Lazarus & Folkman (1984) Stephens and Gwinner (1998)	**Martin (1996)** Educational level is an influential factor **Zinkhan & Wallendorf (1985)** Higher education levels lead to greater dis- satisfaction	**Chou & Hsiao (2007)** The higher education learners hold much more positive expectation toward computer learning while the lower education learners pay more attention to their learning capability and deficiency. **Burton-Jones & Hubona (2005)** Word processing and email were not complex enough to lead to differences across education levels. **Kim et al. (1999)** Higher education-availability of info is a very important feature
Disability			Schneiderman (2000) Aykin & Aykin (1991)
Disabling conditions			Schneiderman (2000)
Culture	**Liu & McClure (2001)** Customers in different cultures do have different complaint behaviours and intentions **Richins & Verhage (1985)** Dutch consider complaint-making a more important, but more painful, experience than do consumers in the US **Yuksel et al. (2006)** People form individualistic culture are expected to complain more than people from a collectivist society Keng & Liu (1997) Laufer (2002)	**Leventhal et al. (1996)** Some higher-level aspects of interface design may have cultural implications, in much the same way as the semantics of colour **Chen-Yu et al. (2001)** Apparel product consumer satisfaction, both similarities and differences between US and South Korea Khalid (2006)	**Kim et al. (2006)** There are differences in preferred user interface between different cultures **Hariandja & Daams (2005)** The way of using electronic products is partly different from cultures **Leventhal et al. (1996)** Nationality did not emerge as particularly important in user interface design but American had a markedly stronger dislike of women's style. Honold (2000) Schneiderman (2000)
Ethnic group (race)	**Keng & Liu (1997)** Non-Chinese-people are group-oriented, and they take private actions	**Martin (1996)** Influential factor	
Region		Martin (1996) Influential factor	
Socio-economic aspect			
Income	**Keng & Liu (1997)** People making High income are self-oriented, and they take public actions	**Zinkhan & Wallendorf (1985)** High levels of income are associated with high levels of satisfaction **Martin (1996)** No difference	Schneiderman (2000)
Marital status	**Keng & Liu (1997)** No difference	**Martin (1996)** Influential factor	
Affiliation		Khalid (2006)	

Staff seniority		**Burton-Jones & Hubona (2005)** Senior staff perceived the email system to be more useful for their tasks than lower level staff: more senior staff perceived the word processing system to be less useful for their tasks.
Social activity	**Warland et al. (1984)** Complaining behaviour was significantly related to community involvement	
Cognitive aspect		
Experience	**Broadbridge & Marshall (1995)** Poor experiences may intensify private actions Day (1984) Lazarus & Folkman (1984) Stephens & Gwinner (1998)	**Kim et al. (1999)** Poor experience-ease of learning is an important factor of interaction style Aykin & Aykin (1991)
Skills		**Kim et al. (1999)** Poor computer skill and poor experience led to difficulty of learning. Skills are an important factor for ease of learning Schneiderman (2000)
Creativity		Khalid (2006)
Knowledge		Schneiderman (2000)
Literacy		Schneiderman (2000)
Spatial ability		Aykin & Aykin (1991)
Reading speed		Aykin & Aykin (1991)
Intelligence		Aykin & Aykin (1991)
Mathematical ability		Aykin & Aykin (1991)
Personality trait		
General beliefs (personal norms)	**Halstead & Droge (1991)** No significance **Richins (1983)** Some consumers don't like to be seen as nuisances or troublemakers Lazarus & Folkman (1984) Stephens & Gwinner (1998)	
Extroversion	**Mooradian & Oliver (1997)** No influence	
Neuroticism	**Mooradian & Oliver (1997)** High score in neuroticism are less likely to repurchase or to provide useful feedback in the form of complaints	

Commitments	Lazarus and Folkman (1984) Stephens and Gwinner (1998)		
Attitudes towards complaining	**Halstead & Droge (1991)** Attitudes play a significant role in the prediction of consumer complaining behaviour responses **Keng & Liu (1997)** People who think complaining is distasteful are group-oriented, and they are likely to take private actions Stephens and Gwinner (1998)		
Religion		Martin (1996) Influential factor	
Expectation		**Chen-Yu & Hong (2002)** Performance expectation is a significant determinant of consumer satisfaction and dissatisfaction Sheth (1977) Anderson & Jolson (1973) Singh & Widing (1991)	
Self-confidence	**Keng & Liu (1997)** People with high score in self-confidence are self-oriented and so take public actions		
Conservatism	**Keng & Liu (1997)** People with low score in conservatism are self-oriented and so take public actions		
Assertiveness	**Keng & Liu (1997)** People with high score in assertiveness are self-oriented and so take public actions		
Risk-taking	**Keng & Liu (1997)** People who take risks are self-oriented and so they take public actions		Aykin & Aykin (1991)
Sense of justice	**Keng & Liu (1997)** No difference		
Alcohol consumption		**Martin (1996)** Those who drink alcohol are more tolerant of other's behaviour	
Self-respect	**Keng & Liu (1997)** People with high score in self-respect take public actions		Aykin & Aykin (1991)
Being well-respected	**Keng & Liu (1997)** People well respected take public actions		

Self-fulfilment	**Keng & Liu (1997)** People with high score in self-fulfilment take public actions		
Sense of accomplishment	**Keng & Liu (1997)** People with high score in sense of accomplishment take public actions		
Fun and enjoyment in life	**Keng & Liu (1997)** People who seek for fun and enjoyment in life take public actions		
Excitement	**Keng & Liu (1997)** People with excitement take public actions		
Security	**Keng & Liu (1997)** People with high in security take private actions		
Sense of belonging	**Keng & Liu (1997)** People with high score in sense of belonging take private actions		
Warm relationships with others	**Keng & Liu (1997)** People with warm relationships with others take private actions		Aykin & Aykin (1991)
Assertiveness	**Fornell & Westbrook (1979)** People with high score in assertiveness are likely to have more active complaining behaviour **Richins (1983)** The non-assertive individual has difficulty standing up for his rights in the consumer environment.		
Social activity	**Reynolds & Darden (1971)** Opinion leaders have been found to have more contacts with individuals and to participate in more informal social activities		
Curiosity		Khalid (2006)	
Satisfaction		Khalid (2006)	
Power		Khalid (2006)	
Consumer type			**Geudens et al. (2005)** There are different usability issues between innovator, early adapter, early majority, later majority, and laggards. **Den Ouden et al. (2006)** Each consumer type has its own specific expectations or priorities in requirements
Locus of control			Aykin & Aykin (1991)
Imagery			Aykin & Aykin (1991)

Interests	Aykin & Aykin (1991)
Aptitudes	Aykin & Aykin (1991)
Anxiety	Aykin & Aykin (1991)
Emotional aspect	Babber & White (2002) Han & Hong (2003)

Aykin and Aykin' s study (1991) also involved individual differences to affect the performance and preferences in human-computer interaction. They categorized user characteristics into four groups: level of experience, personality traits (Jungian personality types, field dependence, locus of control, imagery, spatial ability, type A/B personality, and ambiguity tolerance), demographic characteristics (age and sex) and others (background, reading speed, comprehension, intelligence, interests, mathematical ability, etc.)

Johnson and Fornell (1991) established a framework to integrate economic and psychological perspectives in order to compare customer satisfaction on perceived performance across individuals and product categories. They argued that individual and product category differences affect satisfaction via expectations and perceptions of current performance.

Schneiderman (2000) demonstrated in his universal usability that diversity of users involves differences in age, gender, skills, knowledge, physical abilities, conditions such as noise and sunlight, literacy, and cultural background, household income.

2.3.3 Influence of user characteristics

As can be seen above, diverse user characteristics have been mentioned in the literature. Many of them have been used in studies in order to figure out how those characteristics are related to usability experience, consumer (dis)satisfaction, expectations, and complaining behaviour. In this section, we summarize the influence of user characteristics in those fields.

Usability

How a product is easy to use is judged through the usability given by its designers. However, the experience depends on not only the product itself but also characteristics of the user. According to literature, the perception of usability of a product is closely related to demographic aspects of the user such as gender, age, educational level and so on. For instance, men were found to make more errors on simple tasks than women (Bogman, 1986). Chou & Hsiao (2007) conducted a study to examine the usability of human-computer interface for middle-aged learners. Their finding is that educational level, gender, and age are the major factors influencing their use of computer interfaces. Thus, they recommended that designers should take user characteristics into account in the design of a new web application. Burton-Jones & Hubona (2005) also conducted a study to determine the effect of staff seniority, age, and education level on usage level. According to them, these individual user differences have significant direct effects on both frequency and volume of usage. Moreover, using some social psychology theories they provide four

reasons why individual differences would directly affect usage behaviour: an individual' s behaviour is driven by participative norms, perceived behavioural control, self-identity, and habit. Naïve users lack general knowledge about the common properties of systems. This mean that they do not know just what is was they didn' t know. To naïve users, prior experience and world knowledge is very influential in governing the activity of those users engaged in self-directed learning. Users will have difficulty with manuals as they are currently constructed. An improvement in performance is not necessarily associated with increased knowledge. Meta-knowledge is important to guide the process. Novice users lack it while more experienced users would have this meta-knowledge available. Many manuals assume that users understand the general principles which underlie the process of interaction (Briggs, 1990). When determining an appropriate representation of the use of system features, there are deficiencies in the mental models of novices (Hanisch et al., 1991). Consumer types have something to do with product usability, which are the distinct types such as innovators, early adapters, early majority, late majority, and laggards (Rogers, 2003). Geudens et al. (2005) identified that there is a correlation between the occurrence of soft problems (non-technical problems) and the different customer types. That is to say, different customer-types provoke different types of soft problems when using the same product. Additionally, it was found that complaints are influenced by three user types in installing and initially using products: novice users, familiar or occasional users, and experienced users especially in the phase of the out-of-the-box because they have different perspectives on expectations (den Ouden, et al., 2006). In addition to the changes, emotion is also being emphasized to have an influence on product usability (Babbar et al., 2002; Han & Hong, 2003).

Consumer satisfaction and dissatisfaction

The literature on the interaction between consumer preferences and user characteristics is not much compared with the literature on consumer complaint behaviour. Some researchers (Sheth, 1977; Chen-Yu & Seock, 2002) studied the relationship between consumer preferences and their socioeconomic-demographic factors such as gender, expectation, and perception. They found that both are closely related to each other. Besides, Kim et al. (1999) examined the correlations between user characteristics and their preferred features in a web application. Age, gender, educational level, computer skills and the application experience were used in his study. They found that all variables influence the preference of a web application features. Leventhal et al. (1996) looked for relevant user characteristics in user interface design and found that gender had a stronger effect on the preferred design than nationality. As user populations are becoming more diverse, it is difficult to identify a prototypical user. Accordingly, Khalid (2006) saw that diversity refers to the variety in user needs: aesthetics, achievements, virtuosity, culture, affiliation, creativity, curiosity, satisfaction, physical activity, and power.

Furthermore, some studies (Zinkhan & Wallendorf, 1985; Martin, 1996) used a broader

range of individual differences: for example, income, education, religion, smoking behaviour, and alcohol consumption as personal characteristics in addition to demographics. Only region and race are insignificantly correlated to consumer complaint behaviour.

Expectation is also dependent on consumer characteristics. Anderson & Jolson (1973) found that consumer reactions to expectation-performance disparity would depend on psychographic variables of consumers and the information provided to them. Additionally, according to Singh & Widing (1991), different consumer target groups such as the elderly have different expectancies and norms of seller responsiveness in very similar dissatisfaction situations. As a result, it is found that expectation plays a critical role in consumer satisfaction and dissatisfaction. To attain high levels of customer satisfaction, companies should exceed the expectations of customers through introducing products with attractive usability.

Complaining behaviour

Most of studies on influential factors to consumer complaint behaviour have focused on the relationship between this behaviour and demographic or personal characteristics. For example, Stephens & Gwinner (1998) and Lazarus & Folkman (1984) found that cognitive appraisal in the process of consumer complaint behaviour is greatly influenced by personal characteristics variables: commitment, general beliefs, and experience and education. Some researchers (Halstead & Droge, 1991; Keng & Liu, 1997; Mooradian & Olver, 1997) investigated the relationship with personal variables such as age, gender, perception, attitudes and complaint behaviour. They found that individual differences unveil different complaint behaviour when they are dissatisfied with a product they purchased. Particularly demographic, personal variables and psychographic characteristics were used in Keng & Liu' s study (1997). These are: sex, marital status, ethnic group, age, education and income as demographic factors; self-respect, being well-respected, self-fulfilment, a sense of accomplishment, fun and enjoyment in life, excitement, security, a sense of belonging, warm relationships with others as personal values; and self-confidence, conservatism, assertiveness, risk-taking attitude, attitude towards complaining, and sense of justice as psychographic characteristics. They identified most of the variables to have to do with consumer complaint behaviour. For instance, older people are more likely to seek for group-oriented values than younger people, which lead to private action in complaining. Another evidence to show the relationship between consumer complaint behaviour and personal differences is that consumers who complain are also very likely to be active in other areas of social, economic and political life (Warland et al., 1984). Den Ouden et al. (2006) suggested factors to explain why consumers complain in different ways: the degree of dissatisfaction, the importance of the purchase, personal characteristics, the expected response time to get an answer. As a result, these findings can be summarized in the following sentence; consumer complaint behaviour is a function of relationships between dissatisfaction, importance of product, benefit from complaining and personality

and situations (Landon, 1977).

Demographic variables were also studied by Keng and Liu (1997) and Heung and Lam (2003). They drew a conclusion that females are more likely to complain, while a study by Manikas and Shea (1997) indicates completely the opposite interpretation. Regarding educational background, research has demonstrated that there is a close relationship between educational level and complaining behaviour (Keng & Liu, 1997).

Regarding personal traits such as personality and attitude, these psychographic factors play the major role in complaint behaviour (Davidow & Dacin, 1997). For instance, consumers who are prone to complain have more social responsibility and are willing to take risks although complaining involves the risk of embarrassment. On the other hand, non-complainers think that complaining would be fruitless and is what people with little else to do take.

About attitude toward companies, some researchers indicate that there is a positive relationship between a consumer' s perception of company responsiveness and his/her complaining behaviour. In their study in Chile Valenzuela et al. (2005) found out that Chilean regard complaining as something to shame, and if they do not feel complaining to be social responsible, it might have to do with few consumer complaints. Moreover, they discovered that gender and social class are not applicable to this attitude to complaining, which does not correspond with those conclusions made in other studies (Keng et al., 1995; Phau & Sari, 2004)

Statistically significant is the type of complainer. Active complainers have a more positive attitude toward complaining, whilst passive complainers have a more negative attitude. This is aligned with the findings by Kim et al. (2003) that consumers who have a more positive attitude toward complaining are more likely to engage in such complaining behaviour.

As can be seen from those studies, the focus is on the question why people complain and not on the reasons for complaining: the problems with products.

Like consumer complaint behaviour, many variables on the relationship between user characteristics and usability are found in literature. However, all the variables have not been empirically verified. Therefore, the variables are necessary to be tested again to see if they have something to do with use problems in the project.

2.4 Product properties in human-product interaction

2.4.1 Scope of product properties

Product characteristics have also mainly been addressed in the field of human computer interaction. In general, these characteristics are not dealt with as much as user characteristics. Product characteristics in the literature are summarized in Table 3.

Table 3 Summary of literature on product properties

Factor	Consumer complaining behaviour	Consumer (dis)satisfaction	Usability
Type (nature) of product	**Halstead & Droge (1991)** Whether or not complaints about this particular product are typical and/or appropriate **Day & Landon (1977)** Consumers often fail to complain when dissatisfied because of the nature or cost of the product category **Broadbridge & Marshall (1995)** Type of problems are partly dependent on type of product **Kincade et al. (2007)** Those who purchased dresses were more likely to switch brands than those who purchased outerwear, when products failed.		
Physical variables (e.g. shape)	**Broadbridge & Marshall (1995)** Smaller electrical appliances were found to generate the fewest complaints		Han & Kim (2003)
Complexity	**Broadbridge & Marshall (1995)** Complex items generate a higher incidence of public complaint		
Life expectancy	**Broadbridge & Marshall (1995)** Items with a relatively long life expectancy generate a higher incidence of public complaint		
Price	**Broadbridge & Marshall (1995)** High priced products generate a higher incidence of public complaint		Stephens & Gwinner (1998)
Sensory cues			Compeau et al. (1998)
Problem severity			Richins (1983) Goodwin & Spiggle (1989)
Product importance			Sheth et al. (1998) Stephens & Gwinner (1998)
Product importance	Landon (1977) Richins (1985)		

2.4.2 Influence of product properties

Product usability is actually affected by a large number of design variables such as product shape, colour, materials, information displays, layout of controls, etc. In other words, it implies that the number of design variables could easily go up to hundreds (Han & Kim, 2003) and they all might have something to do with usability problems. However, studies on product characteristics and usability in literature have been limited to only a few design variables. Broadbridge & Marshall (1995) empirically investigated what factors cause consumer dissatisfaction in using consumer domestic electrical appliances such as kitchen and laundry appliances; namely, refrigerators, ovens, dishwashers, microwaves, and washing machines. Their study identified that the nature (type), complexity, life expectancy and price of a product evoke consumer dissatisfaction while inexpensive electrical goods generated the fewest complaints. According to Compeau et al. (1998) sensory cues associated with the product itself, such as colour, aroma, and flavour, also have something to do with consumer satisfaction. That means that dissatisfaction on sensation would come up with use problems. Another finding is that product usage can be conceptualized by three dimensions – usage frequency, usage function and usage situation. Consumer satisfaction on product usage varies across product types such as VCR, food processor, microwave, camera and PC (Ram & Jung, 1991). For instance, usage frequency is closely related to the satisfaction of microwave oven use. Regarding the correlation between product characteristics and complaining behaviour, Day and Landon (1977), and Keng et al (1997). drew a conclusion that consumers are more likely to make complaints if the product do not function as promised or expected and this situation can negatively influence the image of the company it comes from. It was also found out that consumer will engage in the more active complaining behaviour if the product they are using is the more expensive.

Therefore, product type should be taken into account in the study of product characteristics, which can be categorized in diverse ways based on specific features (e.g. cognitive load).

2.5 Situations in human-product interaction

As the second element in our interaction model on usability (see Figure 5), factors related to use situation and marketing are reviewed in this part. Situation cannot be excluded in product-user interaction because user and product always interact in a given environment. Although it plays a critical role in usability, literature on situational factors is scarce. Situational factors are reviewed in the same way as previous the literature study on user characteristics, based on consumer complaint behaviour, consumer (dis)satisfaction, and usability. See Table 4 for a summary. In the next sections the factors will be explained.

Table 4 Summary of Situational factors. Names in bold means the variables were empirically tested.

Factor	Consumer complaining behaviour	Consumer (dis)satisfaction	Usability
Medium of education	**Keng & Liu (1997)** English speakers are take public actions more than non-English ones		
Novelty	Lazarus & Folkman (1984) Stephens & Gwinner (1998)		
Predictability	Lazarus & Folkman (1984) Stephens & Gwinner (1998)		
Imminence	Lazarus & Folkman (1984) Stephens & Gwinner (1998)		
Duration	Lazarus & Folkman (1984) Stephens & Gwinner (1998)		
Ambiguity	Lazarus & Folkman (1984) Stephens & Gwinner (1998)		
Severity of problem	**Broadbridge & Marshall (1995)** Significant determinants to public to private complaints		
Inconvenience of not having the product	**Broadbridge& Marshall (1995)** Significant determinants to public to private complaints		
Context of use		Khaldi (2006)	Babbar & White (2002) Maguire (2001)
Trend		Khaldi (2006)	
Norms		Khaldi (2006)	
Place		**Martin (1996)** Perceptions of others' behaviour are situation-specific: Restaurant vs. bowling centre	
Usage frequency			**Ram & Jung (1991)** Usage frequency played a significant role in the satisfaction appraisal for microwave ovens, VCRs, and food processors.
Usage function			**Ram & Jung (1991)** No influential factor
Usage situation			**Ram & Jung (1991)** Usage situation influenced the satisfaction appraisal for personal computers and cameras.

2.5.1 Use context

Lazarus & Folkman (1984) identified five situational factors that may impact the appraisal process in the consumer complaint behaviour, which are novelty, predictability, imminence, duration, and ambiguity. In a follow-up study, Stephens & Gwinner (1998) identified that cognitive appraisal in the process of consumer complaint behaviour is deeply influenced by the same situational factors like the five elements.

Culture as situational factor plays an important role in consumer complaint behaviour satisfaction and usability. It has been a key word in the field of research as a consequence

of globalization and internationalization. Regarding complaint behaviour, a few researchers (Keng & Liu, 1997; Liu & McClure, 2001) recognized that consumer this behaviour had been primarily western in its orientation although globalization had goods traded across national borders. For the comparison between different cultures, some empirical studies (Chen-Yu et al., 2001; Laufer, 2002; Yuksel et al., 2006) were conducted in consumer complaint behaviour. They identified that customers in different cultures have different complaint behaviours and intentions. For instance, there are differences in hotel customers' attitudes toward their complaining behaviours between countries according to Yuksel et al. Laufer (2002) examined theories from social psychology that play an important role in explaining dissatisfaction in a consumer behaviour context to show differences on consumer dissatisfaction behaviour in different countries. Finally, usability is influenced by culture as well because user satisfaction can be defined as the users' subjective feelings toward a product (Han et al., 2004). Collective participant feelings on a product is partly influenced by national culture (Kim et al., 2006). Some researchers empirically tried to find any relationship between national culture and usability. For example, Han & Hong (2003) identified critical design features and their common properties for audio/visual consumer products between American and Korean consumers. Hariandja & Daams (2005) carried out a cross-cultural usability test between Dutch and Indonesian user groups. They found differences in performance, in usability problems experienced, the behaviour when using a product and doing a usability test, and also in the needs of a product. However, a study by Leventhal et al. (1996) shows nationality is not always more important than some factors in design: people prefer accessible interface and dislike complex layouts, and this effect does not make a big difference between different nationalities.

Most literature related to situations was found in the field of situational awareness that, for instance, focuses on complicated systems such as a cockpit interface design. However, the literature on situational factors related to complaints, satisfaction or usability regarding physical products is scarce. Khalid (2006) emphasized societal variables in the context of use such as trends, norms and fashion. Different from Khalid' s study, locations such as restaurants and bowling centres are defined as situational factors in Martin' s study (1996), in which it was found that consumer satisfaction varies by locations: namely, consumer satisfaction for the same consumer behaviours significantly differed between restaurants and bowling centres. Some empirical studies are limited to only a certain context, such as households. Mason & Himes (1973) studied which characteristics of households have influence on dissatisfaction with consumer appliances. The characteristics identified in the study were the number of people in the household, annual household income, age of the household head, and whether the household owns or rents its home. Another factor is sharing: some consumer electronic products are used and shared by more than one person who are different in prior knowledge and experience with those products. This situation might have an influence on consumer satisfaction (den

Ouden, et al., 2006). Therefore, the sharing situation in use should be taken into account in our study.

Other situational variables in relation to product usage were taken into account by Ram & Jung (1991). They used three situational dimensions being usage frequency, usage function and usage situation more generally, and investigated their role in consumer satisfaction. The dimensions have a significant influence on consumer satisfaction according to their study: disconfirmation in frequency and situation (i.e. less frequently used than expected and fewer usage situations than expected) are closely related to consumer satisfaction, whereas functional disconfirmation (i.e. using less functions than expected) little influences consumer satisfaction.

As a result, it is necessary to find more situational factors through some research methods, which would have something to do with product usability. The variables collected through the literature research are summarized in Tables 3 and 4. However, they will not be taken into consideration in the course of our studies in order to focus on the interaction between user, product and use problems.

2.5.2 Task characteristics

Together with use context, the task itself is the other factor belonging to what has been described in our model (Figure 6) as situations in human-product interaction. In the past several models are developed. The general approach of all of these limited models, which are called `resource models' . Such models assume that mental resources are supplied (allocated) as necessary to meet the task demands defined jointly by the level of difficulty of the task and the level of performance required (Wickens, 2002). According to Eason (1984), the characteristics of a task consist of frequency and openness. Frequency describes the number of times a task is performed by a user and openness refers to whether the task is open-ended and how many options it has. A routine task which is frequently done and closed, benefits from effectiveness while in case of a rarely performed but open task a good guidance is more critical. Both references show similarity with Rasmussen' s model according to which people operate on one of the levels (skill, rule or knowledge), depending on the nature of the task and their degree of experience with the situation (see Figure 12). Experiments in this area have been conducted to define resource demand in time sharing and the effect on task inference (for example in driving a car), measured by both subjective ratings and objectively defined task characteristics such as the bandwidth of information, the working memory load, or the skill level of the operator performing the task (Kahneman, 1973; Wickens, 2002).

Therefore, it is important to be aware of the nature of the task because it influences people' s behaviours. The characteristics of task are, however, not explicitly considered in our study.

2.6 Conclusion: Conceptual framework for this research

The project aims to enhance consumer satisfaction by means of improving product usability. To begin with, usability was defined as the interaction of four elements: user, task, product properties and contextual environment surrounding them. As the findings in literature show, usability is a function of all four dimensions.

These elements are transformed to user characteristics, product properties, use context, and brand identity in order to deal with soft problems.

User characteristics refer to personal characteristics of consumers. Those characteristics include demographics, personality, cognitive aspects, personal values, culture, knowledge and experience. Product properties encompass type of product, cost of the product, importance of the product to the consumer, frequency of use, and severity of the problems.

Use context, which regards the situation in which a product is experienced, includes use in specific context, distributed cognition, and dynamic use. Brand image and marketing, manipulated by the company, can also affect consumers' expectation of product quality and use.

As a result of the interaction between user characteristics, product properties, use context, and brand image, a consumer is supposed to form certain expectations of product usability with a specific product. However, the initial expectation that the consumer had could be different from what s/he experiences in actual use of the product. When the consumer experiences more than his or her initial expectations on the product, s/he is likely to feel satisfied. However, negative disconfirmation leads to feelings of dissatisfaction.

A conceptual framework is proposed with regard to those factors as well as soft problems of electronic household products. This framework, partly derived from Donoghue and De Klerk (2006) who studied consumers' complaint behaviour concerning product failure of major electrical household appliances, integrates four major elements: user characteristic variables, product-specific variables, use context, and brand identity (Figure 17).

Unfortunately, the studies done so far have not dealt with the interaction of all the elements. Therefore, this project first sets a goal to explore whether factors, found in the literature, have to do with usability or not, and if that is not enough, it goes for broadening the scope of all possible factors. We try to find the correlation between the factors in details. It must be a challenge to deal with user characteristics that define a user, situations where a product is used, and product properties because details in each dimension could be infinite: e.g., every aspect of the product could lead to consumer complaints.

The outcome of these studies is used to define how user characteristics and product properties from a usability perspective interact and based on our outcomes and the findings in the literature a design methodology is developed for the new product development process.

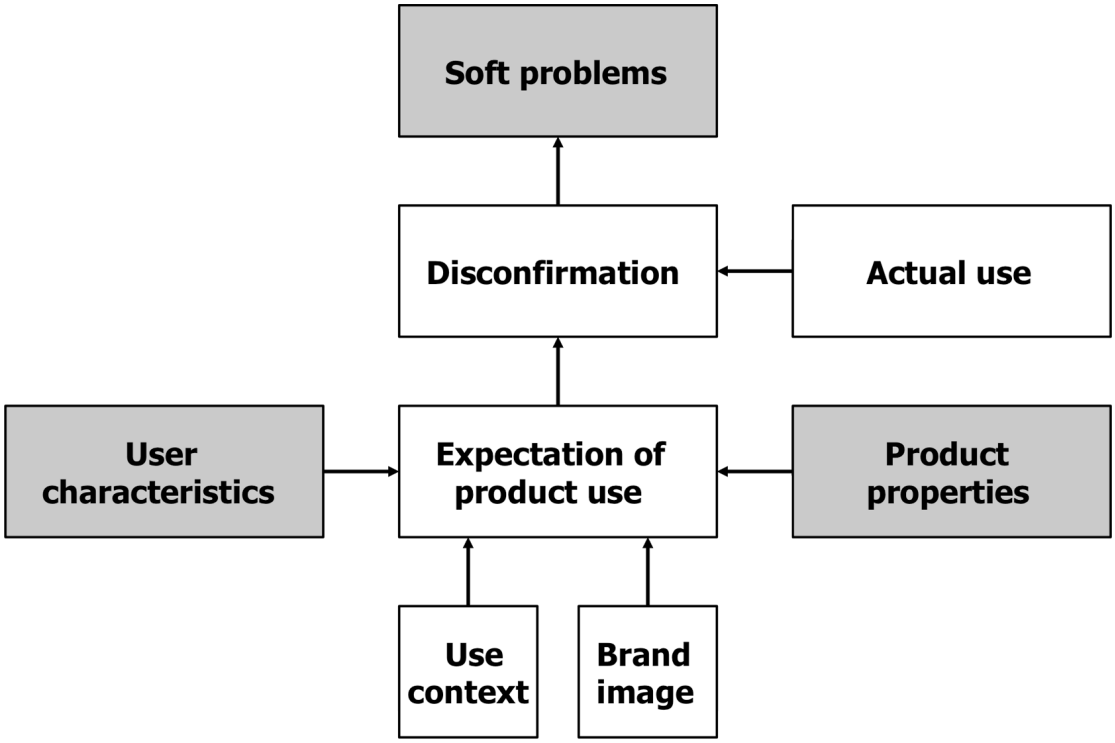

Figure 17 Conceptual framework for this study, adapted from Donoghue and De Klerk (2006)

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“I expected to comfortably hold it with my hand, but not at all!”

Age 29 | Male | New York, USA

This chapter is based on the paper:

Kim, C., & Christiaans, H. (2007). Soft Problems in Using Consumer Electronic Products. Paper presented at the IASDR conference, Hong Kong.

ABSTRACT

This chapter presents an explorative survey, through which the first research question, the root causes of soft problems, will be answered. 109 South Koreans and 46 Dutch people participated in the web-based questionnaire. They were asked to tell about soft problems with their electronic products. From the collected problems we first created categories of soft problems, analysed the correlation between product categories based on cognitive load and soft problems, and then compared the differences between both groups. The results indicate that most soft problems are very closely related to usability and they differ between product categories. Differences are also found between the two cultural groups. These findings provide starting points for revealing the interaction between user characteristics, product properties and soft problems. The implications of these findings are discussed.

CHAPTER 3 SOFT PROBLEMS WITH CONSUMER ELECTRONIC PRODUCTS

3.1 Introduction

Considering that experience in previous use of products influences purchase of new products, consumers who have been dissatisfied with a product even due to use problems are unlikely to buy the same product again (Geva & Goldman, 1991; Anderson, 1998; Schneider & Bowen, 1999; Spreng & Thomas J. Page, 2001; Bougie et al., 2003). This kind of dissatisfaction could also reproduce negative word-of-mouth publicity thus influencing the buying decision of other consumers (Anderson, 1998; Lau & Ng, 2001; Brown et al., 2005). Therefore, it is significant to know and understand soft problems, which have not been reported to the manufacturers, but which the consumer has experienced, compared with the technical problems reported. In the chapter, the first research question, what kind of use problems users have experienced with their electronic products, is answered. At present there is a lack of information on the causes of such soft problems. Hence, this chapter focuses on the root cause of soft problems experienced by the user in the interaction with consumer electronic products. First, soft problems in using consumer electronic products are explored in order to see if these problems are linked to the field of industrial design. Then, based on product categories, we examine whether or not soft problems are specific to a certain category of products. Finally, it has been found that customers in different cultures have different complaint behaviours and intentions (Manrai & Manrai, 1993; Chen-Yu, et al., 2001; Liu & McClure, 2001; Laufer, 2002; Han & Hong, 2003; Yuksel, et al., 2006). Moreover, people with different cultural backgrounds have different preferences regarding usability (Honold, 2000; Hariandja & Daams, 2005; Kim, et al., 2006; Ono, 2006). Accordingly, soft problems are compared between groups with different cultural backgrounds to determine whether cultural differences play a role in the kind and level of soft problems caused by dissatisfaction.

3.2 Method

A method had to be developed in order to address some of the issues raised here. First, some product designers were interviewed, focusing on consumers' complaints and the product development process. Based on the interviews, a questionnaire was designed to ask consumers about soft problems they experience. Participants were recruited to answer the questionnaire uploaded from a webpage on the Internet.

3.2.1 Interview

To set up an initial study for soft problems, four product designers were interviewed who were working or had worked at major companies that produce consumer electronic products for the international market in South Korea. As an explorative study, it was asked what kind of complaints and in what form they usually get from a helpdesk or from consumers, how they implement the demands collected from complaints in the process of product development, and finally what they think about soft problems from a manufacturer' s perspective.

3.2.2 Questionnaire

Several open-ended questions were formulated to discover the causes of the soft problems experienced by users. Under conditions where dissatisfaction with a product does not need to be settled as urgently as a request for help to a helpdesk or a service centre, the first question in the list was what product participants feel most dissatisfied with other than technical problems, while interacting with household electronic products. The second question was what specific dissatisfaction or complaints about non-technical complaints they have with the product mentioned in the first question.

3.2.3 Participants

South Korean and Dutch people were targeted in this study because, firstly, as members of OECD (Organization for Economic Co-operation and Development), they have no big difference in economic status and secondly, they differ in the cultural dimensions proposed by Hofstede (2003). According to Hofstede' s dimensions, the Netherlands can be regarded as a representative of Western European culture, with South Korea as a representative of Far East Asian culture.

A total of 155 participants participated in the web-based questionnaire: 109 Koreans and 46 Dutch, living in their own country were recruited through product review forums on the Internet. First, 109 Koreans and 23 Dutch took part in the open-ended questionnaire and then the other 23 Dutch participants, who have used an iPod, joined the web-based questionnaire focusing on the iPod as a product. The last group was involved in the study because we wanted to compare research methods focusing on a specific product versus on a broad range of products.

3.2.4 Procedure

A link to the questionnaire was placed in a website and designed in such a way that participants could answer the questions on the Internet in their own country. Participants were invited to visit the website and answer some questions by email. No restrictions were placed in the open-ended questions. The answers given by participants were automatically saved into a database on the Internet.

3.3 Results

Through the interviews and the web-based questionnaire raw data were obtained. The information from the interviewees gave an overview of soft problems in practice. Categorization of the soft problems was done on the basis of the complaints from the questionnaire. Again, soft problems were analysed or compared on many variables such as types of products, and cultural difference.

3.3.1 Interview

While interviewing the product designers, the focus was on three questions; how they gather consumer complaints, how they use those complaints in product design, and their opinion on soft problems. With regard to the first question, it was found that there was no official channel for them to get or gather consumer complaints in the companies. Thus, they actually did not know much about consumers' dissatisfaction. As a consequence of the fact that there was no channel to get feedback from the consumer, consumer complaints were not considered in the following product development process. In addition, there is no information available on soft problems of a non-technical nature to give insight into the cause of the consumer' s dissatisfaction. Regarding the question as to how they cope with the soft problems that emerge in the consumer electronic product market nowadays, they gave the common opinion that soft problems are very difficult to deal with in the field of product design because every aspect of the product can pose a soft problem to someone because of diversity in preference and personality among consumers. Therefore, consumer complaints including soft problems were not regarded as an important factor in the process of product design in industry, despite the fact that product returns resulting from non-technical failures are growing.

3.3.2 Categorization

A total of 336 complaints were reported through the web-based questionnaire in South Korea and the Netherlands. As mentioned in the interview with the product designers, soft problems come in a wide variety. While user problems have usually been translated into product design terms such as conceptual models, mapping, affordance, etc., in this study soft problems were categorized based on the consumer' s point of view in this study (see Figure 18 and Table 5). In order to avoid culturally biased interpretation categorizing was conducted by four independent judges (two Dutch and two Korean). The result was a categorization of the 336 soft problems on consumer electronic products into 9 main categories and 24 subcategories.

Figure 18 Categorisation of soft problems

Table 5 Categorization of soft problems

Category	Description	Quote
Understanding		
Functions	Users know that a function exists and have no difficulty in finding it, but they don't understand how to use it.	"Difficult to understand how to use a specific function" (mobile)
Navigation	Users have difficulty in finding a specific function.	"Many steps are required to use a function" (mp3 player)
Lack of need	Users don't use and need some functions. Sometimes these functions just confuse them.	"Too many useless functions" (digital camera)
Performance		
Compatibility	Product is impossible or difficult to use with other software or hardware.	"Not all songs are playable" (mp3 player)
Time	Product is annoying because it is too slow or too fast.	"It is too slow" (laptop computer)
Battery	Battery life is not long enough and seems to become less and less.	"Battery is gone very fast" (vacuum cleaner)
Efficiency	Product is less efficient with regard to technical performance.	"My bread is still frozen or burned" (microwave)
Error	Sometimes an error occurs that cannot be solved through a helpdesk.	"Frequent errors and jams" (printer)
Sensation		
Sound	Product is not loud enough to listen to or is too noisy.	"Noisy" (vacuum cleaner)
Tactility	Users feel unpleasant touching or using product.	"Uncomfortable touch feeling" (mobile phone)
Weight	Product is heavy to carry or use.	" Heavy to carry" (digital camera)
No sense	User cannot feel any differences between options or levels.	"I don't know how to estimate how much coffee and water I am supposed to put" (coffee machine)
Health		
Fatigue	Users feel tired or fatigued in a part of their body while using product.	"I can't use it for a long time" (mouse)
Safety	Users are worried about harming their health.	"Electromagnetic wave" (mobile)
Product structure		
Cable	Product is annoying because of its cable.	"Annoying cable" (earphones)
Structure	Users feel uncomfortable because of product's mechanical structure.	"USB slots are backside" (laptop computer)
Shape	Product is too small or big to comfortably use or press. Problems occur because of its exterior form.	"Hard to press or read the buttons because of their small size or shape" (mobile)
Connection	Ejecting or connecting is irritating.	
Maintenance		
Service	It is difficult to get help or support.	"The helpdesk is hopeless"(stereo)
Cleaning	It is annoying to clean a product.	"There are too many things to do for it" (coffee machine)
Care	Product requires more care.	"Easy to drop because it's small and sleek" (mobile)
Durability	Product is not strong or durable enough.	"Painting is easily worn out" (digital camera)
Constraint		
Lack of function	Users feel a need for a specific feature or function, with which the product would be more convenient to use	"Many functions but no particular function I need" (mp3 player)
No improvement	Product is not improved compared with its previous version	"My new mobile is the same as the old one" (mobile)
Insufficient information	There is no feedback or feedforward in use	" I can't see how long the program will run" (dishwasher)
Trend		
	Product's design soon becomes boring or old-fashioned	"The design easily becomes boring and old-fashioned" (refrigerator)
Third party		
	The problem comes not from the product itself but from a third party.	"Spam messages" (mobile)

3.3.3 Soft problems

At first glance, not all subcategories of soft problems may appear to be closely linked to the field of product design. However, by taking a wide definition of product design (Han, et al., 2001), all the categories shown above are in fact dealt with in the process of product development. Some of them fall under product strategy, some under product safety and form- giving, and others under product usability in that they include both emotion and performance of products (Tractinsky, et al., 2000; Han, et al., 2001).

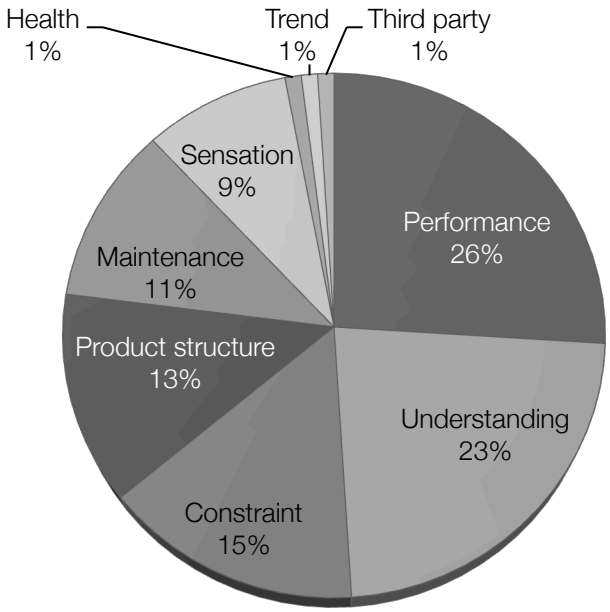

Figure 19 Soft problems in per cent of total number of complaints (k=336)

The most commonly occurring soft problem experienced was with regard to the performance of products (see Figure 19). People' s complaints are about low compatibility, too slow or too rapid response time, low battery life, low efficiency and irregular errors of products. This is different from the technical problems, where products cannot be used at all any more, in that the product still works and is still used, even though users are dissatisfied due to the soft problems. Then, secondly, complaints about understanding are largely reported. This category consists of subcategories of understanding, finding, and lack of need. The participants complained about having difficulty in understanding or finding functions. Furthermore, they were dissatisfied because products had many functions they did not need or use, confusing them when using these products. Constraint is ranked in the third place. Constraint means that a product lacks a necessary function, is not improved compared with its previous version, and gives insufficient information despite a consumer need for feedback or feedforward. Fourth, the participants said that they had complaints about the structure of products: electronic products had a complex wiring system or a short cable, an irritating connection, uncomfortable mechanical structure, or were too large or too small in shape. Soft problems ranked in the fifth position were related

to product maintenance. The participants expressed dissatisfaction with disappointing service, difficult cleaning, special care, low durability, or the production of (a) by-product(s) while using the product. Maintenance was followed by sensation, which is linked to human sensual dissatisfaction such as low sound quality, uncomfortable tactility, heaviness, heat generated by products, and obscure sensual perception. The others are health, trend, and problems due to a third party, which were the lowest ranked in soft problems by the participants. For health, they complained that they felt tiredness or fatigue while or after using. And for trend, their complaint was that their products became old-fashioned too soon after having bought them. Finally, for the problem due to a third party, their complaint was that they were irritated by spam messages on their mobile phone.

3.3.4 Product categories and soft problems

Based on the soft problems and products that the participants complained about, a next step is to investigate the correlation between products and product category. Because there is variance in consumer complaints across different types of products (Oster, 1980), products were also categorized based on the cognitive effort required for use (see Table 6 and Figure 20). For instance, more mental load is invested in using a laptop computer than a coffee machine. Besides, there are more possible adjustment and interaction opportunities with a laptop computer than with a coffee machine.

The results show that most of the soft problems come from products in category 2 (see Figure 21). The soft problems in category 1 and 3 were placed second and third respectively. Ironically, the least soft problems were experienced with the most complex products.

The diagrams below show the percentage of soft problems according to product category (see Figure 22, 23, and 24). Considering the four major soft problems that account for more than 50%, it was found that there is a major difference between product categories. For category 1 products the soft problems, product structure, understanding, maintenance, and performance are ranked highest while the most important soft problems for category 2 products are performance, understanding, constraint, and maintenance. Finally, performance, sensation, product structure, and maintenance account for most soft problems in category 3. For the category 1 products participants expect them to be well organized in terms of shape and structure. The functions of category 1 and 2 products are expected to be easily found and understood. On the other hand, ‘ sense’ -friendliness and high performance are expected in the fairly complicated category 3 products. These differences between categories demonstrate that soft problems are dependent on the type of products as categorized according to the cognitive level required to use them.

Table 6 Product categories based on cognitive effort

Category	Description
Category 1	Simple products with buttons that have distinct functions
Category 2	Complicated products with several adjustments
Category 3	Highly complex products with almost infinite functions and adjustments

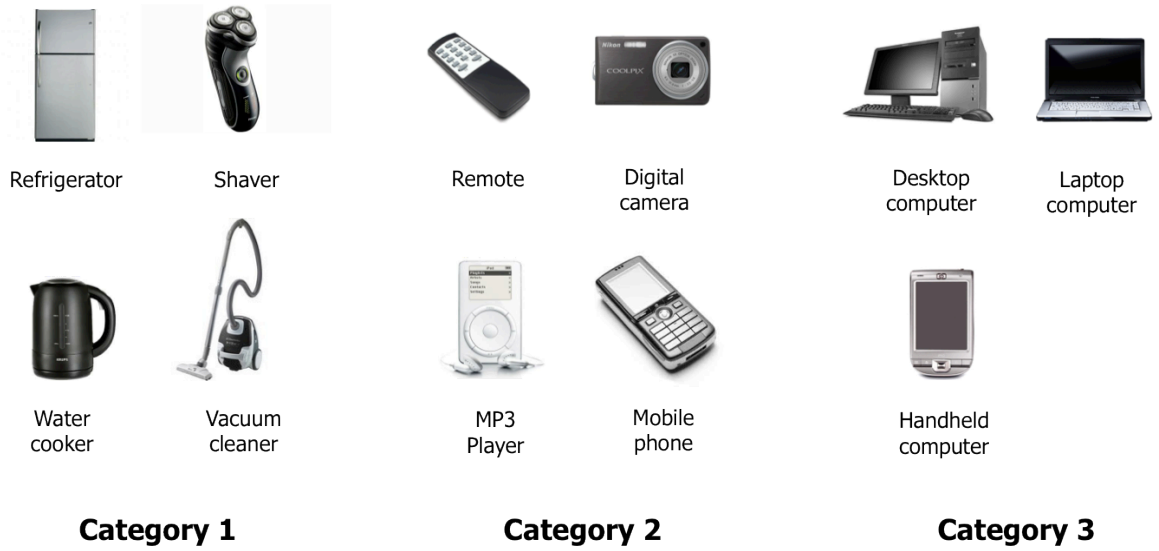

Figure 20 Examples of each category based on cognitive effort

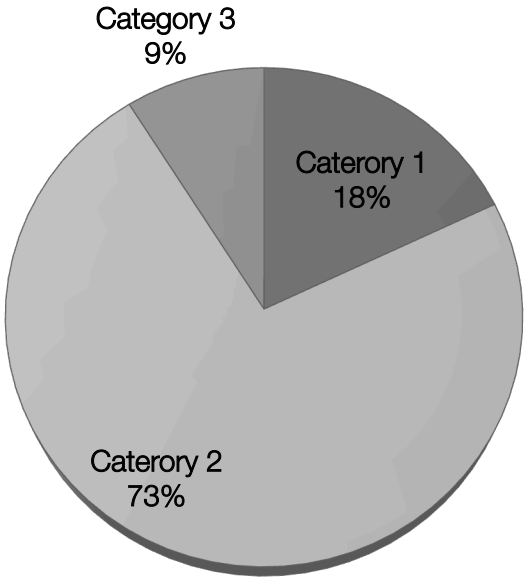

Figure 21 Proportion of soft problem per product category

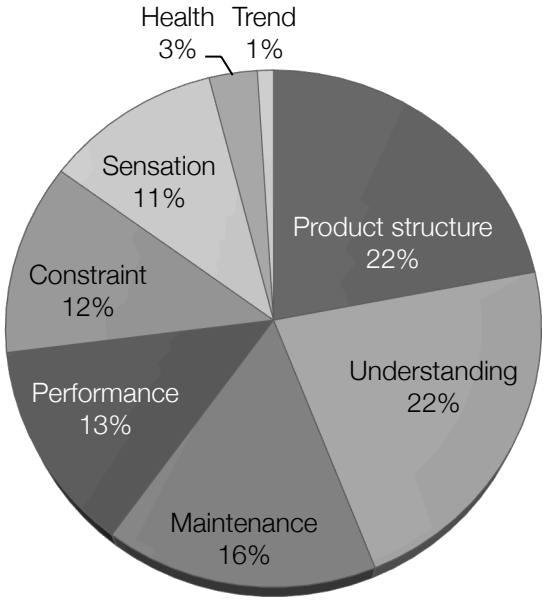

Figure 22 Soft problems with category 1 products
(in per cent of number of complaints; k=76)

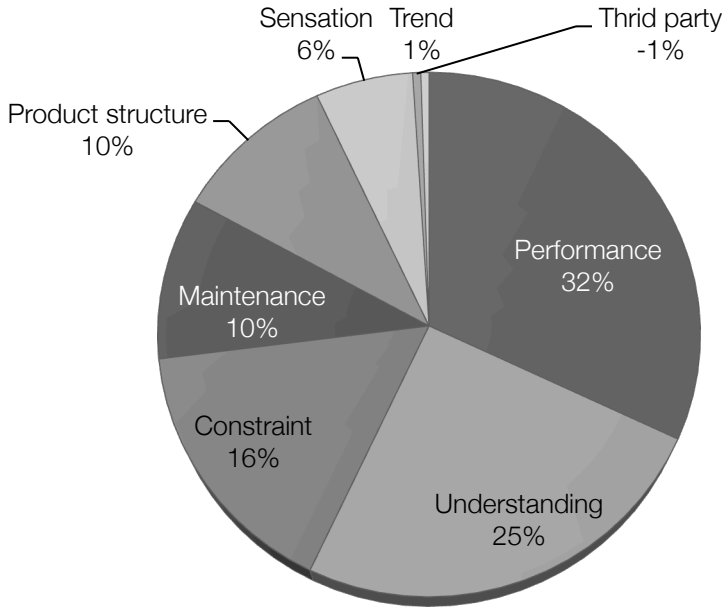

Figure 23 Soft problems with category 2 products
(in per cent of number of complaints; k=232)

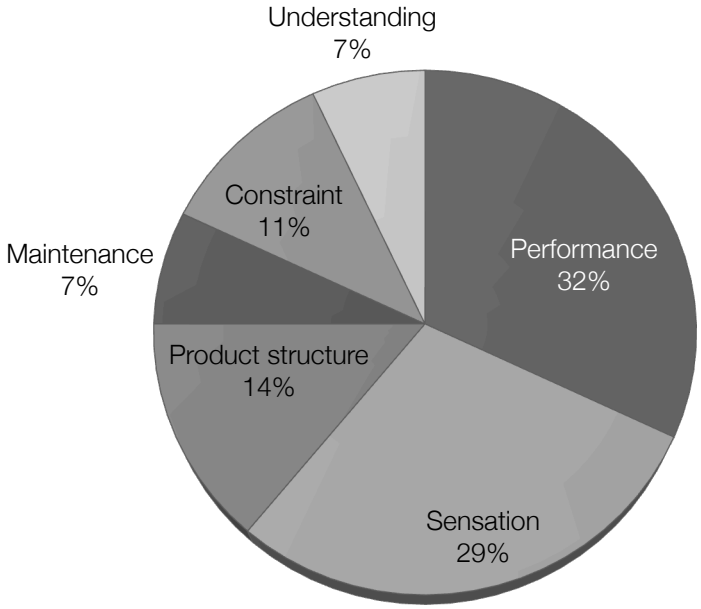

Figure 24 Soft problems with category 3 products
(in per cent of number of complaints; k=28)

3.3.5 Cultural difference in soft problems

Two samples of participants with different cultural backgrounds participated in this study, people from the Netherlands and South Korea. The aim was to investigate whether or not culture influences soft problems by comparing people from the two countries. The number of soft problems reported was again used for comparison. First, the total number for each problem category was compared. Second, they were compared again according to product category. However, the number of soft problems between product categories between the two groups could not be compared since half the Dutch participants were iPod users who described only their iPod from a soft problem perspective.

Soft problems between the cultural groups

Figure 25 shows the distribution of soft problems for both cultural groups. In order to see if the differences are significant, the Mann-Whitney U test was used. See Table 7 for the results. Understanding, sensation, and constraint are significantly different between the Dutch and the South Koreans.

Soft problems per product category between the cultural groups

The same comparison was made for each product category (see Figure 26, 27, and 28). To determine the significant level the Mann-Whitney U test was used again. As Table 9 shows the two cultural groups differ significantly regarding complaints about understanding, sensation, and constraint of category 2 products; but there are no

differences in category 1 and 3 (see Table 8 and 10). However, considering the noticeable differences in the graphs the lack of statistical significance is probably due to the low number of complaints.

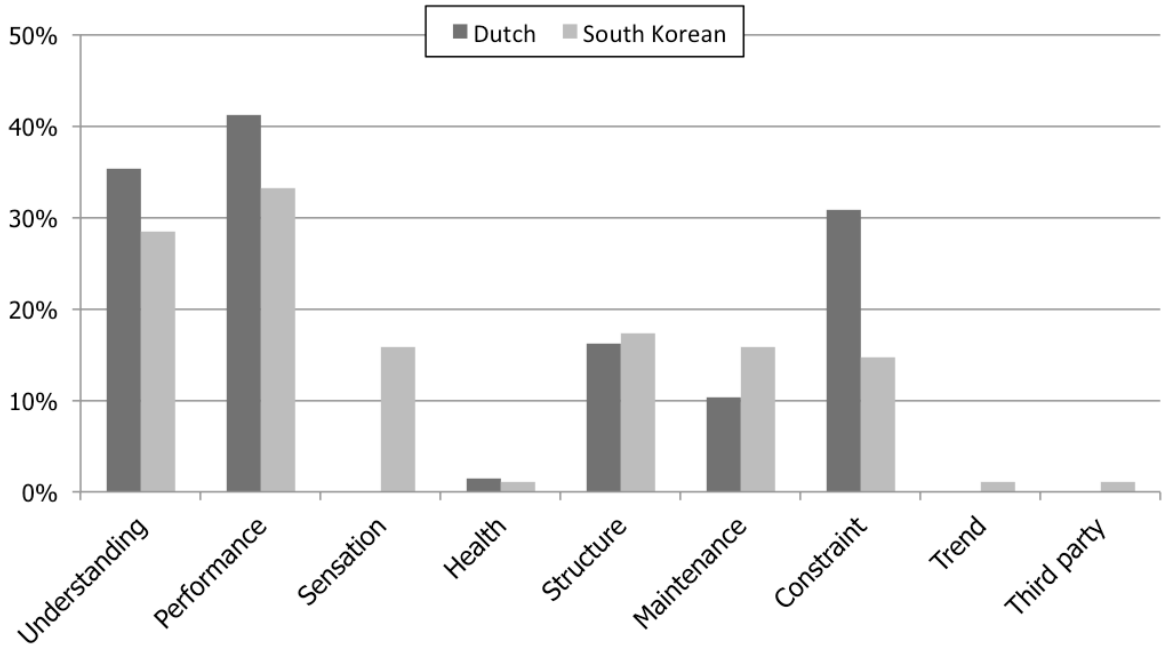

Figure 25 Soft problem comparison between Dutch and South Korean samples

Table 7 Mann-Whitney U test result on all the soft problems

	Under.	Perfor.	Sensa.	Health	Struct.	Mainte.	Constr.	Trend	Third.
Mann-Whitney U	1667	2081	1710	2171	2175	2184	1733	2160	2160
Wilcoxon W	9170	9584	2376	9674	9678	2850	9236	2826	2826
Z	-2.69	-.54	-3.09	-.44	-.12	-.07	-2.50	-.77	-.77
Asymp. Sig. (2-tailed)	.00**	.59	.00**	.66	.90	.94	.01*	.44	.44

Grouping Variable: cultural background.

**p < .05. ** p < .01.*

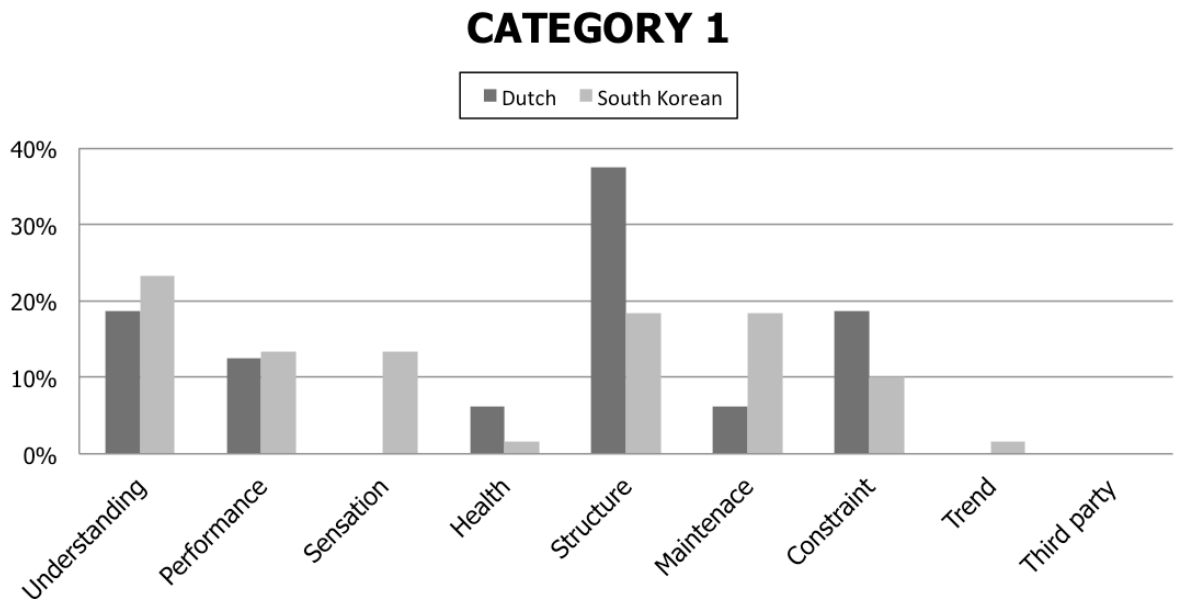

Figure 26 Soft problem comparison in product category 1

Table 8 Mann-Whitney U test result on the soft problems in category 1

	Under.	Perfor.	Sensa.	Health	Struct.	Mainte.	Constr.	Trend	Third.
Mann-Whitney U	177	176	144	164.5	133	159	147	175.5	180
Wilcoxon W	997	996	189	984.5	953	204	967	220.5	1000
Z	-.11	-.15	-1.45	-1.17	-1.61	-.78	-1.27	-.47	.00
Asymp. Sig. (2-tailed)	.91	.88	.15	.24	.11	.44	.20	.64	1.00

Grouping Variable: cultural background.

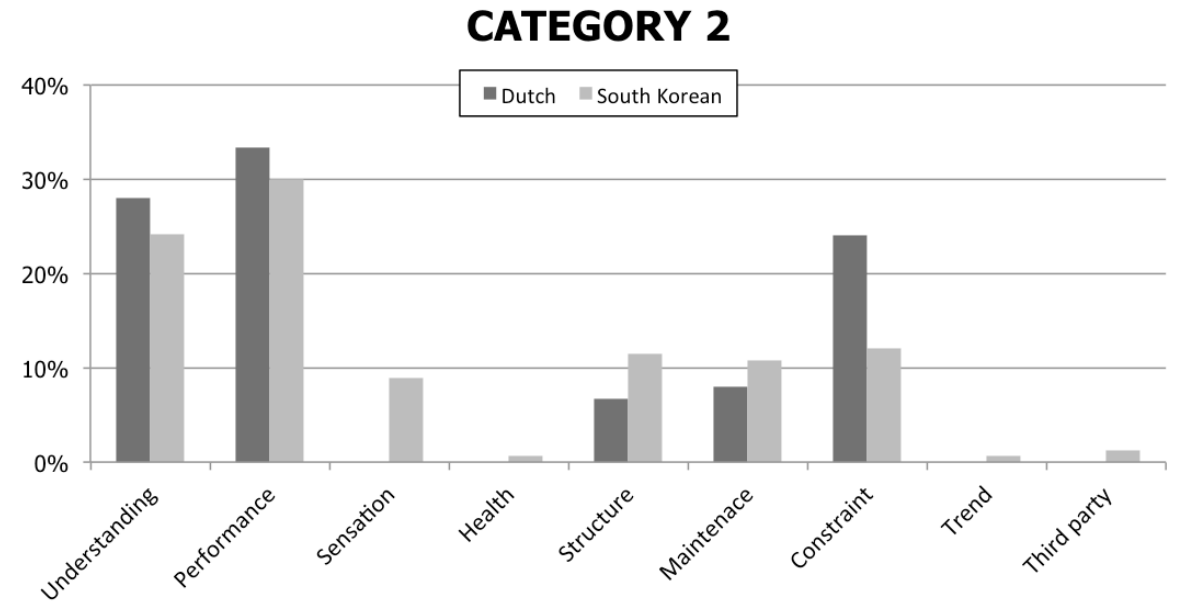

Figure 27 Soft problem comparison in product category 2

Table 9 Mann-Whitney U test result on the soft problems in category 2

	Under.	Perfor.	Sensa.	Health	Struct.	Mainte.	Constr.	Trend
Mann-Whitney U	638	874.5	741	884	831	862	695.5	884
Wilcoxon W	3053	3290	1092	1235	1182	3277	3111	1235
Z	-2.48	-.20	-2.26	-.61	-.78	-.42	-2.07	-.61
Asymp. Sig. (2-tailed)	.01*	.84	.02*	.54	.44	.67	.04*	.54

Grouping Variable: cultural background.

**p < .05.*

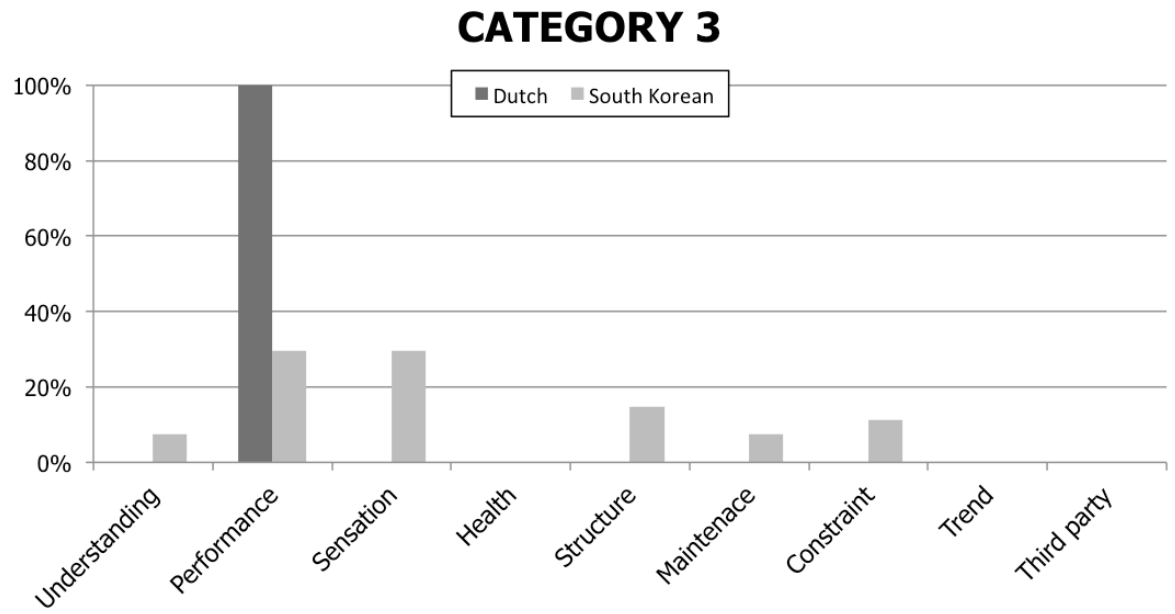

Figure 28 Soft problem comparison in product category 3

Table 10 Mann-Whitney U test result on the soft problems in category 3

	Under.	Perfor.	Sensa.	Health	Struct.	Mainte.	Constr.	Trend	Third.
Mann-Whitney U	5.50	3.50	3.00	6.50	5.00	5.50	5.00	6.50	6.50
Wilcoxon W	6.50	94.50	4.00	97.50	6.00	6.50	6.00	97.50	97.50
Z	-.41	-.83	-.97	.00	-.52	-.41	-.52	.00	.00
Asymp. Sig. (2-tailed)	.68	.41	.33	1.00	.60	.68	.60	1.00	1.00

Grouping Variable: cultural background.

3.4 Conclusions and Discussion

Rather than taking a general, theoretical approach to soft problems, we chose to define, explore and compare them and how they relate to product type and user culture. In doing so, this represents an attempt to gain insight into the soft problems that are becoming more and more prevalent by weighing the appropriate empirical evidence.

All the soft problems surveyed through the web-based questionnaire are dealt with in the

field of product design, although they are very diverse. They seem closely related to product design. Accordingly, the reported soft problems can play an important role in product design because they have hardly been considered in the process of product development to date, even though more and more consumers complain about these non-technical failures. According to responses given by the participants, it can be concluded that most consumers feel dissatisfaction with the low performance of products, with difficulty in understanding functions and with constraints, even though they may meet technical specifications. For products requiring less cognitive effort, product structure, understanding, and maintenance are the main causes of soft problems, while they are not considered to be the major causes for products requiring more cognitive effort. It is interesting that soft problems related to sensation are followed by performance for the most complex consumer electronic products, and also that most soft problems come from the second product category (e.g. mobiles, digital cameras). The fact that the least soft problems are reported in the third product category, which requires the most cognitive effort, implies that ease of use is the main issue that needs to be dealt with in the second category.

Soft problems are ranked differently in each product category. This demonstrates that soft problems are dependent on the type of product. Product developers can therefore give priority to some aspects that are relatively more important to a particular category under which a new product falls rather than others when developing and designing the product.

The results also show that soft problems differ between people with different cultural backgrounds. This means that it is necessary to take into account cultural aspects or local preference when a product is developed for a market with a different culture. However, it appears necessary to further study soft problems in product categories 1 and 3, because the number of complaints about products in both categories was small and thus may have influenced the result of the comparison between the two cultural groups. For the research method, it was found that using open-ended questions on products having a soft problem is much more useful than focusing on a specific consumer product in order to get to know a broad range of soft problems. These explorative findings therefore represent a starting point for further research, as soft problems are diverse and dependent on product type and user culture. This is also considering the current trend of consumers complaining more often about the non-technical aspects of consumer electronic products.

In conclusion, these findings are used for the follow-up study, aimed firstly at finding the correlation between the soft problems associated with certain electronic products and the characteristics of users as to their sensorial, mental and physical capacities, and secondly, the limitations coupled to differences in, for instance, age, gender, and culture.

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PART B

THE INTERACTION BETWEEN
USER CHARACTERISTICS,
PRODUCT PROPERTIES
AND SOFT PROBLEMS

This chapter is based on the paper:

Kim, C., & Christiaans, H. (2012). 'Soft' usability problems with consumer electronics: the interaction between user characteristics and usability. Journal of Design Research, 10(3), 223 - 238.

ABSTRACT

In this chapter a survey is described with a new categorization of soft problems. The aims of the survey are to see if user characteristics and product properties are related to particular soft problems (the second research question), and to filter out insignificant user characteristics for further study. 60 Dutch and 59 South Korean people participated in the survey, in which both soft problems, user characteristics and product properties were measured. The findings indicate that a number of demographic, socioeconomic and cultural characteristics as well as personal traits show significant correlations with soft problem type. Moreover, experienced problems seem to differ with product properties.

CHAPTER 4 DO USER CHARACTERISTICS MATTER IN SOFT PROBLEMS?

4.1 Introduction

In this chapter, the second research question, whether user characteristics and product properties are related to particular soft problems is answered. In the previous study a survey among Dutch and South Korean people was conducted in order to get more insight in the kind of soft problems consumer experience. On the basis of the complaints nine categories of soft problems were defined: low understanding, poor performance, sensory problems, (expected) health problems, lack of structure, maintenance failures, functional constraints, trend sensitivity, third party interference. These categories were related to product qualities such as sensory, functional, and operational quality (Madureira, 1991; Dantas, 2011). The nine categories were categorized again into the three product qualities: in most of cases, sensation, structure, health and trend are related to sensory quality, performance, constraint, and third party belong to functional quality, and understanding and maintenance are linked to operational quality of electronic product (see Figure 29).

Sensory quality is related to the sensory perception. By means of the perceptive faculties, assessments are made through the senses of the structure, the visibility, the weight, the sound, the texture, and the smell of the product. The response to this quality is usually immediate and momentary, based on human body sensors. It leads to pleasant or unpleasant experiences. User dissatisfaction related to the quality is related to awkward product structure, visual hindrance, over- or low- weight, noise, irritating touch, and unpleasant smell.

Functional quality is related to how well the instrumental aim of a product is achieved. This quality is evaluated through the results obtained in making use of the product after repetitive use on a long-term base. Accordingly, the appreciation of the quality is not immediate and it lasts long. Complaints related to this quality mostly result from the technological limitation or lack of durability of products: for instance, functional constraints such as lack of function and incompatibility, low performance in terms of for example slow reaction and short battery sustainability, irregular unexpected error and frequent breakdown. They are also related to poor product service.

Operational quality is related to user' s cognitive efforts and care, often leading to physical efforts spent during the whole life of the product. Although the response on poor operational quality starts immediately, the effects are long-lasting. The user evaluates the ease to use, the need for maintenance and repairs. Complaints related to this quality are

made because the usage of the product requires continuous cognitive efforts and care; for example, difficulty in understanding functions, confusing navigation, too much care and inconvenient maintenance. Any shortcoming in operation quality mainly results from lack of information and feedback.

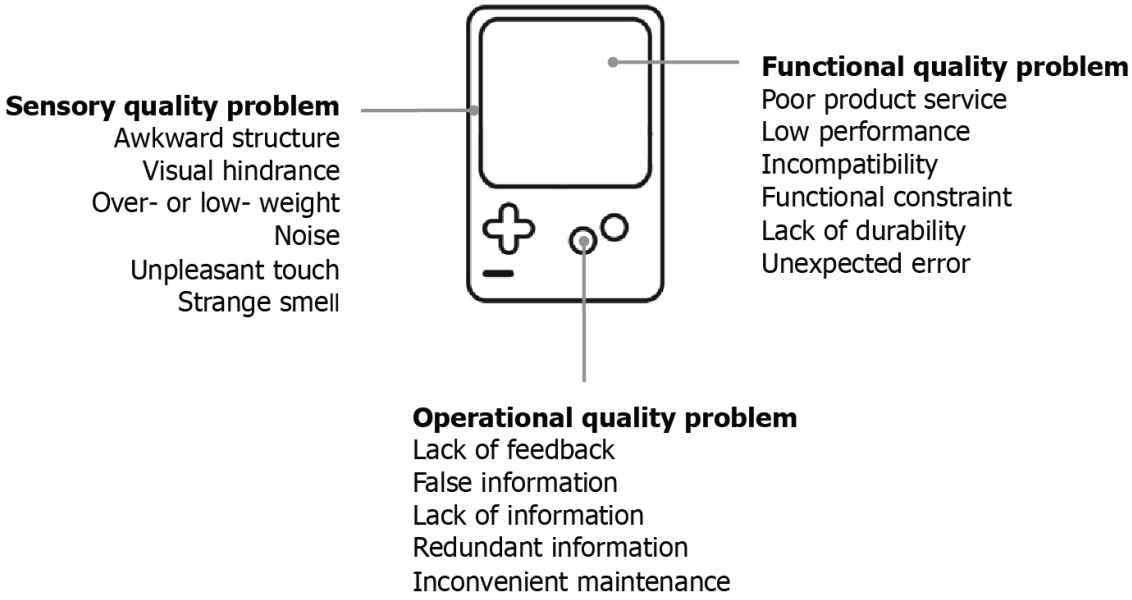

Figure 29 Three Categories of Soft Problems

These interaction qualities become the three categories of soft problems in the following studies on.

According to literature, complaining behaviour show high correlation with particular user characteristics. However, the focus is on why people complain and not on the reasons for complaining: the problems with products. Considering a number of user characteristics dealt with in literature, it is necessary to filter out insignificant factors. Therefore, this chapter focuses on how soft problems are related to user characteristics and product type in an explorative manner.

4.2 Method

In order to investigate what soft problems users experience with electronic consumer products and to measure their personal characteristics a questionnaire was developed. South Korean and Dutch participants were recruited to participate in the study.

4.2.1 Participants

A total of 119 participants participated in the survey: 60 Dutch (34 males and 26 females) and 59 South Korean (37 males and 22 females) people, who live in their home country (See details in Table 11). Since culture plays a role in the field of product design two countries were selected (Hofstede, 2003; Kim, et al., 2006). They were randomly recruited

through discussion forums on the Internet and through the network of the researchers. Their age ranges from late teens to 60. It turned out that 15 participants reported that they had no complaints about their electronic products. It would have been interesting to compare complainers with non-complainers, but (1) this was not the aim the study, and (2) the number of non-complainers was too small. They were, therefore, excluded in the study.

Sample selection in this way is not scientific if the aim is to generalize findings to the total population from which the sample has been selected. However, this study had an exploratory character meant to derive hypotheses for a next study.

Table 11 Demographic Characteristics of Complainers (N=104)

Demographic factor	Frequency	% per variable
Age at time of survey (years)		
17-29	64	61
30-39	23	22
40-49	8	8
50-59	9	9
Gender		
Male	67	64
Female	37	36
Highest education level completed		
High school graduate	1	1
Junior college graduate	9	9
University graduate	22	21
Postgraduate (Master degree)	46	44
Postgraduate (Doctoral degree)	26	25
Cultural background		
South Korean	59	57
Dutch	45	43

4.2.2 Questionnaire

Two open-ended questions were formulated to discover the causes of the soft problems experienced by users in the questionnaire (see for the first question Figure 30). The first question was with what product participants feel most dissatisfied with, other than technical problems, regarding interacting with electronic household products. In the second question, participants were asked to explain for the product, mentioned in question 1, what specific dissatisfaction or complaints they had. The other questions were about user characteristics, which consist of demographic factor, cognitive aspect, and personality trait (Table 12). The variables were selected on the basis of research findings in the field of consumer complaining behaviour and consumer (dis)satisfaction (Aykin & Aykin, 1991;

Leventhal, et al., 1996; Keng & Liu, 1997; Mooradian & Olver, 1997; Stephens & Gwinner, 1998; Chen-Yu & Hong, 2002; Khalid, 2006). Donoghue and De Klerk' s conceptual framework (2006) on consumers' complaining behaviour was another source for our selection. They made a distinction between causal attribution, user characteristic and product-specific variables. This division was used to come up with a conceptual framework in our study as well. For most questions a five-points scale was used while some were dichotomous (yes or no) and multiple choice (e.g. locus of control). In order to increase the reliability of the scores on some variables questions were asked twice, with the same content but with different formulation. In the analysis, the mean of the two similar questions was taken as data. In Table 12 the variables with an asterisk (*) include that type of questioning.

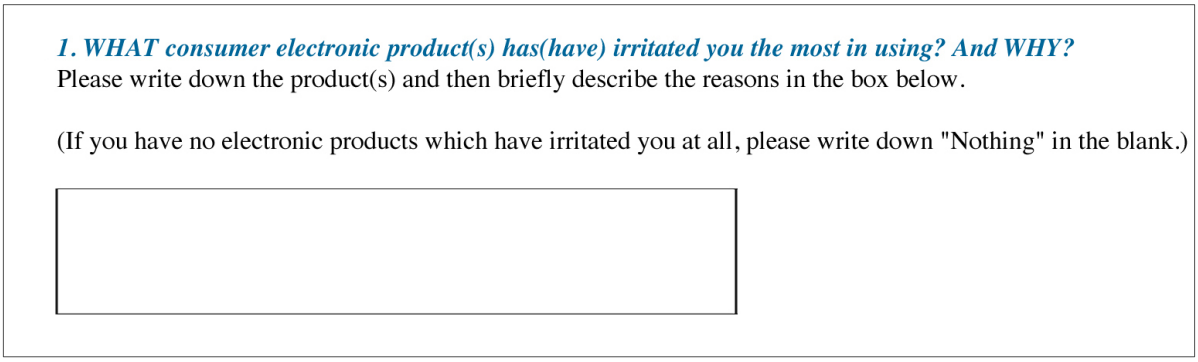

Figure 30 An Example of Question in the Questionnaire

Table 12 List of User Characteristics measured

User characteristic	Measured variable
Demographic factor	Age, Gender, Educational level (the higher number the more educated) and Nationality (cultural background)
Cognitive aspect	Memory (the higher number the more memorizing ability)* and Use fixation (the higher number the higher use fixation) *
Personality trait	Patience (the higher number the more patient)*, Locus of control (the higher score the stronger external locus of control), and Uncertainty avoidance (the higher score the higher uncertainty avoidance)

4.2.3 Procedure

The participants participated in the survey by filling in either a web-based questionnaire or a questionnaire on paper. Through discussion forums for product review and the network of the researchers people were invited to visit a website where the questionnaire were uploaded. The answers given by them were automatically saved into a database on the Internet. The second way to recruit participants was through the researchers' network of

people who live either in Korea or in the Netherlands. They were asked to fill in the questionnaire on paper. All the answers from both the web-based and the paper questionnaire were input into a SPSS data sheet and were then statistically analysed.

4.3 Results

Demographic variables of the sample are presented in Table 12. The survey came up with 185 complaints that have no relation with technical failure. Some participants reported more than one complaint. The statistical analysis was based on 185 complaints in total. First, the complaints reported are classified based on the three soft problem categories and on two consumer electronic product properties such as cognitive load and interaction density. Next, the relationships between soft problems and product properties will be explored, followed by the interaction between user characteristics and soft problems. The sample will not be representative for the total population between 20 and 60 years old. Because most participants are not recruited or selected other than through a Web-platform, they will be probably representative for the population of internet visitors: more men than women, most of them from the age group between 20 and 30, and highly educated. Nevertheless, for the purpose of this study this ' biased' sample can offer interesting insights into the relationship between user characteristics and soft problems.

4.3.1 Soft problems and product properties

These complaints reported through the questionnaire survey concerned a total 35 types of electronic products. Together with the types of products that were complained about the results are summarized in Figure 31. The numbers in the figure show the frequency of complaints on each soft problem without distinction between both countries. The total number of 35 types of household electronic products complained about varies from mobile phone and desktop computer to shaver and toaster. Most complaints are about complex electronic products such as mobile phones while simple ones such as washing machine cause relatively less trouble. Interestingly, there were many complaints related to the vacuum cleaner although it is a simple product.

Since there was variance in consumer complaints across different types of products, the products were first divided in two categories according to operational transparency (Figure 32). Operational transparency refers to the extent to which cognitive load in operating an electronic product is required or an electronic product is operationally easy to use. The number of functions is related to the extent to which an electronic product is operationally transparent. For instance, more mental load is invested in operating a laptop computer, or mobile phone that belongs to operationally non-transparent category, than a coffee machine, which belongs to operationally transparent category. They were also divided in two categories according to physical interaction density (Figure 33). Physical interaction density refers to the extent to which an electronic product is involved in physical interaction

while using the product. For example, close physical interaction between user and product occurs in using a vacuum cleaner or shaver that belongs to high interaction density category than a washing machine or toaster that belongs to low interaction density category.

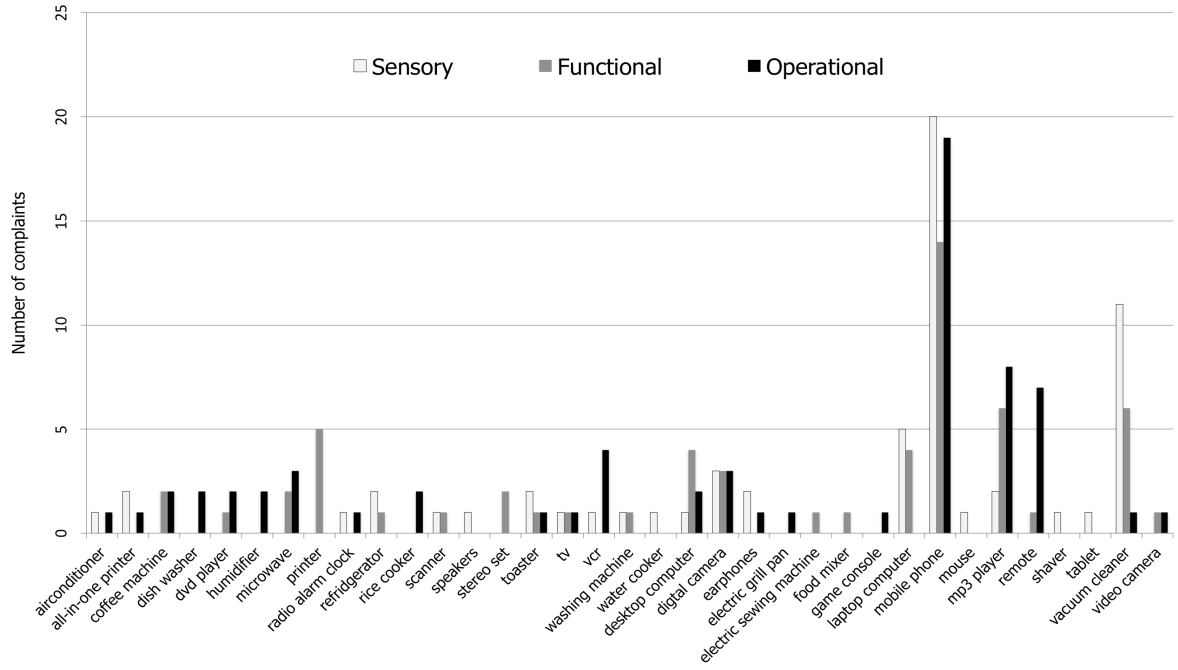

Figure 31 Number of soft problems per product

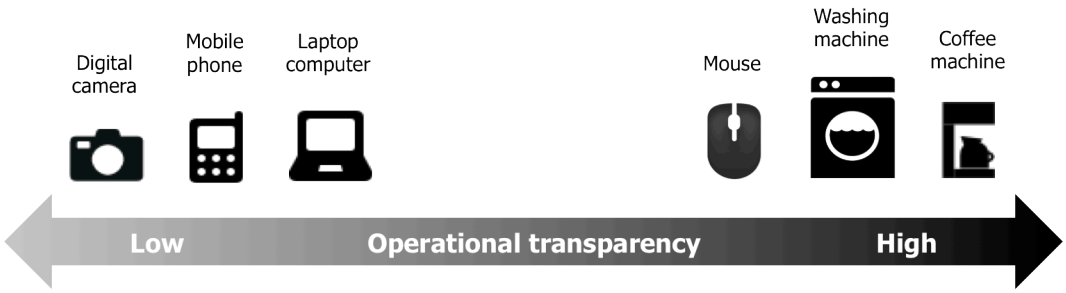

Figure 32 Examples of electronic products according to operational transparency

Figure 33 Examples of electronic products according to interaction density

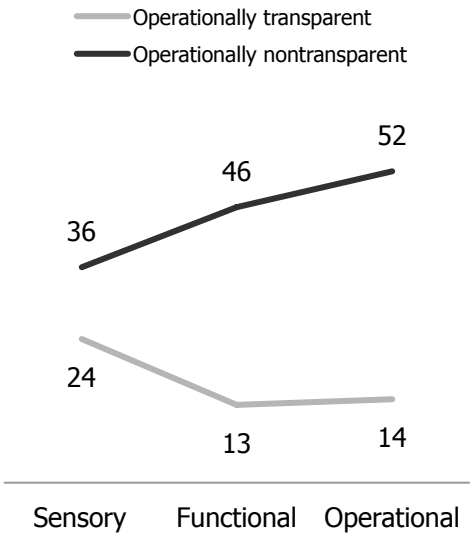

Figure 34 Relation between type of soft problem and operational transparency (in frequency)

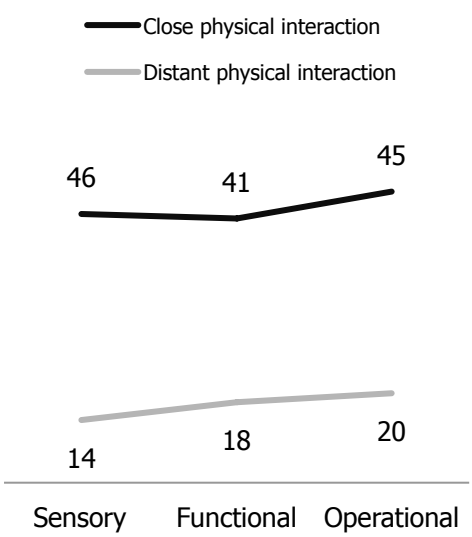

Figure 35 Relation between type of soft problem and interaction density (in frequency)

Figure 34 and 35 show the number of complaints per type of soft problem in terms of each product property. According to Chi square analysis there was a significant association between cognitive load and soft problem categories ($x^2(2)=6.67$, $p=.036$). Complaints about electronic products requiring low cognitive load or being easy to use (e.g. refrigerator, shaver, and mouse) are mostly related to sensory quality but least to functional quality. On the other hand, complaints about electronic products requiring high cognitive load or being hard to use (e.g. laptop computer, mobile phone, and mp3 player) are mostly related to operational quality but least to sensory quality. Although there was no statistically significant correlation between interaction density and soft problem categories ($x^2(2)=1.28$, $p=0.527$), it seems that complaints about distant physical interaction electronic products (e.g. microwave, washing machine, and coffee machine) are linked to operational quality and close physical interaction products (vacuum cleaner, remote, and mobile phone) to sensory quality.

Every product reported in the study belonged to either high or low level of each product characteristics: that is, whether a product is operationally transparent vs. non-transparent and close interaction vs. distant interaction. Looking at products that are mostly complained about, three major soft problems were identified in each product attribute domain defined by the two dimensions. The results indicate that soft problems are partly dependent on product property in terms of operational transparency and physical interaction density (see Figure 36). In operationally transparent but distant physical interaction products (e.g. washing machine and refrigerator) problems related to operational quality were most reported. These problems were also most reported in operationally non-transparent but close physical interaction products (e.g. mobile phone

and laptop computer). However, sensor related problems were secondly ranked for the former while function-related problems secondly ranked for the latter. Whereas, sensory quality plays a dominant role in operationally transparent but close physical interaction product group (e.g. vacuum cleaner and earphones) while problems related to functional quality were the biggest in the operationally non-transparent and distant physical interaction product group (e.g. printer and microwave).

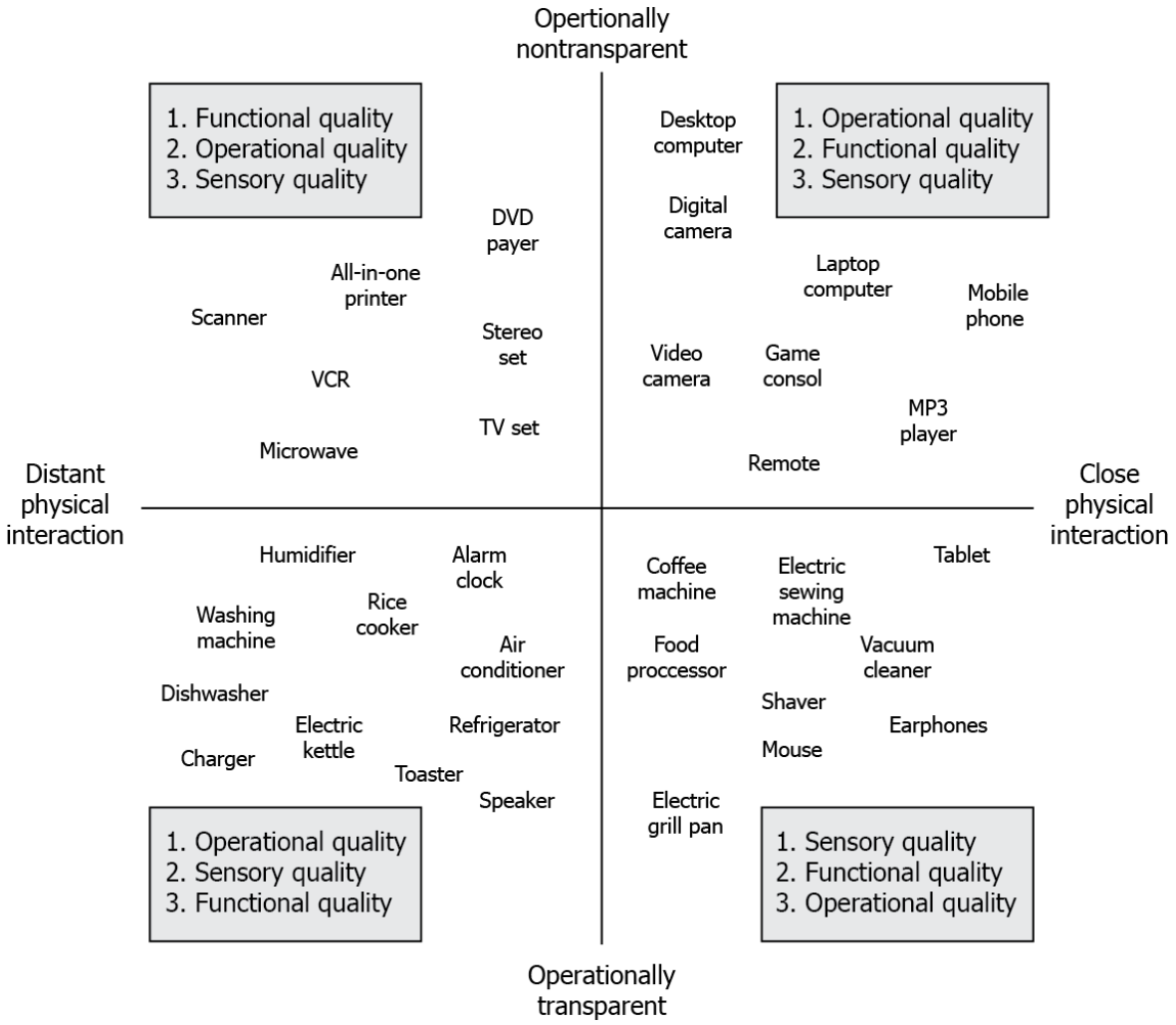

Figure 36 Electronic product distributions on operational transparency and physical interaction density graph and dominant soft problems in the four product attribute domains

4.3.2 User characteristics and soft problems

In order to get a deeper understanding of the correlations a multinomial logistic regression was used for predicting the probability of occurrence of a particular soft problem type together with a particular user characteristic (Table 13, 14, 15 and 16). A multinomial logistic regression for three categories compares sensory quality complaint group to functional quality complaint group (Table 14), operational quality complaint group to functional quality complaint group (Table 15), and operational quality complaint group to

sensory quality one (Table 16).

From the tables it becomes clear that the user variables that show significant relation are age, use fixation, uncertainty avoidance, patience and curiosity. Age differences are significant in sensory and operational quality complaints relative to functional ones: on average, people mentioning sensory and operational problems are older, while those reporting functional problems are the youngest. Use fixation makes difference between sensory and operational quality problems. People who have higher mean scores of use fixation complain about operational quality more than sensory quality. The average score on uncertainty avoidance is higher among participants who complained about operational quality than among those who complained about functional quality. People with a low mean score of patience report dissatisfaction related to operational quality more than sensory quality. Curiosity makes difference between all the three quality problems. People who have relatively high mean scores of curiosity complain about sensory quality more than functional and operational ones.

The other variables do not show significant correlations. There is no significant difference between males and females ($x^2(2)=1.42$, $p=.492$) as well as between Dutch and South Korean participants ($x^2(2)=.419$, $p=.811$).

Table 13 Mean Values or Percentages for Predictor Variables as the occurrence of Soft Problem

Variable	Sensory quality (k=60)		Functional quality (k=59)		Operational quality (k=66)	
	M	SD	M	SD	M	SD
Age	31.83	8.40	28.05	7.33	32.95	9.78
Educational background	4.83	1.14	4.73	1.23	4.97	1.01
Household income	1.72	.76	1.54	.70	1.86	.86
Memorizing ability	3.53	.918	3.53	1.08	3.55	.83
Use fixation	2.50	.81	2.72	1.01	2.85	.87
Uncertainty avoidance	61.75	13.96	59.41	16.77	64.92	14.18
Locus of control	74.58	10.51	71.44	13.77	73.33	14.66
Patience	2.71	.75	2.68	.64	2.57	.64
Curiosity	3.85	.91	3.35	1.12	3.43	.94
Male (%)	33.9		28.7		37.4	
Female (%)	30.0		37.1		32.9	
South Korean (%)	33.9		30.6		35.5	
Dutch (%)	29.7		34.4		35.9	

Table 14 Summary of Multinomial Logistic Regression Analysis Predicting Sensory quality complaint relative to Functional quality complaint

Variable	B	SE	Odd ratio	Wald statistic
Age	.08	.03	1.08	7.05***
Educational background	-.01	.22	1.01	.00
Memorizing ability	-.18	.23	.83	.61
Use fixation	-.20	.24	.81	.73
Uncertainty avoidance	.01	.02	1.01	.87
Locus of control	.02	.02	1.02	.93
Patience	.32	.34	1.38	.88
Curiosity	.56	.22	1.76	6.48**
Gender	.41	.42	1.51	.97
Cultural background	.12	.53	1.12	.05

*** p < .05. **** p < .01.*

Table 15 Summary of Multinomial Logistic Regression Analysis Predicting Operational quality complaint relative to Functional quality complaint

Variable	B	SE	Odd ratio	Wald statistic
Age	.08	.03	1.08	8.14***
Educational background	.20	.22	1.23	.84
Memorizing ability	-.12	.23	.89	.25
Use fixation	.21	.23	1.24	.89
Uncertainty avoidance	.04	.02	1.04	5.72**
Locus of control	.01	.02	1.01	.10
Patience	-.33	.34	.72	.92
Curiosity	.19	.21	1.21	.81
Gender	.39	.40	1.47	.91
Cultural background	.37	.51	1.45	.54

*** p < .05. **** p < .01.*

Table 16 Summary of Multinomial Logistic Regression Analysis Predicting Operational quality complaint relative to Sensory quality complaint

Variable	B	SE	Odd ratio	Wald statistic
Age	.00	.02	1.00	.03
Educational background	.19	.21	1.21	.80
Memorizing ability	.06	.23	1.07	.08
Use fixation	.41	.23	1.51	3.23*
Uncertainty avoidance	.02	.02	1.02	2.39
Locus of control	-.01	.02	.99	.53
Patience	-.65	.34	.52	3.74*
Curiosity	-.38	.22	.68	3.02*
Gender	-.03	.41	.98	.00
Cultural background	.26	.53	1.29	.23

* $p < .10$.

4.4 Conclusions and discussion

As an explorative study, the findings offer some interesting results in relation to the original aims. The study focused on whether user characteristics and product property are related to soft problems. Subsequently, the relationships between soft problems, product properties and user characteristics were studied with explorative character. The study reveals that soft problems have to do with user characteristics and product properties. In the data some relationships were also observed between soft problems and product properties, between demographic variables and product properties, and between user characteristics and soft problems. They are discussed below.

4.4.1 Soft problems and product properties: operational transparency and interaction density

Operationally transparent products are relatively simpler and easier to use and vice versa. It makes sense that participants had fewer complaints on understanding or finding functions in using such simpler products; unlike, complaints related to operationally non-transparent products were dominant on operational quality level. An obvious explanation is that people have more difficulty in understanding functions of complex products than of simple products.

An interesting finding is also that when there are complaints about operationally transparent products they are more often related to sensory qualities. Opposed to this, complaints related to sensory quality were least reported in using operationally non-transparent products. However, the percentage (32%) is not too low to be neglected. Looking at interaction density, a second product property, close physical interaction

products give more complaints related to sensory quality than distant physical interaction products. This correlation makes sense considering that the closer physical interaction electronic products are associated with more frequent exposure to our senses. Complaints related to operational quality were most reported in using distant physical interaction products. One of the reasons is that distant physical interaction products require physical or cognitive efforts in starting to operate and maintaining them compared with close physical interaction products.

4.4.2 User characteristics and soft problems

Cognitive and personal characteristics such as age, use fixation, uncertainty avoidance, patience and curiosity are related to particular types of soft problems. This implies that consumer electronic products are experienced in different ways between individuals.

Age makes a difference in types of complaints. Older participants complained about sensory and operational qualities in the study while younger ones complained mostly about functional quality. It might be because older ones could be more sensitive to sensorial inputs and have less understanding of how electronic products work. For younger participants, performance and functionality of their electronic products are more seriously taken into account in using them. Use fixation is also related to type of soft problems. The higher level of Use fixation is the more likely to complain about operational quality. It implies that use fixation makes users operate electronic products in a certain way and this leads to problems in finding or understanding functions to which they are not used. Uncertainty avoidance is also related to types of complaints. People who are reluctant to unexpected events are likely to meet operational quality problems. A possible explanation is that such kind of people could be much more easily frustrated than those who like to explore and challenge in case they are unable to operate specific functions. People who are not patient are likely to complain about operational quality as well. It makes sense that they have such type of complaints considering that operational quality of an electronic product requires much cognitive efforts than the other two qualities. Curiosity is also related to types of soft problems. People with much curiosity are likely to be easily dissatisfied with sensory quality of their electronic products. Much curiosity refers to many positive expectations until before a product is experienced. This explains why they get easily disappointed with sensory quality of the product, which is related to momentary experience right after using the product.

Interestingly, gender and cultural background seem to have little influence in the occurrence of specific soft problems. Since this study has an exploratory character, it is necessary to do an in-depth study about the role of user characteristics with specific type of products.

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“I have to carry the charger as big as my camera on my travels”

Age 32 | Male | Shanghai, China

This chapter is based on the paper:

Kim, C. & Christiaans, H. (in press). User characteristics and behaviour in operating annoying electronic products. International Journal of Design (accepted in September 2012).

ABSTRACT

This chapter describes an experiment investigating the effects of the relation between product properties and user characteristics by way of a user trial with two products whose usability is known to be problematic (an in-depth study related to the third research question). 84 participants, between the ages of 20 to 74, participated in this study. The experiment was conducted in the USA, South Korea and the Netherlands. In this way we were able to compare the results of an actual use situation with those from our previous retrospective studies. The study concludes that there are indeed differences in type of soft problems between actual use and retrospective evaluation. The kind of soft problems experienced is partly dependent on both user characteristics and product properties. The role of users' expectations as well as their follow-up behaviour in relation to soft problems will be discussed.

CHAPTER 5 USER CHARACTERISTICS AND BEHAVIOUR IN OPERATING ANNOYING ELECTRONIC PRODUCTS

5.1 Introduction

In the previous chapters a mismatch has been observed between intended use and actual use influenced on the one hand by product properties and on the other hand by user characteristics. These studies are all based on retrospective data. However, common practice in the manufacturing industry is to test their prototypes through user trials, which means testing products in actual use. On the other hand, the focus of the surveys was on whether types of soft problems are influenced by user characteristics and product properties. Respondents in the survey were asked to choose any household electronic products with which they had felt most annoyed. This led to multiple types of electronic products. Both physical interaction density and operational transparency were used to see if soft problems are related to specific product properties instead of product types. Therefore, the study presented here imitates a user trial with two existing products whose usability is problematic, focusing on how user characteristics are related to the two specific electronic products. In this way we were able to compare this actual use situation with the previous retrospective studies, investigating product properties and user characteristics in relation to soft problems, and the resulting behaviour of the participants. As an explorative study an experiment was set up in America, South Korea and the Netherlands.

5.2 Method

Being an exploratory study it is characterized by a mixed methods approach. The emphasis is on a quantitative analysis, which does not mean that we are looking for high external validity but rather aim at gathering introspective data that can be compared with previous retrospective data. The experiment was carried out in three countries, USA, South Korea and the Netherlands. The choice for these three countries was that they are very different in cultural background. Using Hofstede' s cultural dimensions as criteria, the United States are characterized by individuality, masculinity, and short-term orientated culture; South Korea by collectivism, high uncertainty avoidance and long-term orientation; and the Netherlands by horizontal hierarchy, femininity and risk-taking behaviour (Hofstede, 2003). The focus was on how different each individual is with regard to actual product use and types of soft problems.

5.2.1 Participants

The experiment was carried out with 23 people from USA, 33 from South Korea and 28 from the Netherlands, who all lived in their home country at the moment they participated in the experiment. They were recruited via advertising and selected according to a balance in gender and age groups. Detailed demographic characteristics of the participants are shown in Table 17.

Table 17 Demographic characteristics of the sample (N=84)

Variable	Frequency			Total	%
	American	S. Korean	Dutch		
Age at time of survey (years)					
20-29	6	10	8	24	28.6
30-39	9	4	10	23	27.4
40-49	3	8	10	21	25.0
50-59	2	7	-	9	10.7
60+	3	4	-	7	8.3
Gender					
Male	10	20	13	43	51.2
Female	13	13	15	41	48.8
Highest education level completed					
Middle school graduate	-	-	4	4	4.8
High school graduate	4	12	3	19	22.6
University graduate	11	12	8	31	36.9
Postgraduate	8	9	13	30	35.7
Annual household income (Euro)					
<€20,000	-	-	4	4	4.8
€20,000-29,000	8	10	11	29	34.5
€30,000-39,000	11	17	2	30	35.7
€40,000-49,000	1	4	5	10	11.9
€50,000+	3	2	6	11	13.1
Percentage	27.4	39.3	33.3	84	

5.2.2 Instruments

In order to create an experimental situation two electronic consumer products were selected, an alarm clock and an MP3 player (Figure 37). Both products were known to have many consumer complaints in product reviews at Dutch online shops (the alarm clock) and at Global shopping sites such as Amazon (the MP3 player), which were all related to soft problems. The reason for taking two products instead of one was to avoid bias caused by a particular type of product. The two products are different in terms of

product properties, operational transparency and physical interaction density, as defined before. The alarm clock has a few conventional functions such as clock, alarm with four different alarm sounds and FM radio (defined as ‘ operationally transparent’) and the physical interaction between user and the product occurs only at the beginning and the end of usage (defined as ‘ low physical interaction density’). The selected MP3 player is highly functional but also very compact: many main functions such as music playing, FM radio, voice recording and a USB memory stick, and many secondary functions such as shuffling songs, sound tone, and play mode (defined as ‘ operationally opaque’) and the physical interaction is quite intensive during usage (defined as ‘ high physical interaction density).

The sessions were videotaped with consent of the participants. Observations were based on these videotapes, including the recording of the comments made by participants during task operation, of the time taken for the subsequent tasks and task completion, and of Manual use. In the final interview with the participant these data were used to stimulate verbalisations of their experiences with the tasks.

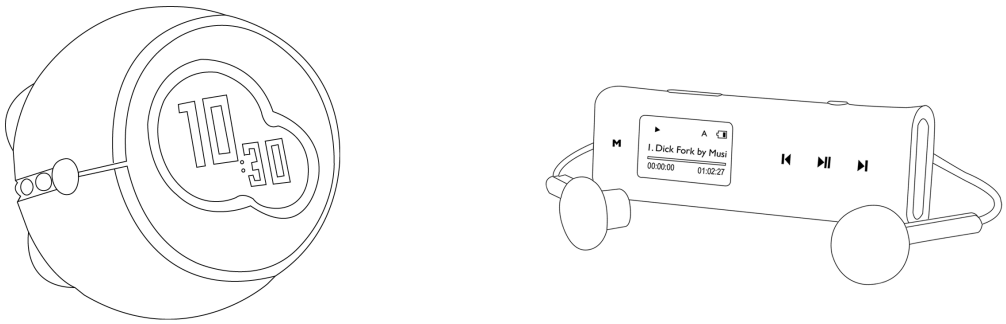

Figure 37 Alarm clock (left) and MP3 player (right)

Based on existing tests we developed a questionnaire to measure user characteristics such as demographic factors, personality traits, and cognitive aspects (see Figure 38).

For most questions a five-points scale was used while some were dichotomous (yes or no) and multiple choice: questions measuring cognition (e.g. memorizing ability) and personality (e.g. self-efficacy and locus of control) were adopted from free online cognition and psychology tests. The NEO Five-Factor Inventory, NEO-FFI, (McCrae & Costa Jr, 2004) was used to assess agreeableness, conscientiousness, extraversion, neuroticism, and openness. In the analysis, a higher value on a variable usually means ‘ more of that characteristic’ . Exceptions are the nominal variables gender and culture while a value for age, education and household income has the meaning of ‘ higher’ .

Follow-up (re)actions in relation to soft problems were measured via a retrospective interview after product trials.

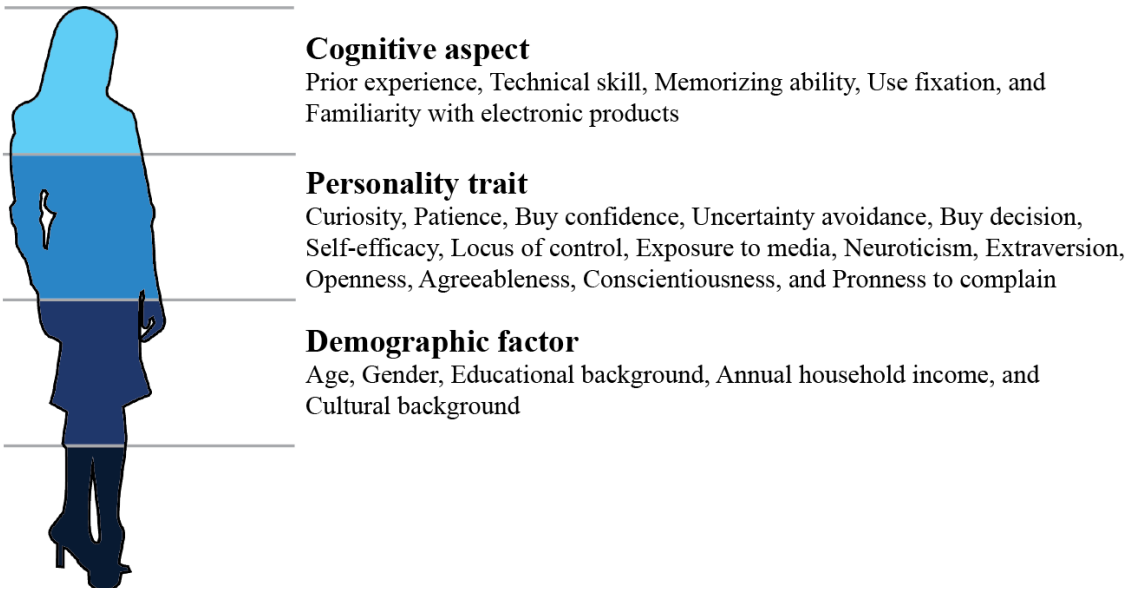

Figure 38 User characteristics measured

5.2.3 Coding individual soft problems

The individual problems were coded according to one of three categories of soft problems, defined as sensory quality, functional quality and operational quality. Some of the problems were difficult to categorize because they were sometimes related to a combination of both qualities. In this case, the cause of a problem has priority over the outcome of the problem. For example, difficulty to press the buttons of the alarm clock due to its tiny buttons was categorized into sensory quality although the small size of buttons leads to the problem in operating the product. To increase the reliability and internal validity the coding was done by both authors, the researchers, and two independent external scientists at the same faculty.

5.2.4 Procedure

The American and South Korean participants were invited to participate in the experiment at any location where they felt convenient, such as their home, a cafeteria or library meeting room. The Dutch participants were invited to the Product Evaluation Laboratory at the university where the researchers work (Figure 39).

First, the aim of the experiment was introduced to them by one of the researchers clearly using a pre-determined script, followed by the request to the participant to fill out the first part of the questionnaire. In order to prevent participants from becoming bored, and thus losing concentration, the questionnaire was divided into two parts. In addition, privacy-sensitive questions such as household income and personality were asked in the last part: part A covers information about cognitive aspects, and part B deals with general information about the participant, her/his personality traits.

Next, the participants were asked what expectations they had about the alarm clock or the MP3 player before using it: to minimise any ordering effect, the order of the alarm clock and MP3 player trials was alternated between users. The questions in this session were:

- Have you used an alarm clock (an MP3 player) before or are you using one at home?
- What expectations would you have about an alarm clock (an MP3 player) if you need to replace it with a new one?

Then they were given several common tasks with the alarm clock, which aimed at letting them experience it at different levels of cognitive load, ranging from simple to complicated tasks. Participants were allowed to use the instruction manual of both products. All sessions were videotaped. The participants verbalized their thoughts (concurrent think aloud protocol) while they performed the operation tasks. These tasks are presented in Table 18.

Table 18 Instructions for the tasks with the alarm clock and the MP3 player

Alarm clock	MP3 player
1. Put batteries into the alarm clock and turn it on	1. Turn the MP3 player on
2. Set the time at 11:00 AM	2. Find a given song and then listen to the song
3. Tune a radio station	3. Adjust the volume
4. Set an alarm at 11:05 AM and set a radio channel as alarm sound	4. Set the shuffle function on
5. Turn it off when it alarms	5. Activate the voice recorder and show that it works
	6. Pull out the USB part and put it back again

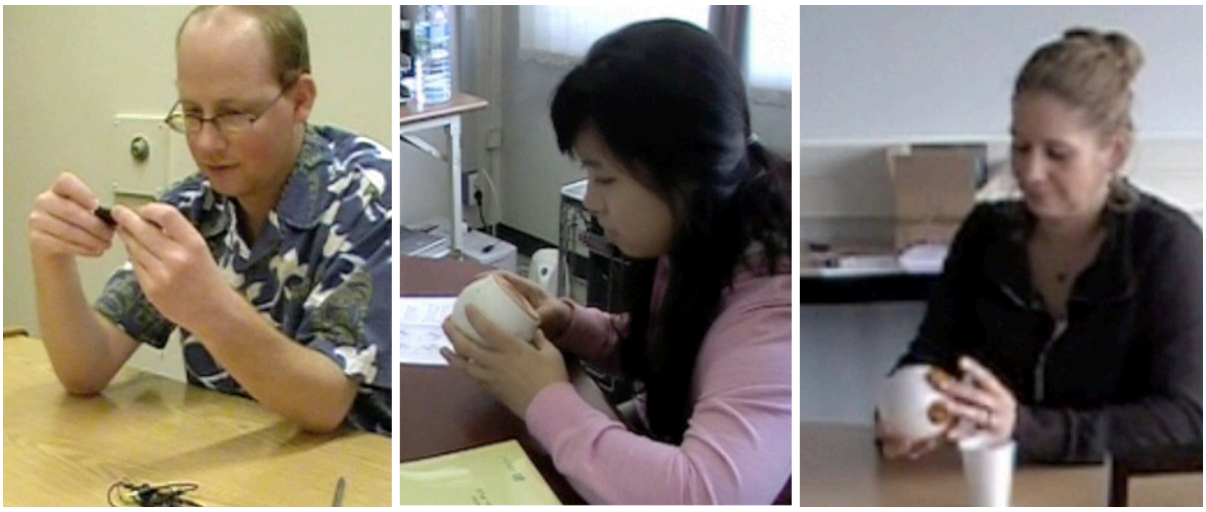

Figure 39 Example picture of the experiment in the United States, South Korea, and the Netherlands

After this, they filled out the last part of the questionnaire. Next, the MP3 player (or the alarm clock) was asked to operate following the same procedure. Finally a retrospective interview was held to find out their overall experience. First, each participant was asked to mention which among their many problems they experienced was most annoying and whether that one would lead to product return. The problems were classified into one of the three aforementioned categories. Next, errors and particular behaviour of the participant, which occurred during product interactions, were discussed.

5.3 Results

The results are based on three measures: observations made during the experimental sessions, the retrospective interview at the end and the questionnaire. Because the data of these measures are related to each other, the presentation of the results will follow the logic of the content.

5.3.1 Soft problem categories and product property

Data about problems users experienced with the two products were derived from the retrospective interviews. The percentage and examples of soft problems with the alarm clock and the MP3 player are shown in Figure 40. There is a significant difference between the two products in problems experienced [$\chi^2(1, N=84) = 13.93, p < .001$]. With the alarm clock participants mainly complained about the sensory quality such as unpleasant sound or ugly shape, followed by problems with operational quality such as confusing to set an alarm. In the experiment with the MP3 player, problems related with operational quality such as hard to find functions were most reported, followed by sensory quality such as hardly visible buttons. There were hardly any problems regarding the functional quality of the two products.

5.3.2 Soft problems and user characteristics

Which user characteristics are related to the occurrence of each soft problem and in which way do they interact with the perceived product qualities? In Table 3 and 4 means and standard deviations of user characteristics are presented on two of the three qualities, sensory and operational. Because functional quality is hardly mentioned it is not included here. In order to test the significance of the relations a t-test was used for the continuous variables (Table 19), while for the dichotomous variables a chi-square test was performed (Table 20). For the alarm clock uncertainty avoidance, locus of control, proneness to complain, and culture are significant. For the MP3 player age (the older the less tendency to mention operational problems), proneness to complain (the higher the more sensory problems), and prior experience (the more prior experience the more operational problems) are significant.

With these findings it is still not clear whether any of these variables have a real effect on

the dependent variable (the type of problem) given the influence of the other variables. For that reason only a binary logical regression can be used. However, considering the huge number of independent variables a selection was made putting only significant variables in the analysis. See Tables 21 and 22 for the results.

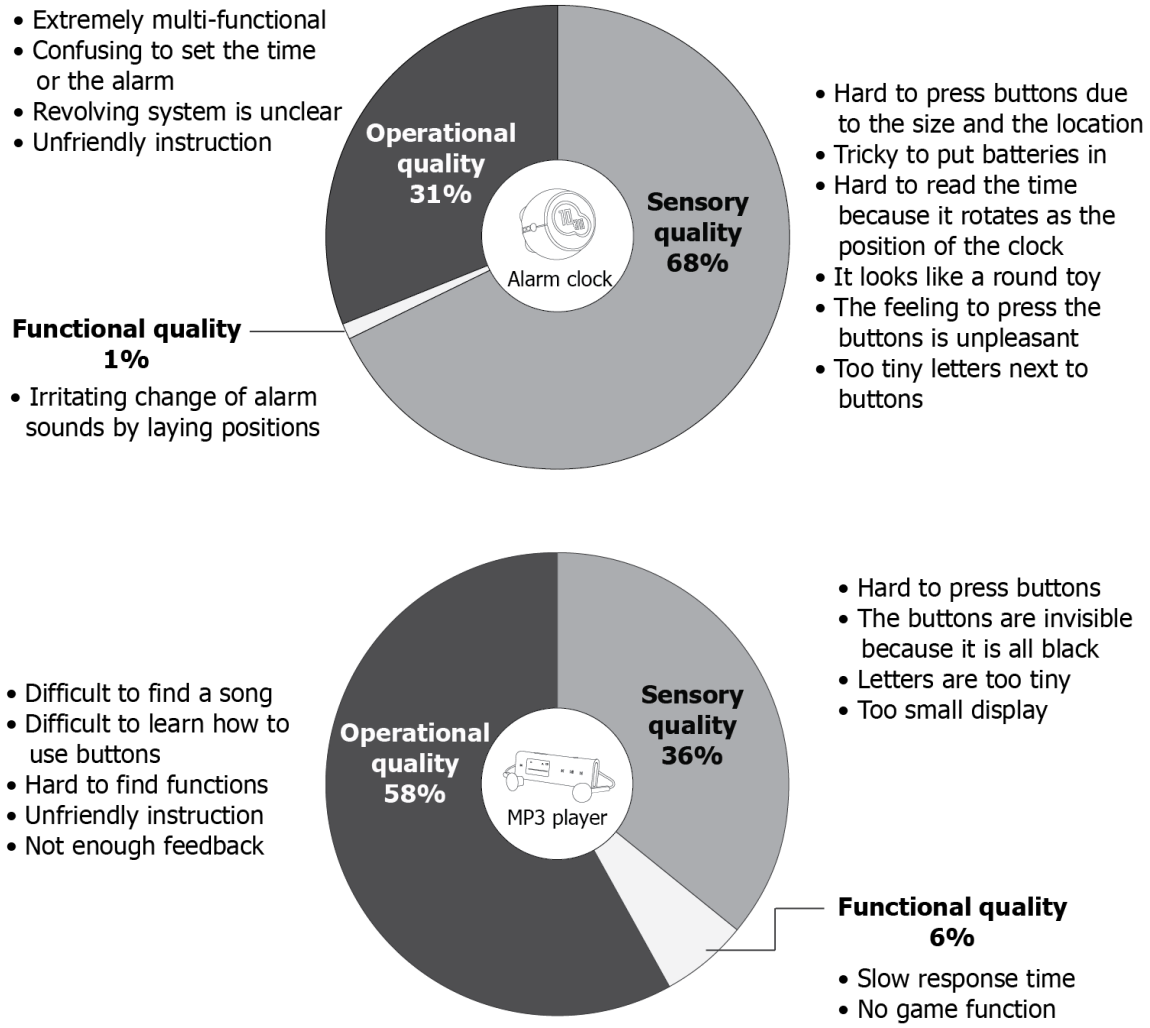

Figure 40 Percentages and examples of soft problems for the alarm clock (upper) and the MP3 player (below)

For the alarm clock the Wald criterion demonstrates that locus of control, proneness to complain, and culture make a significant contribution to the prediction. Participants with strong internal locus of control tend to complain more about sensory quality. The average score on ' Proneness to complain' is higher among participants who complain about operational quality than among those who complain about sensory quality. There are significant cultural differences in soft problems (See also Figure 41), indicating that Dutch and American participants are more likely to complain about operational quality than the

South Koreans. Although uncertainty avoidance does not show statistical significance in the alarm clock, a Kruskal-Wallis test indicates that uncertainty avoidance is significantly affected by culture [$H(2) = 12.98$, $p < .01$], with the highest average score for the South Koreans (50.8), followed by the Americans (40.9) and the Dutch (29.4).

Table 19 Soft problems and related user characteristics (continuous variables) in alarm clock and MP3 player

Variables	Alarm clock					MP3 Player				
	Sensory (n=56)		Operation. (n=25)		t(81)	Sensory (n=29)		Operation. (n=47)		t(76)
	M	SD	M	SD		M	SD	M	SD	
Age	40.6	13.9	35.6	10.6	1.57	44.9	14.2	35.6	10.7	3.25**
Educational background	2.98	.88	3.12	.93	-.64	2.97	.87	3.02	.92	-.26
Household income	3.02	1.02	2.68	1.22	1.30	3.03	1.02	2.85	1.18	.69
Curiosity	2.68	1.39	2.36	1.04	1.15	2.41	1.32	2.74	1.26	-1.09
Patience	3.66	1.10	3.68	.85	-.08	3.45	1.12	3.79	.91	-1.45
Uncertainty avoidance	3.73	1.14	2.92	1.29	2.85**	3.66	1.20	3.34	1.20	1.11
Self-efficacy	31.0	4.07	32.0	4.56	-.95	30.6	4.26	31.1	4.34	-.46
Locus of control	77.1	8.52	67.8	12.4	3.39**	73.1	13.3	74.3	9.4	-.41
Exposure to ad.	2.91	.93	3.34	1.00	-1.88	2.97	.81	3.15	.97	-.86
Neuroticism	17.6	6.66	18.1	7.09	-.29	18.2	6.34	18.0	7.69	.17
Extraversion	31.1	7.75	30.0	6.54	.62	28.5	6.42	30.9	8.01	-1.42
Openness	29.4	5.49	30.2	4.91	-.59	29.6	5.0	29.7	5.58	-.12
Agreeableness	32.5	5.17	34.2	5.77	-1.29	32.8	5.05	33.7	5.51	-.72
Conscientiousness	32.6	6.40	33.5	7.46	-.57	31.9	7.60	32.9	6.71	-.60
Technical skill	2.95	1.45	3.24	1.17	-.89	3.10	1.37	3.15	1.30	-.15
Memorizing skill	2.98	1.37	3.16	1.38	-.54	2.90	1.32	3.30	1.37	-1.26
Use fixation	3.36	1.35	3.08	1.26	.87	2.97	1.38	3.40	1.23	-1.45
Familiarity with electronics	2.34	.75	2.44	.51	-.71	2.45	.69	2.43	.62	.15
Buying decision	3.07	1.28	3.32	1.35	-.80	3.45	1.09	3.06	1.31	1.32
Buy confidence	2.70	.85	3.08	1.12	-1.70	2.93	.96	2.83	.96	.45
Proneness to complain	3.96	1.66	4.84	1.03	2.89**	3.86	1.43	3.17	1.43	2.04*

*$p<.05$. **$p<.01$

Table 20 Soft problems and related categorical variables in alarm clock and MP3 player tested by χ^2 in respectively a 2x2 and 2x3 table

Variables	Alarm clock			MP3 player		
	Sensory	Operational	$\chi^2(1)$	Sensory	Operational	$\chi^2(1)$
Gender (male)	29	11	.42	17	21	1.39
Gender (female)	27	14		12	26	
Use experience (Yes)	53	23	.21	13	38	10.54**
Use experience (No)	3	2		16	9	
	Sensory	Operational	$\chi^2(2)$	Sensory	Operational	$\chi^2(2)$
Culture (American)	14	8	19.22***	6	15	2.74
Culture (S. Korean)	30	2		14	14	
Culture (Dutch)	12	15		9	18	

***p < .01. ***p < .001.*

Table 21 Summary of binary logistic regression analysis predicting soft problems of the alarm clock

Variable	B	SE	EXP(B)	Wald statistic
Uncertainty avoidance	.03	.28	1.03	.02
Locus of control	-.12	.04	.89	9.65**
Proneness to complain	.68	.31	1.98	4.75*
Culture				9.64**
American vs. Dutch	-.77	.72	.46	1.14
South Korean vs. Dutch	-3.04	.98	.05	9.64**
South Korean vs. American	-2.27	.99	.10	5.31*

***p < .01.*

Table 22 Summary of binary logistic regression analysis predicting soft problems of the MP3 player

Variable	B	SE	EXP(B)	Wald statistic
Age	-.03	.03	.97	1.34
Use experience	1.39	.71	4.01	3.78*
Proneness to complain	-.19	.20	.83	.90
Culture				2.88
American vs. Dutch	.49	.73	1.64	.45
South Korean vs. Dutch	-.73	.70	.48	1.10
South Korean vs. American	-1.23	.73	.29	2.79

**p < .05.*

For the MP3 player the Wald criterion demonstrates that only prior experience makes a significant contribution to the prediction. This indicates that people, who are experienced with an MP3 player, are more likely to complain about operational problems. No significant

differences were found between countries in case of the MP3 player (See also Figure 8).

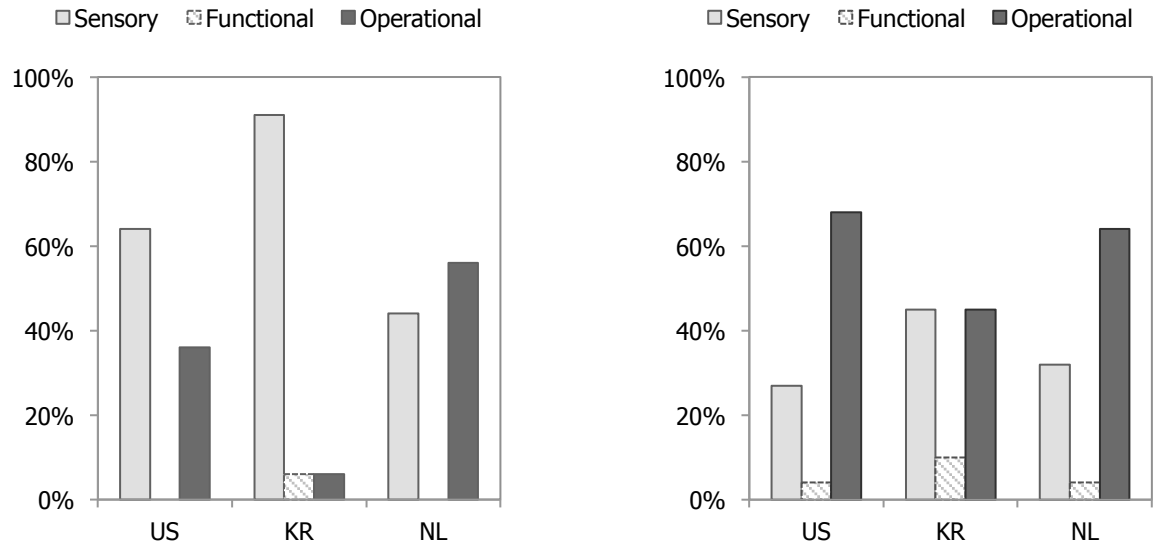

Figure 41 Percentages of soft problems of alarm clock (left) and MP3 player (right) among three countries

Participants who have more prior experience with MP3 players are significantly younger than those who have not, as was tested by the Mann-Whitney test [U = 150.50, p < .001, r = -.57]. On the basis of a general belief that younger people have more experience with portable multifunctional electronic products and will thus experience less operational problems with unfamiliar devices, we expected that younger participants would mention less of these problems than older participants. However, the results from Table 3 indicate that younger people are reporting more operational problems than older people.

To see whether or not participants who complained about either sensory or operational quality of the alarm clock also complained about the same quality when operating the MP3 player, a Chi-square analysis was performed. The results indicate that there is no significant relation between soft problems of the alarm clock and MP3 player [χ^2(1, N=84) = 0.51, p = 0.48]: more than half of the participants (approximately 55% of the participants) mentioned different types of problems for the two products.

5.3.3 Soft problems and user expectations

Users' expectations, as were asked participants *before* the actual operation of the two products, were categorized into the three categories sensory, functional and operational quality. For instance, expectations related to sensory quality are mainly about: big display, good looking, natural sounds, and lightweight. As functional quality expectations are mainly mentioned: Working well, multiple functions, long battery life, and large memory space. Expectations related to operational quality are mostly about ease to use. Comparison of participants' expectations before the task operation with their soft problems expressed

after operating the products (Figure 42) shows that these expectations are formulated in a more general way. For instance, some participants said they expected ' easy to use' but their problem during use was ' ..confusion between setting the time and setting an alarm' . There is little difference in expectations between the alarm clock and the MP3 player (Figure 42). With both products, prior expectations related to functional quality are dominant; interestingly so, while hardly any functionality problem was reported in this experiment.

Expectations differ between the three cultures. As mentioned before, most of the expectations regarding both products are about functional quality. South Korean participants diverge in that with the alarm clock, expectations related to sensory quality are as important as functional quality. See Figure 43 for the differences between countries.

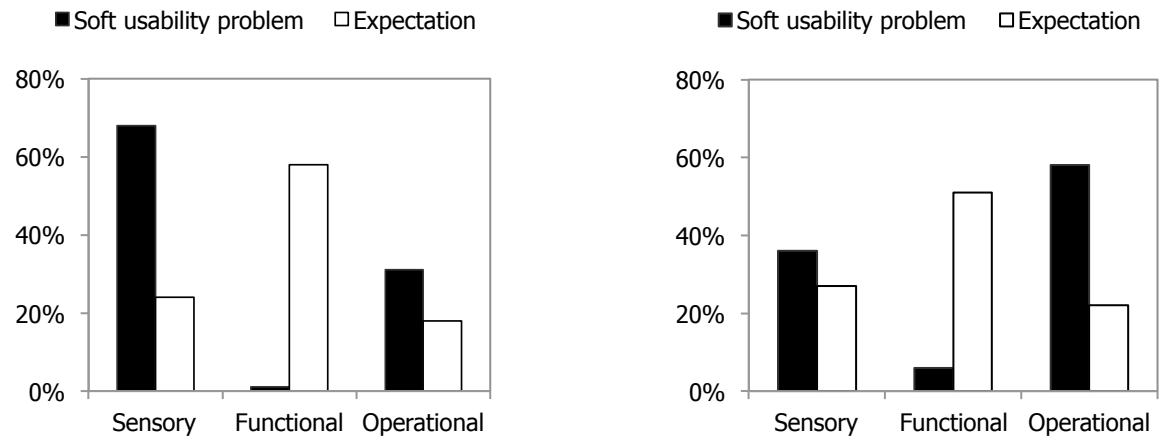

Figure 42 Soft problems and user expectations in alarm clock (left) and MP3 player (right)

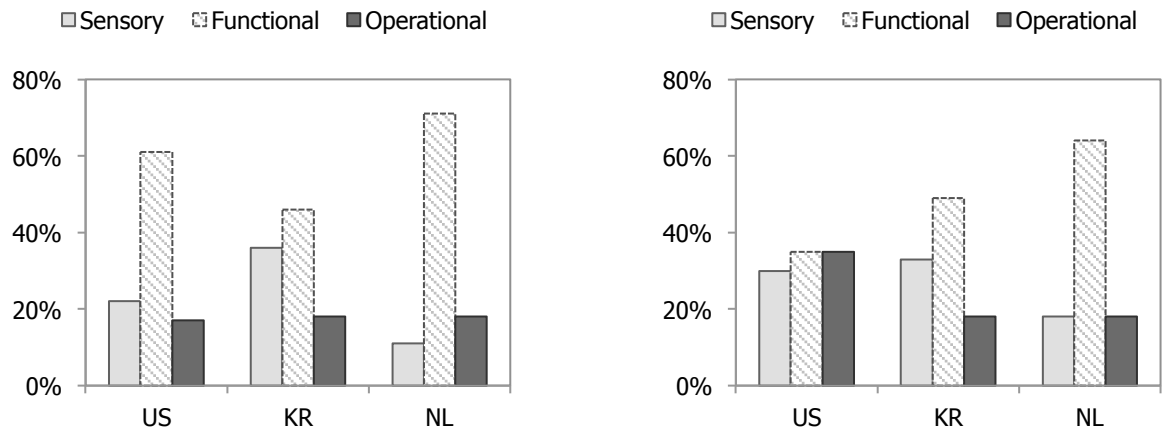

Figure 43 User expectations of alarm clock (left) and MP3 player (right) among three countries

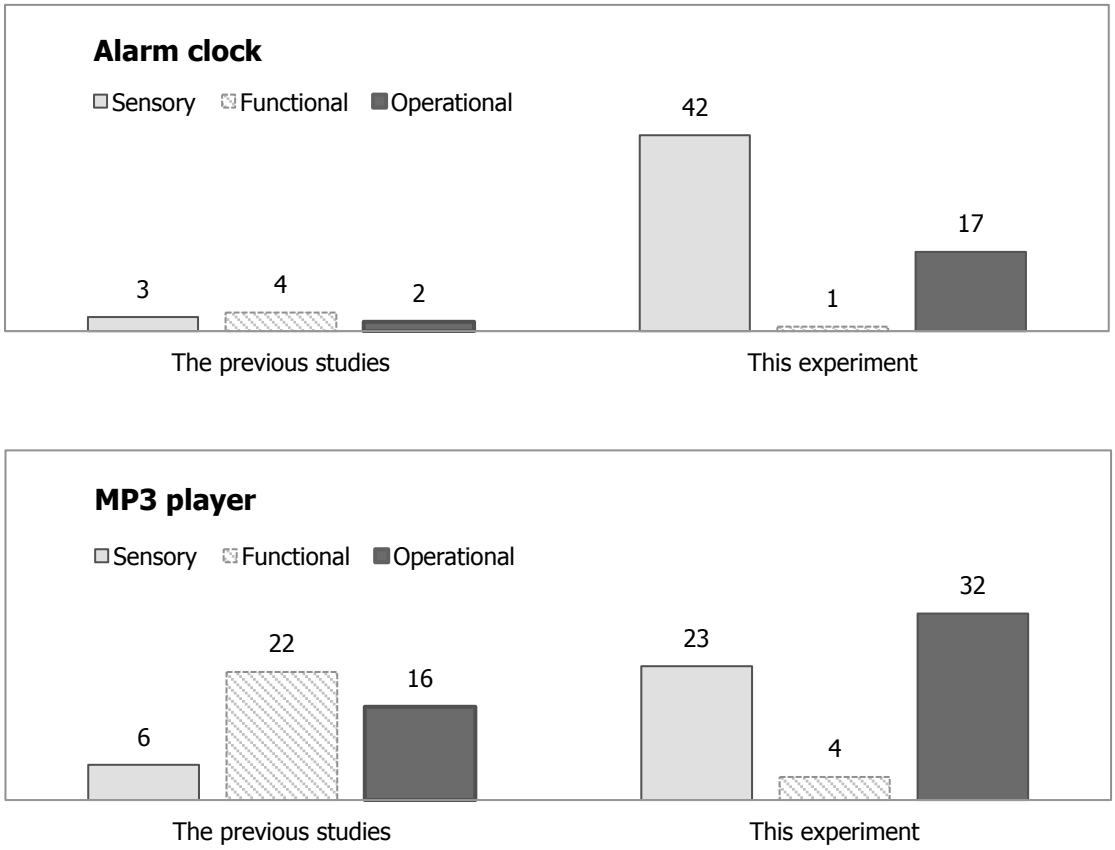

Figure 44 Frequencies of Soft problems of alarm clock (upper) and MP3 player (below) between the previous studies and the experiment

5.3.4 Soft problems in actual use: introspective vs. retrospective evaluation

The percentages of soft problems in this study are significantly different from those in the previous studies. In our previous two studies, all three categories of soft problems are more or less evenly distributed: in the first study (Kim *et al.*, 2007) 25% sensory, 41% functional, and 34% operational problems were found; and in the second study (Kim & Christiaans, 2012) 33% sensory, 32% functional, and 35% operational problems. Again, hardly any functional problems are reported in the experiment.

If the alarm clock and the MP3 player used in our experiment are prototypical for their category, it might be interesting to compare the results with the results of our previous studies in which these two product categories were spontaneously mentioned. See for both results Figure 44. It is clear that in the previous (retrospective) survey studies more functional and less sensory problems were reported. This can be partly explained by the fact that the products complained about in the three studies were not the same.

5.3.5 Implications of experienced soft problems on follow-up (re)actions

Previous studies (Kim, *et al.*, 2007; 2009; Kim & Christiaans, 2009) showed that people

are very irritated by soft problems. But what effect does it have on their behaviour afterwards? In the retrospective interview participants were asked (a) whether they would return the product if they had bought, and (b) whether they would like to buy this sort of product again in spite of the use problems. The results indicate that the experience of soft problems will not necessarily lead to the return of products as participants indicate (see Figure 12). About 32% to 44% would return the alarm clock against 41 to 71% regarding the MP3 player. Whether they would buy the same product again was negatively answered by 63% to 82% of the participants for the alarm clock and by 65% to 79% for the MP3 player. Cultural differences, as shown in Figure 45, are not significant.

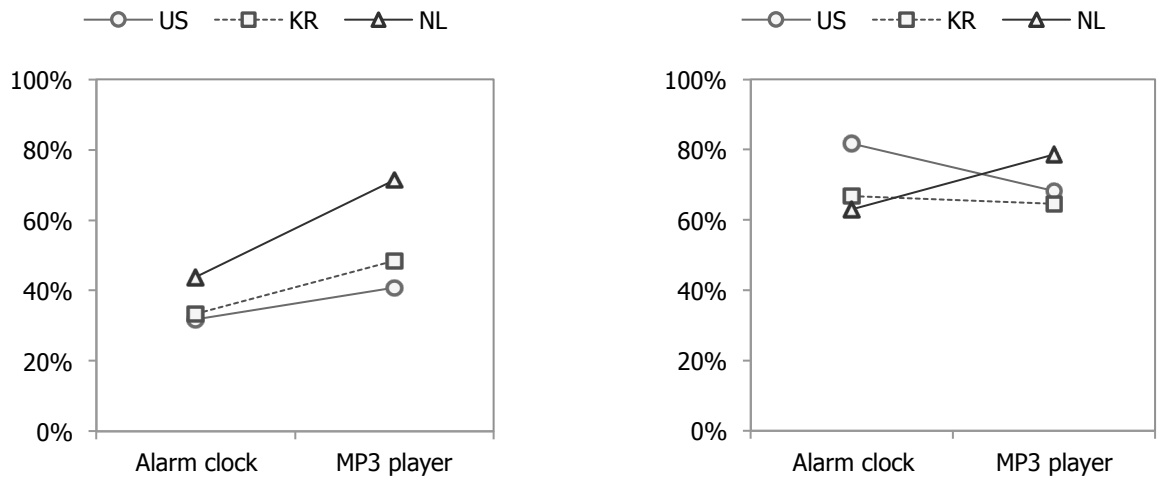

Figure 45 Percentages of "Would return the product" (left) and "Negative Purchase Intention" (right) per country

5.3.6 Observations during tests

All videotaped sessions were graphically analysed, illustrating time to complete a task, whether or not a task was completed, and whether they made use of the product manual (see examples in Figure 46). Operation tasks in the experiment were divided into three levels based on Rasmussen' s information procession model: skill-based, rule-based, knowledge-based (Rasmussen, 1983). The terms refer to the degree of conscious control exercised by the individual over his or her activities. For example, knowledge-based tasks (' set the shuffle function on') require serious cognitive thinking and problem-solving; this occurs in a situation where the individual is faced with a completely novel situation, while skill-based tasks (' put the batteries in') refer to the smooth execution without conscious monitoring. The rule-based level may include the conscious use of rules, an intermediate level of control.

Results of the graphical analysis shows that participants are able to complete all operation tasks in both products that required low cognitive load (skill-based mode). However, they spend much more time in doing operation tasks with the MP3 player than the alarm clock.

And they also spend much more time with tasks requiring high cognitive load (knowledge-based mode), which did not necessarily lead to the completion of such tasks.

For a further analysis of the tasks' completion rate requiring high cognitive load and time taken doing the tasks a selection of these tasks was made: for alarm clock, ' set the time' and ' set an alarm' , and for MP3 player, ' find a song' , ' set the shuffle function on' , and ' activate the voice recorder' . The average of completion rate of these tasks is approximately 70% for the alarm clock and 40% for the MP3 player; the average of time spent is 252 seconds for the alarm clock and 434 seconds for the MP3 player. The average of task completion rate and time is highest and shortest for the alarm clock because it requires relatively less cognitive load than the MP3 player.

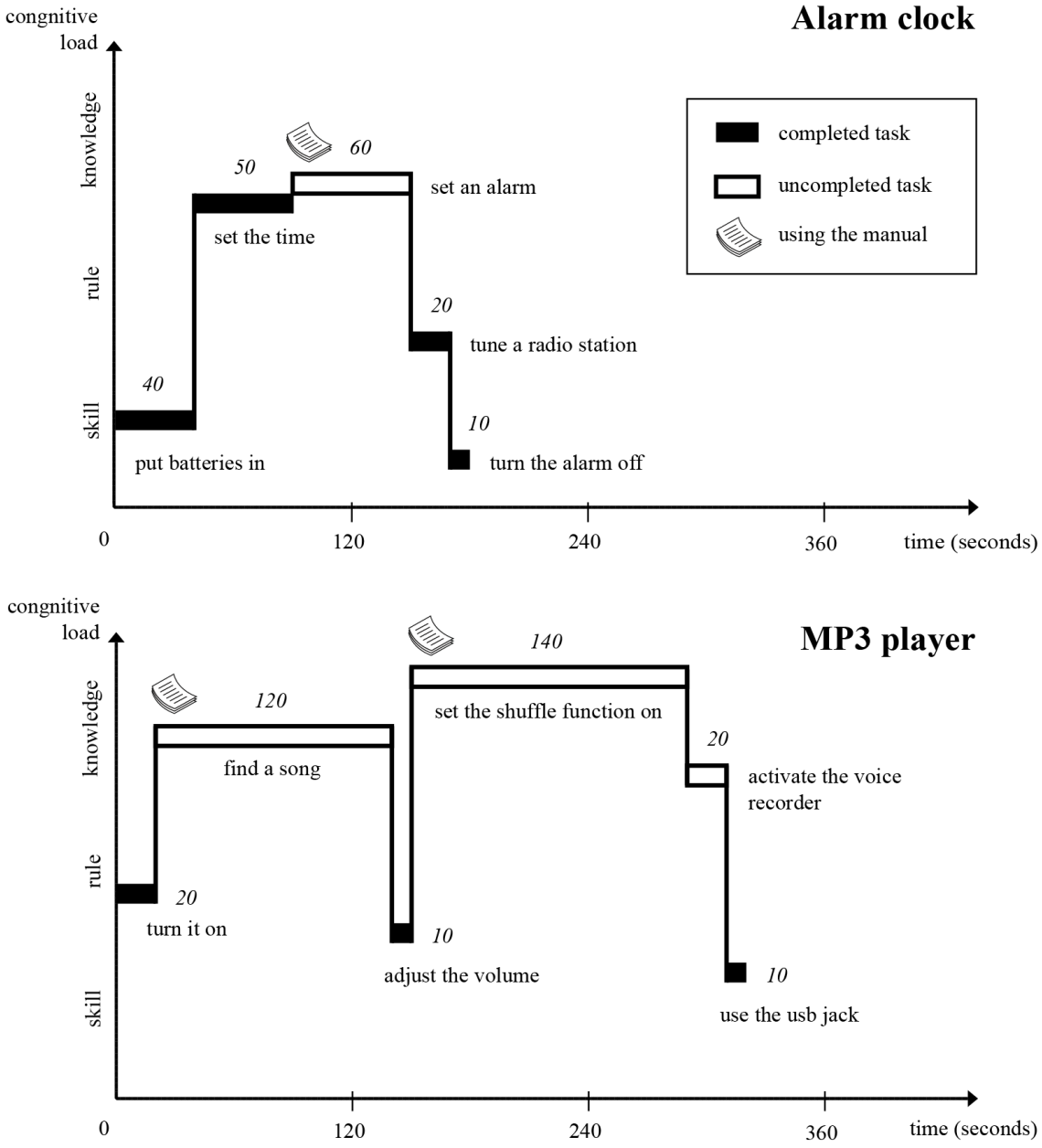

Figure 46 Examples of operation task completion in terms of cognitive load and time to be spent

Task completion rate and time taken were also statistically analysed to see how they are related to particular user characteristics such as age, gender, and familiarity with electronic products, prior experience and culture. See Table 23 for an overview.

The results indicate that age, familiarity with electronic products, prior experience and culture are related to task completion rate and time taken. The older participants are the more time is taken and the less task completion rate is shown. The more familiarity with electronic products a participant has, the more task completion rate but the less time were observed. The same holds for prior experience with these types of products. Gender does make a difference in time taken for the alarm clock tasks only. Females spend more time than males. Finally, culture plays a role in the time spent on the tasks with the alarm clock. No significant relation has been found between the aforementioned user characteristics and the use of the manual.

Task completion rate does not show any significant relation between the intention to return the product or not to buy products of this brand in the future. Task completion rate, time taken, and use of manual have no relation with sensory quality and operation quality problems.

Table 23 Results of a Mann-Whitney test between time and completion rate and user characteristics for the alarm clock and the MP3 player

Variable		Alarm Clock				MP3 player			
		Time	*p*	Com. Rate	*p*	Time	*p*	Com. Rate	*p*
Age	20-39 (n=47)	36.3	.008**	49.9	.001**	31.8	.000***	50.3	.001**
	40–60+ (n=37)	50.4		33.1		56.2		32.7	
Gender	Male (n=43)	37.3	.043*	46.6	.079	39.3	.210	47.1	.067
	Female (n=41)	48.0		38.2		45.8		27.7	
Familiarity with electronic products	Low (n=42)	48.6	.021*	35.3	.003**	53.7	.000***	31.3	.000***
	High (n=42)	36.4		49.7		31.3		53.7	
Prior Experience	Yes (n=55)	34.6	.000***	42.9	.81	34.5	.000***	48.5	.001**
	No (n=29)	57.6		41.7		57.6		31.1	
Culture	US (n=23)	31.1	.001**	46.0	.234	48.9	.266	36.5	.307
	KR (n=33)	39.4		37.4		41.8		43.4	
	NL (n=28)	55.6		45.6		38.1		46.4	

***p < .01. ***p < .001.*

Observations of the comments made during the task operations show that in spite of stimulating thinking aloud, participants hardly express their thoughts. Therefore, observations were based on the comments made during the retrospective interview after the trials, as presented before.

5.4 Conclusions and discussion

The experiment described in the study was conducted in order to get a deeper insight into users' usability experience in operating household electronics. The main aim of this study was to gain understanding of how soft problems are influenced by 'actual use' as compared to previous survey studies (retrospective evaluation). Second, the study tried to find out any relationship between expectations, soft problems, product properties and the personal background of participants. Although the contribution of the study lies foremost in the emphasis on user diversity related to the occurrence of soft problems, a number of other conclusions can be drawn as well.

Influence of user characteristics compared to product property

The experiment shows that a limited number of user characteristics have influence on the performance of the operation tasks with the two electronic products. First, age influences the time taken for the tasks and the ability to complete the tasks: the older the more time taken and the fewer tasks completed. Second, gender only has an effect in the alarm clock tasks, meaning female participants take more time. Thirdly, familiarity with electronic products and prior experience with these types of products have a positive effect on time taken and task completion. Finally, culture plays a role regarding the time needed to complete the tasks. However, these measures of time and task completion are not necessarily good predictors of participants' opinion about the usability of the products. As this study also shows, most usability problems have their origin neither in isolated user characteristics nor in product properties, but rather in the interaction between the two. Several findings illustrate this statement:

- 'Locus of control', an important factor in consumer complaining behaviour and by Donoghue and De Klerk (2006) referred to as attribution of blame, plays in our study a role in the type of soft problems that are mentioned. Only for the alarm clock we found that the weaker participants' internal locus of control is – and hence the more blame is attributed to the product or to others – the more operational than sensory problems are mentioned; and vice versa. This is an expected result because operational problems are more serious and in this experiment mainly seen as weaknesses of the product.
- 'Proneness to complain', as measured through the questionnaire, affects the type of soft problems mentioned, but only significantly so for the alarm clock. Participants who are prone to complain are more dissatisfied with operational quality than with sensory

quality; and vice versa.

- Cultural effects are only significant in the alarm clock: sensory quality problems are more expressed by South Koreans while operational quality problems more by Dutch participants. However, this is not observed with the MP3 player.
- Prior experience only influences the type of soft problems for the MP3 player. Participants with experience are likely to complain more about operational quality of such product type, but those who have not, complain about sensory quality. This result is striking considering that the more past experience a user has with related technology the quicker they can learn to use newer ones (Lewis *et al.*, 2008), and interactions that exploit prior-knowledge contribute to faster, easier and less prone to error (Langdon *et al.*, 2007; Blackler, 2008; Lewis, *et al.*, 2008; Blackler *et al.*, 2010). A possible explanation is that people with more prior experience would have more use fixation especially in using complicated electronic products such as MP3 players. Such high use fixation can easily lead to problems related to operational quality when they use an unfamiliar user interface. People stick as closely as possible to their habitual way of use (Reason, 1990). Acquired use habits seem to limit the ability to be flexible when confronted with the unfamiliar: people who regularly use a particular type of coffee-cream container need more attempts to open a new type of container than less experienced users (Kanis, 1998). Probably, those who have more pre-knowledge about a technology or interface may also be more equipped to raise use issues and even suggest improvements based on operational problems they have experienced before.
- Although older people are in general more experienced, they are not with electronic products such as MP3 players. It means that prior experience with this kind of products is a better predictor than age. A recent study also supports this assumption in which experience rather than age may be the best predictor of performance and no significant generation-related differences are found in effectively using technological products (Lewis *et al.*, 2007).

Soft problems and product property

In a previous study two product properties showed to influence the type of problems expressed (Kim & Christiaans, 2012). Problems about sensory quality were mainly observed in operationally transparent (low cognitive load required) or close physical interaction products, and problems about operational quality were closely related to operationally opaque (high cognitive load required) or low interaction density products. Reason might be that operationally transparent products have fewer problems on understanding functions than on sensory perception, and that physically close-interaction products have more frequent exposure to our senses. People have more operation difficulty with operationally opaque products than transparent products, while products with physically distant interaction require more physical efforts in starting to operate and

maintain them than those with close interaction. If this interpretation is correct, the experiment was expected to deliver the same results: the alarm clock with its high operational transparency might give many sensory problems and with its low physical interaction density also many operational problems. Likewise, in the MP3 player with its low operational transparency and high physical interaction density the operational and the sensory problems might be high. However, the experiment showed unexpected results: for the alarm clock usability problems are dominantly related to sensory quality. Complaints about the MP3 player are dominantly related to operational quality. This provides more insight into the findings of the previous study regarding the interaction between product properties and soft problems. Operational transparency seems to be a more accurate predictor to anticipate soft problems of an electronic product than its physical interactivity. However, it does not mean that physical interaction density should be neglected. The percentage of operational problems with the MP3 player (36%) and of sensory problems with the alarm clock (31%) is still quite substantial.

In his survey study about (dis)pleasure, Jordan (1998) also used an alarm clock. He found that displeasure is mainly related to the buzz tone and the appearance of the alarm clock. The difference between his study and this experiment was that with our study more and more detailed factors were found. Besides our criterion of our study was not (dis)pleasure but usability.

User expectations compared to actual use

In general, use problems occur when there is a discrepancy between prior expectation and actual use experience. In this experiment it turned out that user expectations as expressed by participants before the actual use of the two products, are mostly related to the functional quality. However, after experiencing the actual usage of the two products only sensory and operational problems were expressed. The obvious reason was that both products appeared to function in spite of the many problems participants experienced often leading to a failure to complete the tasks. The conclusion might be that user tests should focus rather on the operational and sensory qualities of electronic products than on functionality.

Usability problems in actual use and retrospective evaluation

There are differences between the findings of the previous surveys (Kim*, et al*., 2007; Kim & Christiaans, 2012) and of this experiment, which we assume have to do with differences in research method, i.e. between so-called actual use and retrospective evaluation. The frequency of functional quality problems makes the difference, meaning that contrary to the surveys there are hardly any function-related problems mentioned in the experiment.

One of the explanations might be the influence of time of experiencing usability. Criticizing current usability tests, during which the naïve user is learning about the product for the first

time, Dillon (2002) emphasized the importance of stable estimates of long-term usability: data from current usability tests do not provide data about usability but about learnability, and such short-term interactions may not represent stable interaction. Such first time interactions are very likely to lead to sense-related impressions. Supposedly, considering these characteristics of current usability tests, it is predictable that operational problems (from learnability) and sensory problems (from first impression) would dominate in this experiment employing the current usability test format. This could explain why there are few problems related to functional quality in the experiment following the current usability test format.

Another explanation might be that the tasks given in the experiment are focused on performing operations on the products in order to get them work. This (operation) process-oriented attention might also explain that ' on the way' a number of sensory problems are met, which participants keep in mind and express in the de-briefing.

Implications of use problems and complaints for follow-up behaviour

Soft problems do not always lead to product return but it definitely negatively influences the intention of future purchase. We expected that task completion or failure might have influence on this decision, but the results show that this is not the case. The relatively low percentage of participants who would return the product (47 and 38% resp.), compared to the much higher percentage of participants who would not buy that product anymore (around 70%) can be explained by the resistance of people to put efforts in the act of returning.

The current study was done with a limited number of participants and only two electronic products. This is not enough to sketch a complete picture of the interactions between soft problems, product property, expectations and user characteristics. Therefore, a follow-up study should be conducted with a number of participants enough to come up with statistically reliable results and to figure out in which way user characteristics and product properties interact with soft problems.

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“It has no backlight function... I can’t check room temp at night”

Age 30 | Female | Yokohama, Japan

This chapter is based on the paper:

Kim, C. & Christiaans, H. (in preparation for submission) The influence of consumer characteristics and product properties in soft problems and follow-up reactions. Journal of Consumer Marketing.

ABSTRACT

This chapter describes a survey in which a much larger sample size is involved than the previous studies. In this way we could increase the reliability of the study and validate the previous findings (the third research question). A sample of 567 people participated in the web-based survey: 181 North American, 210 South Korean, and 176 Dutch people. Again soft problems, user characteristics and product properties were measured. The results indicate that types of soft problems are related to particular user characteristics and also dependent on specific product properties. It also turned out that soft problems lead to particular follow-up (re)actions. The implications of these findings will be discussed.

CHAPTER 6 THE INTERACTION BETWEEN USER CHARACTERISTICS, PRODUCT PROPERTIES AND SOFT PROBLEMS

6.1 Introduction

The questionnaire survey conducted in Chapter 4 was meant as a first explorative study into the influence of user characteristics on perceived product usability. The sample of Dutch and South-Korean participants in this survey was far from representative and too small to expect any statistically significant results. In order to validate the findings of that study a replication study was conducted first survey and to a more extensive and reliable look at the effects of user characteristics and product type on soft problems, For these reasons in a second survey three changes were made: (1) a third country was added in order to get better insight into the cultural factor, i.e. the US. (2) Much more participants were included so that with the many variables involved statistical analysis could provide more significant results. (3) To increase the internal validity of the survey, variables that in the first survey did not show any relation with soft problems were left out from the new questionnaire.

6.2 Method

6.2.1 Participants

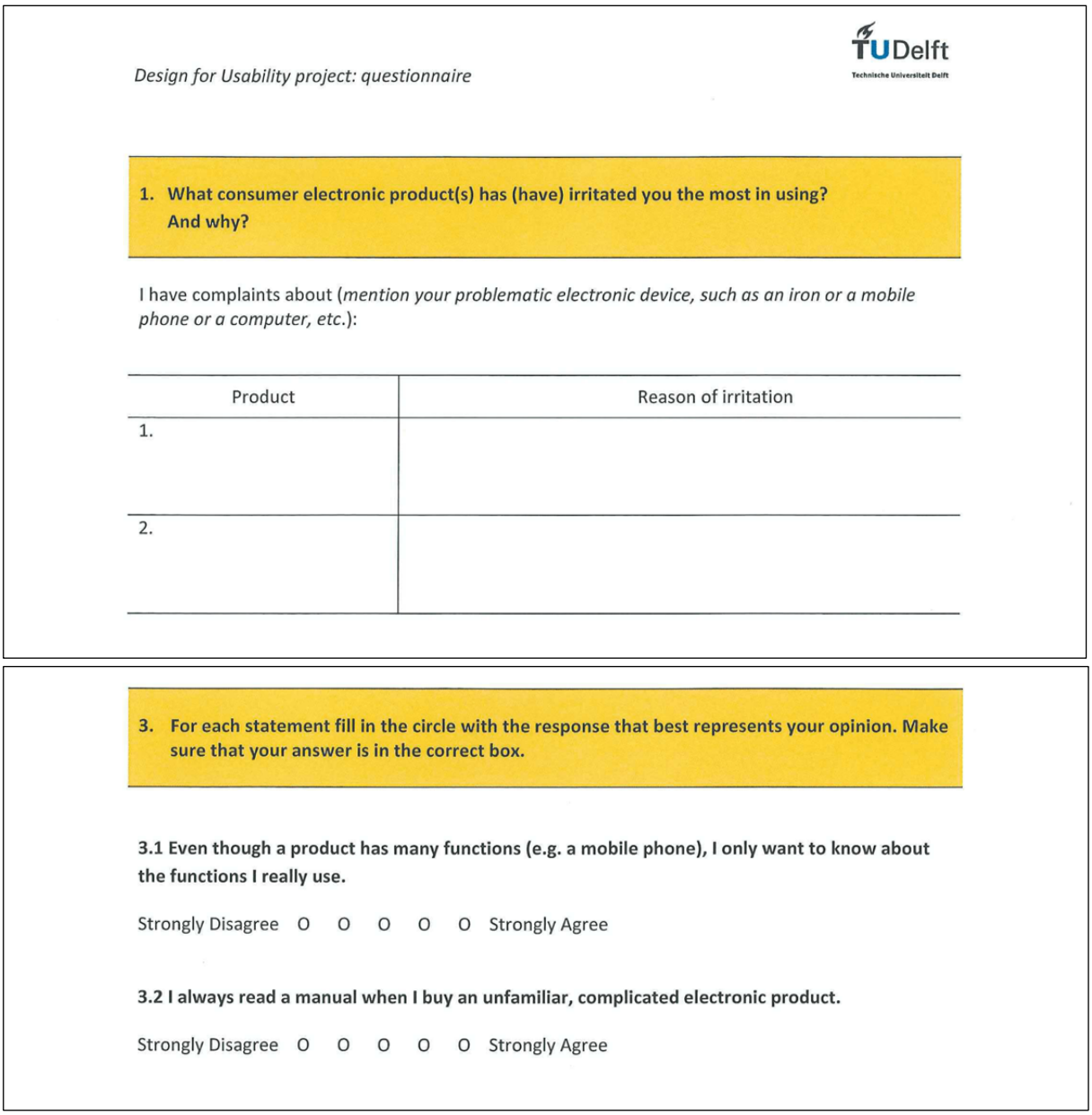
In the previous study culture as a variable was critically taken into consideration. For that reason representatives of two continents, Europe and Asia, were included in the study: the Netherlands and South Korea. This choice was inspired by the companies involved in the usability project, as an important part of their customers are from those two continents. However, that choice was imbalanced in two ways. First, at least the American continent should be included as well; and second, when trying to grasp any cultural differences regarding product usability, investigating only on continental level is not enough. For a company it is interesting or even crucial to know how culture differs between for example Germany and the Netherlands, or China and South Korea. The scope of this thesis, however, is such that a worldwide study into cultural differences was not the primary aim and even not feasible given time and money for the project.

Table 24 Demographic Characteristics of Participants (N = 567)

Variable	USA (n=181)		South Korea (n=210)		Netherlands (n=185)		Total	
	n	%	n	%	n	%	n	%
Gender								
Male	80	44.2	115	54.8	92	50.6	287	50.1
Female	101	55.8	95	45.2	93	49.4	289	49.9
Age at time of survey (years)								
20-29	51	28.2	78	37.1	50	27.0	179	31.1
30-39	30	16.6	40	19.0	50	27.0	120	20.8
40-49	12	6.6	20	9.5	26	14.1	58	10.1
50-59	14	7.7	33	15.7	23	12.4	70	12.2
60+	74	40.9	39	10.4	36	19.5	149	25.8
Educational background								
Not mid. school graduate	-	-	27	12.9	14	7.6	41	7.1
Middle school graduate	16	8.8	59	28.1	29	15.7	104	18.1
High school graduate	87	48.1	61	29.0	21	11.9	169	29.8
Undergraduate degree	66	36.5	37	17.6	73	39.5	176	30.6
Postgraduate degree	12	6.6	26	12.4	48	25.9	86	14.9
Annual household income								
Less than €10,000	17	9.4	44	21.0	36	19.5	97	16.9
€11,000 - €30,000	25	13.8	58	27.6	54	29.2	137	23.8
€31,000 - €50,000	42	23.2	63	30.0	45	24.3	150	26.1
€51,000 - €70,000	32	17.7	20	9.5	29	15.7	81	14.1
More than €71,000	64	35.4	25	11.9	21	11.4	110	19.1
Grown-up environment								
Rural area	21	11.6	35	16.7	13	7.0	69	12.0
Small city	21	11.6	14	6.7	44	23.8	79	13.7
Medium-size city	74	40.9	89	42.4	69	37.3	232	40.3
Large city	65	35.9	72	34.3	59	31.9	196	34.0

So, in addition to the Netherlands and South Korea, the United States was included in the survey. People were recruited by way of either a web questionnaire through social network service or through the local network of the researchers with also paper-version questionnaires as instruments. Especially, elderly participants were recruited through visits to social communities for senior citizens. The total number of participants was 629, but 62 of them answered that they had no complaints. Those participants were not taken into consideration. This process generated a data set on non-failure-found product complaints and user characteristics based on a sample of 567 participants. They lived in their own

country at the time of the survey: 181 North American (80 males and 101 females), 210 South Korean (115 males and 95 females), and 176 Dutch people (89 males and 87 females). Their age ranges from 20 till 80. Their demographic characteristics are shown in Table 24. According to frequency analysis, the sample seems representative of the total population from which they were selected.



Design for Usability project: questionnaire

TU Delft
Technische Universiteit Delft

1. What consumer electronic product(s) has (have) irritated you the most in using? And why?

I have complaints about (*mention your problematic electronic device, such as an iron or a mobile phone or a computer, etc.*):

Product	Reason of irritation
1.	
2.	

3. For each statement fill in the circle with the response that best represents your opinion. Make sure that your answer is in the correct box.

3.1 Even though a product has many functions (e.g. a mobile phone), I only want to know about the functions I really use.

Strongly Disagree O O O O O Strongly Agree

3.2 I always read a manual when I buy an unfamiliar, complicated electronic product.

Strongly Disagree O O O O O Strongly Agree

Figure 47 Examples of The Questionnaire

6.2.2 Equipment

A questionnaire was used to ask for soft problems that participants had experienced, and for user characteristics (see Figure 47). The questionnaire started with two open-ended questions to discover usability problems and the causes of these problems. The first

question was: with what electronic household product participants feel most dissatisfied with, other than technical problems. In the second question, participants were asked to explain for the product mentioned in question 1, what specific dissatisfaction or complaints they had. The other questions were about user characteristics, which consist of demographic, cognitive, personal, and cultural aspects (Table 25), and about product properties such as product importance, perceived performance, frequency of use, and usability importance (Figure 48).

Table 25 List of User Characteristics measured

Category	Variable
Demographic factor	Age, Gender, Educational background (the higher number the more educated), Annual household income (the higher number the more income), and Grown up place (the higher number the more urban place)
Cognitive aspect	Technical skill (the higher number the higher technical skill, Memory (the higher number the higher memorizing ability), Use fixation (the higher number the higher use fixation), and Reading manual (the higher number the more reading instruction)
Personality trait	Curiosity (the higher number the more curiosity), Patience (the higher number the more patient), Sloppiness (the higher number the more sloppy), Buy confidence (the higher number the more buy confident), Uncertainty avoidance (the higher score the higher uncertainty avoidance), Locus of control (the higher the more internal locus of control), Buy decision (the higher number the more buy decision together with family or friends), and Exposure to media (the higher number the more exposed to media)
Follow-up (re)action	Boycott brand, Negative WOM, Seek redress directly, Legal action, Complain to consumer agencies, Brand loyalty, No complaint (the higher number the more in each of complaining behaviour)

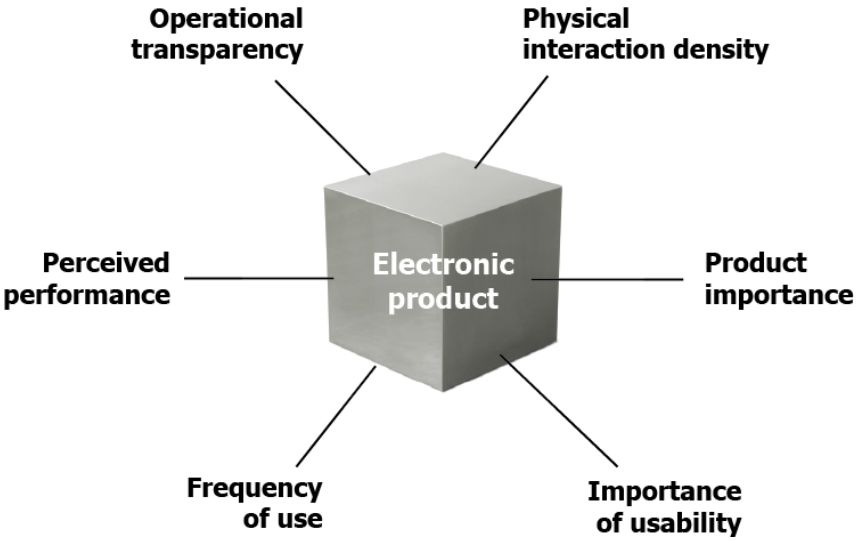


Figure 48 Six product properties of a consumer electronic product

The variables were selected on the basis of research findings in the field of consumer complaining behaviour and consumer (dis)satisfaction (Aykin & Aykin, 1991; Leventhal, et al., 1996; Keng & Liu, 1997; Mooradian & Olver, 1997; Stephens & Gwinner, 1998; Chen-Yu & Hong, 2002; Khalid, 2006).

Donoghue and De Klerk' s conceptual framework (2006) on consumers' complaining behaviour was another source for our selection. They make a distinction between causal attribution, user characteristic and product-specific variables. This division was used to come up with a conceptual framework in our study as well. For most questions a five-points scale was used while some were dichotomous (yes or no) and other multiple choice (e.g. locus of control).

6.2.3 Procedure

Participants who could use Internet were individually invited to a webpage where the questionnaire was available. The series of questions started with the introduction of the survey and with an instruction. They were asked to fill out the questionnaire step by step. Only one question was presented on the screen. Only after giving an answer the system went to the next question. The answers given by participants were automatically saved to a database on the Internet.

Participants who were not familiar with a computer, such as some elderly people, participated in a paper-based questionnaire having the same questions and format as the web-based questionnaire. This was done with the help of student assistants in each country: they visited to places where (senior) citizens gather and handed out the questionnaires while giving instruction. Following that, the questionnaires were collected after they were completely filled out. The survey was performed without time constraints. All the answers gained from the questionnaire survey were input into a SPSS data sheet and then were statistically analysed in SPSS 19.

6.3 Results

6.3.1 Soft problems and product

A total of 662 complaints were reported through the questionnaire survey, which are all related to soft problems. A number of participants reported more than one complaint. Because of our aim to correlate the type of complaint and the product involved with user characteristics, only the first mentioned product complaint per participant was put in our analysis. They were categorized according to one of the three previously used soft problem categories: functional, sensorial and operational. Complaints related to functional quality were the most reported, followed by complaints related to operational quality (Figure 49).

Consumer electronic products complained about are summarized in Figure 50, without distinguishing between countries. The total number of 76 types of household electronic

products complained about varies from mobile phone, computer, and DVD player to iron, shaver and toaster.

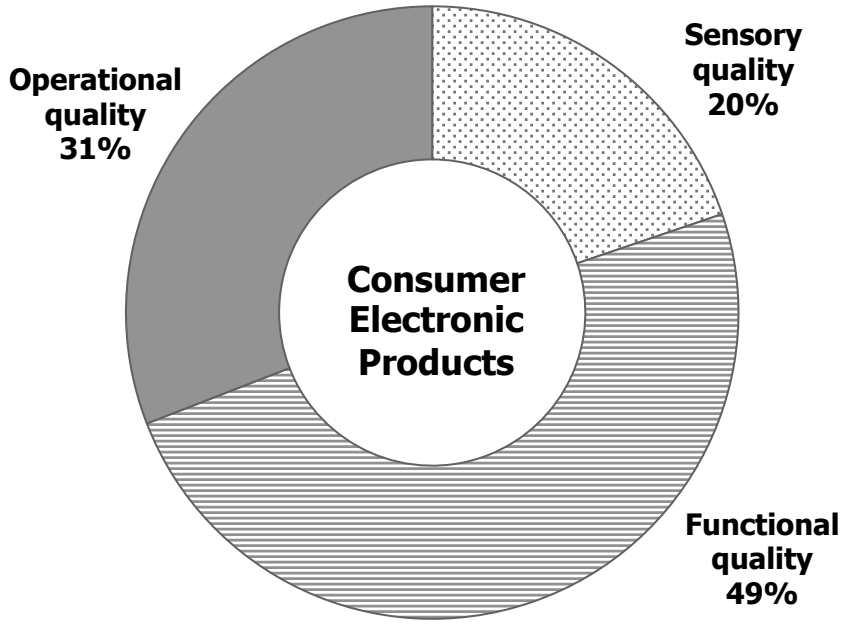


Figure 49 Percentages of soft problems in consumer electronic products

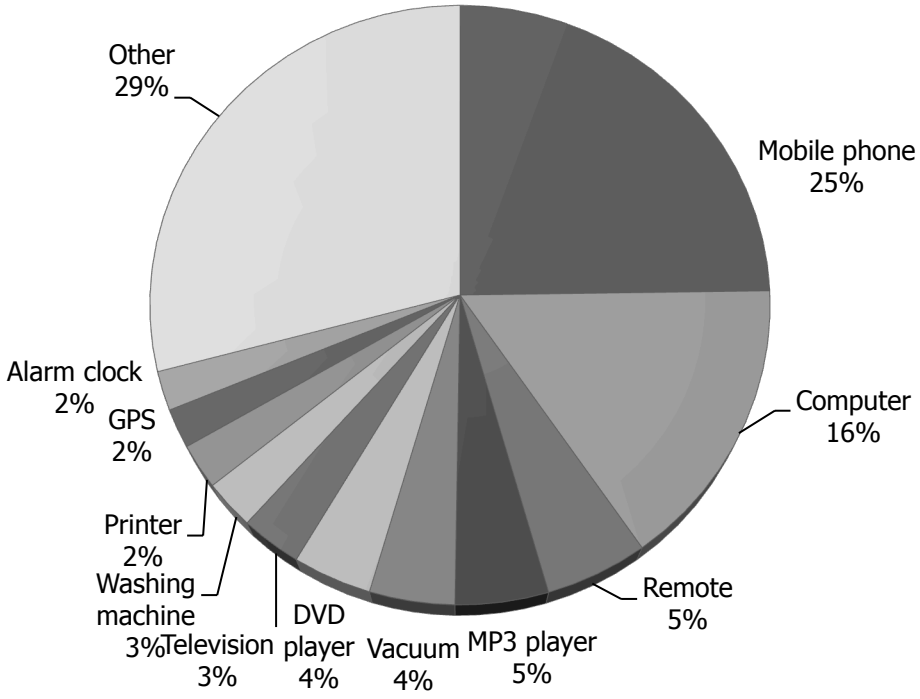


Figure 50 Percentage of consumer electronic products complained by the participants

Most complaints are about complex electronic products such as mobile phone and MP3 player while relatively simple ones such as air-conditioner and dishwasher cause relatively less trouble. Interestingly, many complaints are related to the vacuum cleaner and the washing machine although they seem to be simple products. Other products complained about, but not frequently, are diverse: e.g. refrigerator, digital camera, hair dryer, rice cooker, toaster, earphones, electric mat, monitor, mouse, coffee machine, tablet PC, food processor, thermostat, and so on (See more in Appendix).

Product complaints and culture

Between the three countries there is a similarity on the main products the participants complain about. Commonly, mobile phones are most frequently reported while computers are secondly ranked. Among the American participants both products form more than 50% of the total products complained about (53%), which is quite different compared to the South Korean (34%) and Dutch (34%) participants.

In spite of the similarities, each country seems to have its own character in terms of products they complain about.

American participants (see Figure 51):

- Complain more than the other two countries about products related to automobile such as GPS and car computer system;
- Make few complaints about products saving household labour such as vacuum cleaner and washing machine.

South Korean participants (see Figure 52):

- Have less complaints about a remote control which is one of the most annoying products among American and Dutch participants;
- Often complain about products saving household labour such as the vacuum cleaner and the washing machine as well as kitchen appliances such as the refrigerator and the rice cooker.
- Hardly complain about the DVD player, which is one of the frequently complained products American and Dutch participants have problems with.
- Often complain about the television that does not hold for both American and Dutch participants.

Dutch participants (see Figure 53):

- Often complain about kitchen appliances but about different products than the other countries, such as the microwave and the coffee machine.
- Are hardly annoyed about an MP3 player in contrast to American and South Korean people.

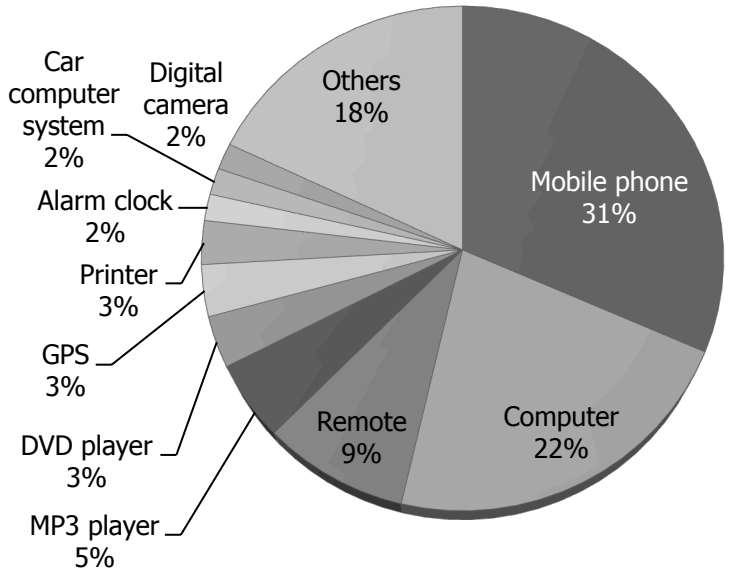


Figure 51 Percentage of consumer electronic products complained by American participants

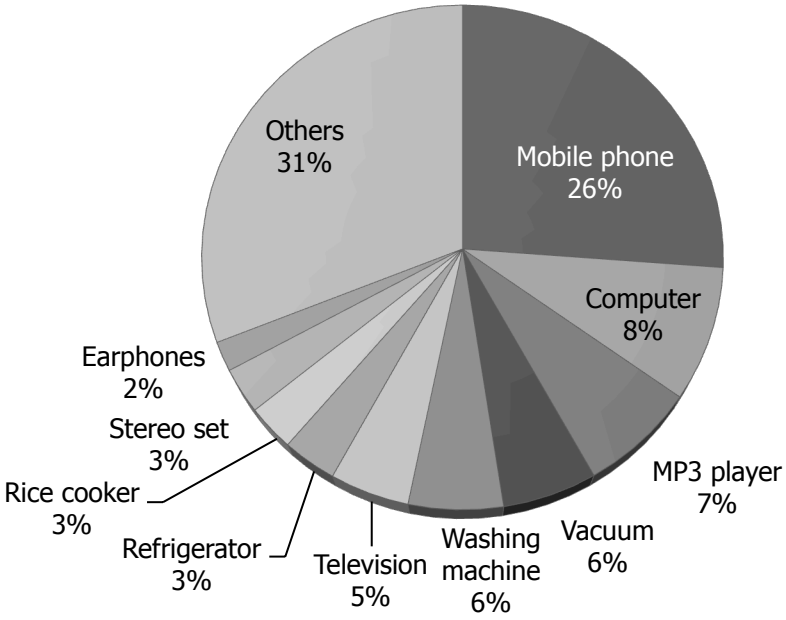


Figure 52 Percentage of consumer electronic products complained by South Korean participants

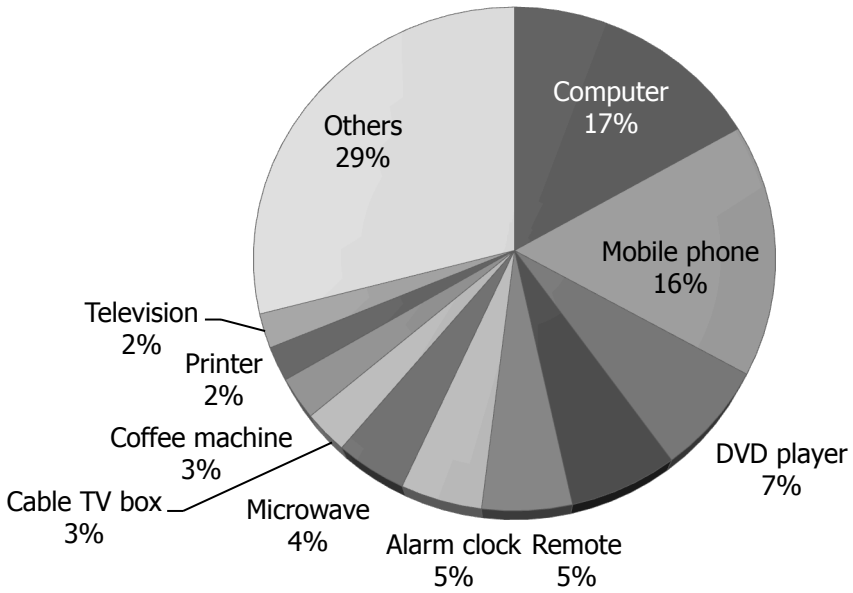


Figure 53 Percentage of consumer electronic products complained by Dutch participants

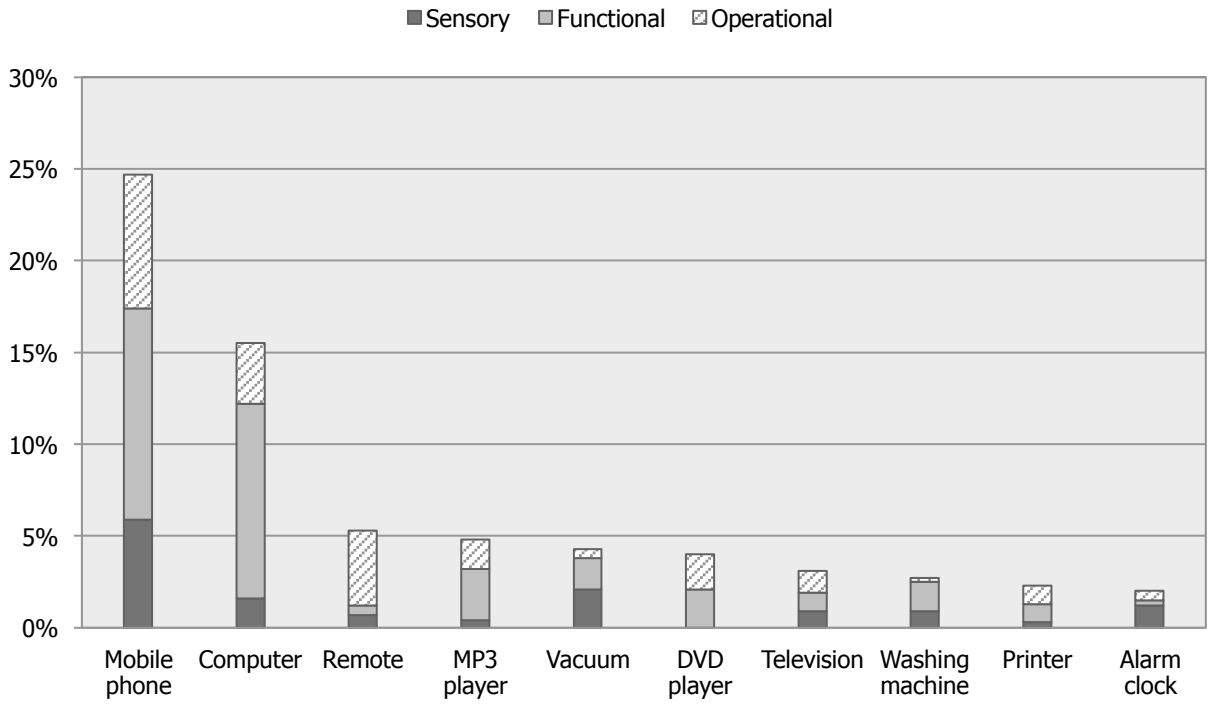


Figure 54 Top 10 consumer electronic products most complained by the participants and their soft problems

Together with the top 10 products that were complained about the percentages of soft problems are summarized in Figure 54. The products seem to have their own profile in terms of these soft problems. Mobile phone, computer, and MP3 player are similar in that functional quality problems are the biggest and sensory quality problems the least. With the remote control, complaints related to operational quality seem dominant. With the vacuum cleaner and the washing machine, both sensory and functional qualities stand out while operational quality is least observed. Functional quality is as important as operational quality for the DVD player. With the television, all three qualities are equally mentioned. The sensory quality of the printer should not be ignored although functional and operational qualities are dominant. The alarm clock seems a product most related to sensory quality.

6.3.2 Soft Problems and User Characteristics

Table 26 presents the means and standard deviations of continuous variables and the frequencies of categorical variables in each type of soft problems. The likelihood ratio tests are a hypothesis test that the variable contributes to the reduction in error measured by the -2 log likelihood statistic. In this model, the variables age, educational level, memorizing ability, uncertainty avoidance, and cultural background are all significant contributors to explaining differences in soft problems.

The two equations in the table of Parameter Estimates (Table 27) are labelled by the group they contrast to the reference group. The first equation is labelled "1 Sensory quality problems", and the second equation is labelled "2 Functional quality problems." The coefficients for each logistic regression equation are found in the column labelled B. The hypothesis that the coefficient is not zero, i.e. changes the odds of the dependent variable event, is tested with the Wald statistic, instead of the t-test as was done for the individual B coefficients in the multiple regression equation.

The findings presented in Table 28 highlight the specific direction of the relationship between user characteristics and type of soft problems. The variables that have a statistically significant relationship to distinguishing the participant complaining about sensory quality from those complaining about operational quality in the first logistic regression equation were age, educational level, memorizing ability, uncertainty avoidance, and cultural background (South Korea). The variables that have a statistically significant relationship to distinguishing complainers about functional quality from those about operational quality were age, educational level, memorizing ability, confidence, and cultural background (South Korea).

Table 26 Means, standard deviations and frequency (percentage) for effects of user characteristics on soft problems

Variable	Sensory (n=114)		Functional (n=284)		Operational (n=178)	
	M	SD	M	SD	M	SD
Demographic factor						
Age	43.6	18.2	39.5	16.4	51.3	17.4
Gender (male)	53 (47%)		145 (51%)		89 (50%)	
Gender (female)	61 (53%)		139 (49%)		89 (50%)	
Educational background	3.09	1.22	3.21	1.13	3.52	1.06
Annual household income	2.80	1.31	2.81	1.33	3.27	1.35
Grown-up environment	2.86	1.06	2.97	.95	3.03	.99
Culture (American)	31 (27%)		72 (25%)		78 (44%)	
Culture (South Korean)	52 (46%)		127 (45%)		31 (17%)	
Culture (Netherlands)	31 (27%)		85 (30%)		69 (39%)	
Cognitive aspect						
Technical skill	3.38	1.37	3.24	1.37	3.39	1.48
Memorizing ability	3.23	1.52	3.35	1.38	2.60	1.40
Use fixation	3.13	1.25	3.12	1.20	3.16	1.21
Reading instructions	2.93	1.37	3.09	1.42	3.26	1.41
Personality trait						
Curiosity	2.53	1.41	2.75	1.36	2.31	1.23
Patience	3.46	1.21	3.43	1.11	3.28	1.21
Sloppiness	2.23	1.19	2.35	1.26	2.23	1.13
Self-confidence	3.01	1.27	3.02	1.14	3.14	1.12
Uncertainty avoidance	3.37	1.29	3.63	1.08	3.69	1.17
Locus of control	67.8	18.6	69.9	16.7	72.4	15.5
Buy decision	2.94	1.37	2.86	1.39	2.84	1.40
Exposure to media	2.96	0.74	3.06	0.80	2.95	0.78

Interpretation of the independent variables is aided by the "Exp (B)" column which contains the odd ratio for each independent variable. We can state the relationships as follows:

- Increases in age made a user about 2% less likely to complain about sensory quality over operational quality.
- Increases in educational level made a user about 36% less likely to complain about sensory quality over operational quality.

- Increases in memorizing ability made a user about 27% more likely to complain about sensory quality over operational quality.
- Increases in uncertainty avoidance made a user about 35% less likely to complain about sensory quality over operational quality.
- Being South Korean increased approximately 4 times the likelihood that a user would complain about sensory quality over operational quality.
- Increases in age made a user about 3% less likely to complain about functional quality over operational quality.
- Increases in educational level made a user about 28% less likely to complain about functional quality over operational quality.
- Increases in memorizing ability made a user about 32% more likely to complain about functional quality over operational quality.
- Increases in confidence made a user about 23% less likely to complain about functional quality over operational quality.
- Being South Korean increased approximately 3.1 times the likelihood that a user would complain about functional quality over operational quality.

Table 27 Model fit for user characteristic variables

Effect	Model Fitting Criteria	Likelihood Ratio Tests		
	-2 Log Likelihood of Reduced Model	Chi-Square	df	Sig.
Intercept	1050.192[a]	.000	0	.
Age	1068.995	18.803	2	.000
Educational background	1056.456	6.264	2	.044
Household income	1050.343	.151	2	.927
Urbanism	1052.000	1.808	2	.405
Exposure to media	1052.589	2.397	2	.302
Technical skill	1052.486	2.294	2	.318
Memorizing ability	1061.350	11.158	2	.004
Use fixation	1050.317	.125	2	.940
Curiosity	1052.023	1.831	2	.400
Reading manuals	1052.274	2.082	2	.353
Buy decision	1051.180	.988	2	.610
Patience	1051.951	1.759	2	.415
Sloppiness	1051.356	1.164	2	.559
Self-confidence	1055.077	4.885	2	.087
Uncertainty avoidance	1057.821	7.629	2	.022
Locus of control	1052.027	1.835	2	.400
Cultural background	1074.592	24.400	4	.000

Table 28 Parameter estimates for user characteristic variables

Soft problems	Independent variables	B	Std. Error	Wald	df	Sig.	Exp(B)
Sensory quality problems	Intercept	2.284	1.620	1.988	1	.159	
	Age	-.023	.009	6.301	1	.012	.978
	Educational level	-.305	.137	4.935	1	.026	.737
	Household income	-.013	.110	.013	1	.908	.987
	Urbanism	-.169	.134	1.593	1	.207	.844
	Exposure to media	.079	.177	.201	1	.654	1.083
	Technical skill	.108	.105	1.052	1	.305	1.114
	Memorizing ability	.238	.102	5.470	1	.019	1.268
	Use fixation	-.022	.111	.040	1	.841	.978
	Curiosity	.007	.109	.004	1	.950	1.007
	Reading manuals	-.130	.098	1.768	1	.184	.878
	Buy decision	.096	.103	.863	1	.353	1.101
	Patience	.135	.113	1.412	1	.235	1.144
	Sloppiness	-.012	.114	.012	1	.914	.988
	Confidence	-.223	.121	3.415	1	.065	.800
	Uncertainty avoidance	-.302	.119	6.413	1	.011	.739
	Locus of control	-.007	.009	.598	1	.439	.993
	[America]	.131	.349	.141	1	.708	1.140
	[South Korea]	1.352	.379	12.755	1	.000	3.866
	[The Netherlands]	0[b]	.	.	0	.	.
Functional quality problems	Intercept	1.277	1.352	.893	1	.345	
	Age	-.032	.008	18.069	1	.000	.968
	Educational level	-.246	.115	4.608	1	.032	.782
	Household income	.022	.091	.059	1	.809	1.022
	Urbanism	-.121	.113	1.155	1	.283	.886
	Exposure to media	.215	.146	2.145	1	.143	1.239
	Technical skill	-.031	.088	.127	1	.721	.969
	Memorizing ability	.274	.084	10.512	1	.001	1.315
	Use fixation	-.033	.094	.125	1	.724	.967
	Curiosity	.102	.089	1.315	1	.251	1.107
	Reading manuals	-.023	.082	.077	1	.781	.978
	Buy decision	.020	.086	.052	1	.820	1.020
	Patience	.105	.093	1.265	1	.261	1.111
	Sloppiness	.077	.093	.680	1	.410	1.080
	Confidence	-.210	.103	4.176	1	.041	.811

Uncertainty avoidance	-.059	.102	.334	1	.563	.943
Locus of control	.003	.007	.166	1	.683	1.003
[America]	-.257	.277	.859	1	.354	.773
[South Korea]	1.133	.315	12.916	1	.000	3.104
[The Netherlands]	0[b]	.	.	0	.	.

If these two sets of findings are combined, the following user characteristics are related to particular types of soft problems in a specific direction:

- Age: the older participants are the more likely to complain about operational quality, whereas the younger participants are the more likely to complain about sensory and functional qualities.

- Educational level: the higher educated participants are the more likely to complain about operational quality, whereas the lower educated participants are the more likely to complain about sensory and functional qualities.

- Memorizing ability: participants with the better memorizing ability are the more likely to complain about functional and sensory qualities, while participants with the worse memorizing ability are the more likely to complain about operational quality.

- Uncertainty avoidance: participants having the higher score in uncertainty avoidance are the more likely to complain about operational quality, while participants having the lower score in uncertainty avoidance are the more likely to complain about functional and sensory qualities

- Confidence: the more confident participants are the more likely to complain about operational quality, whereas the less confident participants are the more likely to complain about functional quality.

- Cultural background: South Korean participants more complain about sensory and functional qualities than American and Dutch participants.

South Koreans overall are significantly more likely to complain about sensory quality (3.9 more times) and functional quality (3.1 more times) than operational quality (see also Figure 55). American and Dutch participants overall are less likely to have complaints related to sensory and functional quality, and more about operational quality. There is no significant difference in the types of soft problems reported between American and Dutch participants.

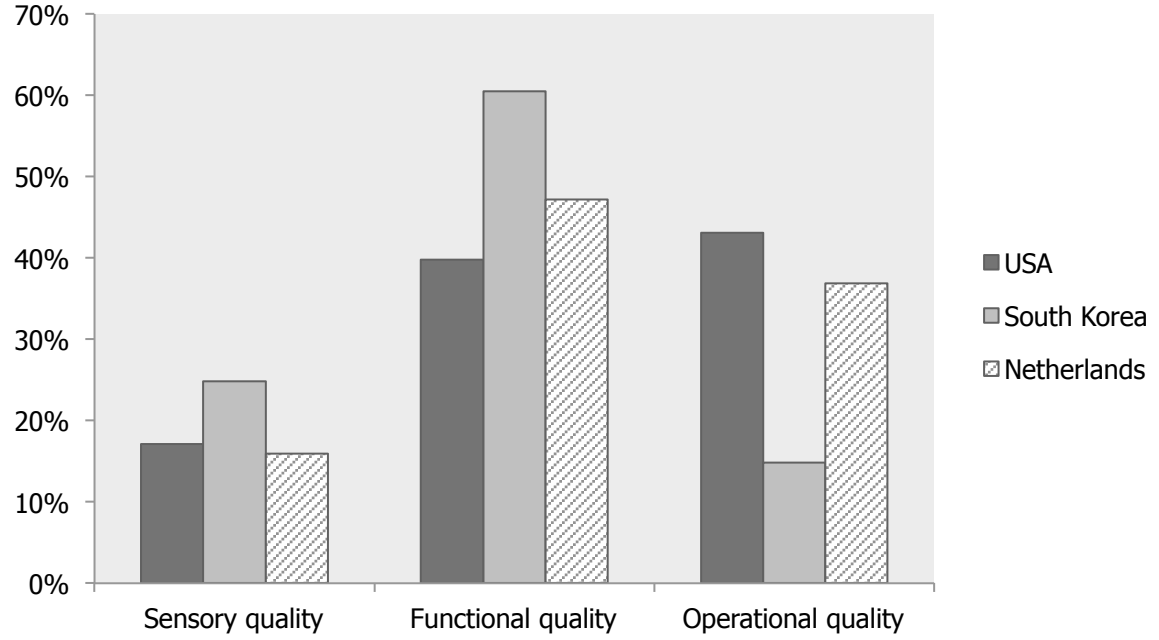


Figure 55 Differences of soft problems among three countries

6.3.3 Product properties and soft problems

Next to the classification into the three aforementioned qualities, the consumer electronic products complained about were categorized based on the product properties interaction density and operational transparency. Both categories have continuous values according to the extent to which a product is physically interactive, and to which it is operationally transparent.

The classification according to product properties indicates that many of the participants complained about electronic products with highly interactive products or with operationally non-transparent products. 60% of all the complaints are related to highly interactive electronic products (e.g. vacuum cleaner and mobile phone), whereas those related to electronic products with intermediate and low interaction density (e.g. washing machine and coffee machine) were much less reported: 22% for intermediate interaction density products and 17% for low interaction density products. Half of the complaints (54%) were related to electronic products having low operational transparency (e.g. mobile phone and computer), while complaints about electronic products with relatively higher operational transparency were much less shown: 24% for highly operational transparency products and 22% for intermediate operational transparency products.

A logistic regression analysis was conducted to predict soft problems from product characteristic variables (product importance, frequency of use, importance of usability, and perceived performance) including the product properties as predictors. A test of the full model against a constant only model was statistically significant, indicating that the predictors as a set reliably distinguish between the three types of soft problems.

Table 29 presents the means and standard deviations of product characteristic variables in each type of soft problems for product property variables. The likelihood ratio tests are a hypothesis test that the variable contributes to the reduction in error measured by the -2 log likelihood statistic. In this model, the variables interaction density, operational transparency, frequency of use, and perceived performance are all significant contributors to explaining differences in soft problems (Table 30).

Table 29 Mean values and standard deviations for product characteristics as a function of soft problems

Product property	Problems with					
	Sensory quality (n=114)		Functional quality (n=284)		Operational quality (n=178)	
	M	SD	M	SD	M	SD
Interaction density	2.39	0.85	2.43	0.83	2.29	0.80
Operational transparency	1.96	0.95	1.69	0.83	1.55	0.72
Product importance	3.15	1.04	3.16	0.96	2.96	0.98
Frequency of use	3.51	0.87	3.46	0.90	3.24	0.97
Importance of usability	3.24	1.00	3.38	0.85	3.37	0.89
Perceived performance	2.46	0.99	2.01	0.89	2.37	0.89

Table 30 Model fit for product property variables

Effect	Model Fitting Criteria	Likelihood Ratio Tests		
	-2 Log Likelihood of Reduced Model	Chi-Square	df	Sig.
Intercept	784.317	22.709	2	.000
Interaction density	775.130	13.521	2	.001
Operational transparency	795.066	33.457	2	.000
Product importance	763.664	2.055	2	.358
Frequency of use	769.685	8.076	2	.018
Importance of usability	765.224	3.616	2	.164
Perceived performance	790.520	28.911	2	.000

The two equations in the table of Parameter Estimates (Table 31) are labelled by the group they contrast to the reference group. The first equation is labelled "1 Sensory quality problems", and the second equation is labelled "2 Functional quality problems." The coefficients for each logistic regression equation are found in the column labelled B. The hypothesis that the coefficient is not zero, i.e. changes the odds of the dependent variable event, is tested with the Wald statistic, instead of the t-test as was done for the individual B coefficients in the multiple regression equation.

Table 31 Parameter estimates for product characteristic variables

Soft problems	Independent variables	B	SD	Wald	df	Sig.	Exp(B)
Sensory quality problems	Intercept	-4.498	1.007	19.965	1	.000	
	Interaction density	.607	.179	11.457	1	.001	1.835
	Operational transparency	1.017	.186	29.764	1	.000	2.764
	Product importance	.065	.145	.202	1	.653	1.068
	Frequency of use	.438	.170	6.658	1	.010	1.550
	Importance of usability	-.270	.142	3.611	1	.057	.763
	Perceived performance	.040	.136	.085	1	.771	1.040
Functional quality problems	Intercept	-1.406	.790	3.169	1	.075	
	Interaction density	.420	.147	8.136	1	.004	1.522
	Operational transparency	.587	.164	12.867	1	.000	1.799
	Product importance	.165	.117	1.987	1	.159	1.179
	Frequency of use	.269	.126	4.550	1	.033	1.309
	Importance of usability	-.119	.119	.995	1	.318	.888
	Perceived performance	-.486	.112	18.763	1	.000	.615

The findings presented in Table 31 highlight the specific direction of the relationship between product characteristics and type of soft problems. The variables that have a statistically significant relationship to distinguishing the participant complaining about sensory quality from those complaining about operational quality in the first logistic regression equation were interaction density, operational transparency, and frequency of use. The variables that have a statistically significant relationship to distinguishing complainers about functional quality from those about operational quality were interaction density, operational transparency, frequency of use, and perceived performance.

Interpretation of the independent variables is aided by the "Exp (B)" column which contains the odd ratio for each independent variable. We can state the relationships as follows:

- Increases in Interaction density made a user about 1.8 times more likely to complain about sensory quality over operational quality.

- Increases in operational transparency made a user about 2.8 times more likely to complain about sensory quality over operational quality.

- Increases in frequency of use made a user about 1.6 times more likely to complain about sensory quality over operational quality.

- Increases in Interaction density made a user about 1.5 times more likely to complain about functional quality over operational quality.

- Increases in operational transparency made a user about 1.8 times more likely to complain about functional quality over operational quality.

- Increases in frequency of use made a user about 1.3 times more likely to complain about functional quality over operational quality.

- Increased in perceived performance made a user about 62% less likely to complain about functional quality over operational quality.

If these two sets of findings are combined, the following product characteristics are related to particular types of soft problems in a specific direction:

- Interaction density: the higher interaction density an electronic product has is the more likely to lead to problems related to sensory quality (1.8 more times) and functional quality (1.5 more times) than operational quality; the lower interaction density is the more likely to lead to problems related to operational quality, on the other way around.

- Operational transparency: the more operationally transparent an electronic product is the more likely to associate any complaints with sensory quality (2.8 more times) and functional quality (1.8 more times) than operational quality. This indicates that the more operationally transparent is the more likely to lead to problems related to sensory and functional qualities, while the less operationally transparent is the more likely related to operational quality.

- Frequency of use: the more often used an electronic product is the more likely to associate any complaints with sensory quality (1.6 more times) and functional quality (1.3 more times) than operational quality. This demonstrates that the more often used product is the more likely to lead to complaints related to sensory quality and this is followed by problems related to functional quality, whereas the less often used product is the more likely to related to operational quality.

- Perceived performance: the better a product performs than expectation is the more likely to associate any complaints with sensory quality and operational qualities, whereas the worse a product performs than expectation is the more likely to lead to problems related to functional quality.

Product properties and culture

A one-way between-groups multivariate analysis of variance was performed to investigate cultural differences in product property complained about (Table 32 and 33). Dependent variables were product properties and the independent variable was culture. There was a statistically significant difference between countries on the combined dependent variables. When the results for the dependent variables were considered separately, the differences to reach statistical significance were found in variables for interaction density, operational transparency, frequency of use, importance of usability, and perceived performance. An inspection of the mean scores indicated that product properties and cultural background are related as follows:

Table 32 The means and standard deviations of continuous variables in each culture for product property variables

Variable	America (n=181)		South Korea (n=210)		Netherlands (n=176)	
	M	SD	M	SD	M	SD
Interaction density	2.54	0.73	2.42	0.83	2.17	0.88
Operational transparency	1.36	0.63	1.87	0.89	1.85	0.85
Product importance	3.16	0.98	3.08	0.97	3.06	1.01
Frequency of use	3.47	0.88	3.50	0.83	3.23	1.03
Importance of usability	3.51	0.80	3.22	0.95	3.40	0.87
Perceived performance	2.35	0.84	2.12	1.02	2.17	0.89

Table 33 Multivariate and Univariate Analyses of Variance F Ratios for the effect of culture for soft problems

Variable	MANOVA	ANOVA					
		Interaction density	Operation. transparen.	Product importance	Frequency of use	Important.. of usability	Perceived performanc.
	F(2, 573)	F(2, 573)	F(2, 573)	F(2, 572)	F(2, 572)	F(2, 572)	F(2, 572)
Cultural background	14.64***	9.76***	23.44***	0.48	5.17**	5.31**	3.21*

**p < .05. **p < .01. ***p < .001.*

American participants mainly complain about:

- High interaction density products
- Operationally non-transparent products
- Often used products
- Usability-critical products

South Korean participants mainly complain about:

- Operationally transparent products
- Often used products
- Performance-poor products

Dutch participants mainly complain about:

- Low interaction density products
- Operationally transparent products
- Not often used products

Product properties and Age

In order to see the influence of age on the products complained about, two extreme age groups, 20s and 60+, were compared. There is no significant difference between two groups. Mobile phone and computer are products most complained about in common. Although the percentages are more or less different, remote, DVD player, vacuum cleaner, washing machine, and microwave are shown in both groups. In the young group, products such as MP3 player, printer, earphones, hair dryer are shown, which do not appear in the old group. On the contrary, refrigerator, GPS, and toaster are seen in the old group only.

Again age was used to see if it has to do with the product characteristics. Bivariate correlation analysis was conducted. The results show that there is no significant relationship between product characteristic variables and age (Table 34): the values of correlation are very low although the statistic analysis indicates they are significant (i.e. interaction density, operational transparency, and perceived performance). In other words, although the characteristics of an electronic product are related to specific types of soft problem, the properties are not associated with the age of the user.

Table 34 Correlations between age and product properties

Measure	1	2	3	4	5	6	7
Age	--						
Interaction density	-.09*	--					
Operational transparency	.13**	-.48**	--				
Product importance	.05	.12**	-.10*	--			
Frequency of use	-.06	.21**	-.25**	.50**	--		
Importance of usability	-.02	.10*	-.09*	.14**	.04	--	
Perceived performance	.18**	-.05	.03	.11*	.08	.03	--

** p < .05. **p < .01.*

Product properties and gender

There is no significant difference between male and female participants in electronic products they complained about. Mobile phones are commonly the most complained products in both groups, which is followed by computers. Vacuum cleaners were often complained about in common but this is the third electronic product annoying female participants (6%): for male participants, it is the 11th ranked products (2%). Although percentages are more or less different, they often complained about almost the same products such as remote, vacuum, MP3 player, television, washing machine, DVD player, printer and GPS. However, Cable TV box and alarm clock are hardly shown in female participants while microwave and refrigerator are hardly shown in male ones.

Table 35 Product characteristics differences between male and female participants

Variable	Male (n=287)		Female (n=289)	
	M	SD	M	SD
Interaction density	2.35	.82	2.40	.83
Operational transparency	1.66	.79	1.75	.88
Product importance	3.03	.99	3.16	.98
Frequency of use	3.44	.88	3.37	.96
Importance of usability	3.37	.86	3.37	.92
Perceived performance	2.18	.90	2.23	.97

In order to investigate the relationship between gender and product characteristics, an independent t-test was performed (see Table 35 for the mean scores and standard deviations). The independent variable is gender. Product characteristics complained about by the participants are the dependent variables. No statistically significant difference was found between male and female on product characteristics. The results indicate that the product characteristics make no difference between male and female respondents.

6.3.4 Soft problems and follow-up (re)action

When consumers experience dissatisfaction and want to complain, there are typically five ways of how to react: boycott brand, negative word-of-mouth (WOM), seek redress directly, complaining to agencies or the government, and no complaint at all. 15 questions were used which are related to the typical five ways of follow-up (re)actions. In order to discover simple patterns in the pattern of relationships among the questions, factor analysis was conducted. The results indicates that actually the questions can be grouped into four types of follow-up (re)actions resulting from soft problems: brand disloyalty, direct redress, helpdesk contact, and active (re)action. The groups of questions according to the four ways are shown in Table 36.

Table 36 Means and Standard Deviations for Effects of soft problems for follow-up (re)action measured on a 6-points scale from ' Strongly Disagree (1)' to ' Strongly Agree (6)' .

Variable	M	Sensory quality		Functional quality		Operational quality	
		M	SD	M	SD	M	SD
Brand disloyalty							
Buy products from another brand next time	3.46	4.48	1.59	4.44	1.55	4.59	1.41
Never buy any products of the brand again	3.24	3.08	1.65	3.25	1.54	3.34	1.62
Loyal to the brand	2.40	2.38	1.45	2.35	1.28	2.43	1.42
Negative comments about the brand	4.38	4.39	1.72	4.52	1.51	4.14	1.60
Tell my friends not to buy that brand product	4.07	4.18	1.54	4.03	1.59	4.05	1.54
Direct redress							
Exchange it for one from another brand	3.93	3.55	1.63	4.11	1.43	3.90	1.55
Speak to the shop manager	4.01	3.99	1.72	3.97	1.56	4.07	1.68
Demand a refund	3.35	3.13	1.61	3.46	1.68	3.32	1.63
Helpdesk contact							
Call the helpdesk	3.25	3.28	1.76	3.37	1.65	3.04	1.67
Complain to the company through mail	2.86	2.96	1.76	2.86	1.64	2.80	1.73
Communicate the dissatisfaction to the helpdesk	4.33	4.36	1.59	4.29	1.48	4.39	1.50
Complain to consumer organization	2.40	2.68	1.74	2.32	1.51	2.36	1.59
Active (re)action							
Upset but not respond	2.81	2.96	1.53	2.79	1.51	2.74	1.61
Wait hoping things improved	2.90	2.92	1.58	3.09	1.57	2.60	1.55
Remain calm until things are sorted out	3.46	3.47	1.56	3.39	1.46	3.56	1.33

A one-way between-groups multivariate analysis of variance (MANOVA) was performed to investigate how types of soft problems are related to particular follow-up actions (Table 37). Preliminary assumption testing was conducted to check for normality, linearity, univariate and multivariate outliers, homogeneity of variance-covariance matrices, and multicollinearity, with no serious violations noted. There is a statistically significant difference between soft problems on the combined dependent variables. When the results for the dependent variables are considered separately, the main differences found are (1) ' Negative comments about the brand' ; (2) ' Exchange the product for one from another brand' ; and (3) ' Wait hoping things improved' . The means of each follow-up (re)action are presented in Table 37.

Table 37 Multivariate and Univariate Analyses of Variance F Ratios for effects of soft poblems for follow-up (re)actions

	Variable		Soft problems
MANOVA		F(2, 573)	1.98**
ANOVA	Buy products from another brand next time	F(2, 575)	.56
	Never buy any products of the brand again	F(2, 575)	.96
	Loyal to the brand	F(2, 575)	.44
	Negative comments about the brand	F(2, 575)	3.22*
	Tell my friends not to buy that brand product	F(2, 575)	.40
	Exchange it for one from another brand	F(2, 575)	5.53**
	Speak to the shop manager	F(2, 575)	.19
	Demand a refund	F(2, 575)	1.67
	Call the helpdesk	F(2, 575)	2.19
	Complain to the company through mail	F(2, 575)	.34
	Communicate the dissatisfaction to the helpdesk	F(2, 575)	.26
	Complain to consumer organization	F(2, 575)	2.29 (.102)
	Upset but not respond	F(2, 575)	.74
	Wait hoping things improved	F(2, 575)	5.43**
	Remain calm until things are sorted out	F(2, 575)	.76

**p < .05. **p < .01.*

An inspection of the mean scores in ' Negative comments about the brand' indicates that participants with functional quality problems reported higher levels of the follow-up (re)action than those with the other quality problems: when participants experienced problems related to functional quality, this leads to negative comments about the brand to their family or friends. On the other hand, complaints related to operational quality hardly seem to lead to negative comments to friends. ' Exchange the product for one from another brand' is associated to functional quality. And sensory quality problems are least related to the follow-up action. ' Wait hoping things improved' is also linked to functional quality problems. However, all the mean scores for the dependent variable are below the average of the scale (3.5). This means that participants do not want to wait until things are improved. In case of functional quality problems, participants are least likely to take the follow-up action.

Cultural differences

A one-way between-groups multivariate analysis of variance (MANOVA) was conducted to investigate cultural differences in follow-up (re)action after having experienced soft problems (see the results in Table 38 & 39). Preliminary assumption testing was conducted to check for normality, linearity, univariate and multivariate outliers, homogeneity of variance-covariance matrices, and multicollinearity, with no serious violations noted. There is a statistically significant difference between countries on the combined dependent variables. These differences are found in most of the follow-up reactions (see Table 38 and 39).

American participants are:

- Less likely to be loyal to the brand
- Unlikely to call the helpdesk to argue dissatisfaction with the employee
- Unlikely to complain to governmental agencies or consumer organization
- Unlikely to wait and hope that things improved

South Korean participants are:

- Less likely to be loyal to the brand
- Significantly likely to spread negative comments about the brand, especially to their friends telling not to buy the brand products
- Very likely to call the helpdesk to argue problems with the employee
- Very likely to speak to the shop manager
- Less likely to stay calm without taking any actions

Dutch participants are:

- Significantly likely to spread negative comments about the brand but not to their friends.
- Very likely to call the helpdesk to argue problems with the employee
- Unlikely to complain to the company through mail
- Very likely to speak to the shop manager
- Unlikely to wait and hope that things improved

In order to see if product properties are related to specific follow-up (re)actions, a bivariate correlation analysis was conducted (Table 40). All correlations are low even though some are significant at given significant levels. The result indicates that product properties have nothing to do with specific follow-up actions.

Table 38 Means and Standard Deviations for effects of culture for complaining behaviour

Follow-up (re)action	USA (n=181)		South Korea (n=210)		Netherlands (n=176)	
	M	SD	M	SD	M	SD
Brand disloyalty						
Buy products from another brand next time	4.65	1.23	4.40	1.79	4.44	1.41
Never buy any products of the brand again	3.17	1.40	3.40	1.79	3.15	1.50
Loyal to the brand	2.27	1.06	2.20	1.44	2.76	1.45
Negative comments about the brand	3.64	1.65	4.74	1.56	4.69	1.30
Tell my friends not to buy that brand product	4.12	1.41	4.42	1.62	3.62	1.55
Direct redress						
Exchange it for one from another brand	4.04	1.39	3.90	1.68	3.86	1.45
Speak to the shop manager	3.49	1.58	4.28	1.67	4.21	1.51
Demand a refund	3.36	1.51	3.49	1.82	3.18	1.59
Helpdesk contact						
Call the helpdesk to argue with the employee	2.56	1.44	3.72	1.73	3.40	1.64
Complain to the company through mail	3.33	1.76	2.72	1.65	2.55	1.57
Communicate the dissatisfaction to the helpdesk	4.35	1.43	4.28	1.64	4.37	1.43
Complain to consumer organization	2.12	1.41	2.37	1.47	2.72	1.81
Active (re)action						
Upset but not respond	2.64	1.49	2.91	1.67	2.85	1.46
Wait and hope that things improved	2.51	1.41	3.55	1.66	2.55	1.40
Remain calm until things are sorted out	3.41	1.25	3.22	1.58	3.76	1.40

$^{**}p < .01$. $^{***}p < .001$

Table 39 Multivariate and Univariate Analyses of Variance F Ratios for effects of culture of complaining behaviour

	Variable		Cultural background
MANOVA		F(2, 573)	13.03***
ANOVA	Buy products from another brand next time	F(2, 575)	1.48
	Never buy any products of the brand again	F(2, 575)	1.53
	Loyal to the brand	F(2, 575)	10.00***
	Negative comments about the brand	F(2, 575)	31.99***
	Tell my friends not to buy that brand product	F(2, 575)	13.68***
	Exchange it for one from another brand	F(2, 575)	.73
	Speak to the shop manager	F(2, 575)	14.13***
	Demand a refund	F(2, 575)	1.70
	Call the helpdesk	F(2, 575)	26.36***
	Complain to the company through mail	F(2, 575)	11.19***
	Communicate the dissatisfaction to the helpdesk	F(2, 575)	.21
	Complain to consumer organization	F(2, 575)	6.82**
	Upset but not respond	F(2, 575)	1.58
	Wait hoping things improved	F(2, 575)	30.99***
	Remaining calm until things are sorted out	F(2, 575)	7.13**

** p < .05. **p < .01*

Table 40 Pearson correlation between product properties and follow-up (re)actions

Variable	1	2	3	4	5	6
Interaction density	--					
Operational transparency	-.48**	--				
Product importance	.12**	-.09*	--			
Frequency of use	.21**	-.25**	.50**	--		
Importance of usability	.10*	-.09*	.14**	.04	--	
Perceived performance	-.05	.03	.11*	.08	.03	--
Brand disloyalty						
Buy products from another brand next time	.06	-.02	.03	.02	.00	-.15**
Never buy any products of the brand again	.05	-.04	.03	-.01	.08*	-.12**
Loyal to the brand	-.07	.08	.03	.04	.00	.19**
Negative comments about the brand	.03	.05	.05	.06	-.05	-.08*
Tell my friends not to buy that brand product	.11**	-.14**	.05	.16**	-.05	-.13**
Direct redress						
Exchange it for one from another brand	.03	.02	.05	.04	.09*	-.03
Speak to the shop manager	-.00	.09*	.11*	.07	.05	.03
Demand a refund	.06	-.00	.03	.08*	.01	.04
Helpdesk						
Call the helpdesk	-.07	.11*	.12**	.11*	-.01	.01
Complain to the company through mail	.10*	-.12**	.10*	.06	.07	.05
Communicate the dissatisfaction to the helpdesk	.03	.00	.13**	.04	.02	.07
Complain to consumer organization	.04	.02	.02	.03	.05	.00
Active (re)action						
Upset but not respond	-.02	.04	-.04	-.04	-.06	-.06
Wait hoping things improved	-.01	.05	-.00	.08	-.04	-.03
Remain calm until things are sorted out	-.08	.10*	.01	-.02	.01	.09*

$^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$

6.4 Conclusions and discussion

6.4.1 Product type and Soft problems

In the interaction between user and product, functional quality such as performance and functionality takes the majority of soft problems. Although operational quality, such as understandability and maintenance, and sensory quality, such as form and touch, are not as often mentioned as functional ones, they are still too frequent to be neglected as soft

problems. For instance looking at complaints related to mobile phones, which take a fourth of all problems reported in the study, the sensory and operational problems are individually almost the same as those related to functional quality: the sensory and operational problems take 24% and 30% respectively compared to 46% functional problems.

In complaining the most frequently mentioned electronic products, such as mobile phone, computer, remote, and MP3 player, are complex products. One might expect this has to do with the difficulty people have with the operations to get the product working. However, complexity of a product is not necessarily related to operational problems: functional problems are here more often mentioned than operational and sensory problems.

Between countries there are similarities and differences in products complained about. Mobile phone and computer are most frequently mentioned. Problems with these products seem hardly be influenced by culture. However, there are also specific country related products complained about. Automobile-related electronic products are often reported by American people. Problems with a printer are also mentioned mostly by American people. On the other hand, South Korean people often complain about kitchen appliances such as rice cooker and refrigerator. Dutch people also complain often about kitchen appliances, but about different products such their coffee machine and microwave.

6.4.2 Soft problems and user characteristics

Soft problems are partly related to user characteristics. Looking at the user dimensions chosen – demographic factors, cognitive aspects, and personality traits – the following characteristics has influence:

Among demographic factors correlations are found only with age, educational background, and culture. Age is a critical factor to predict anticipated soft problems. Elderly people complain more about operational quality than about functional quality or sensory quality. Meanwhile, young people complain mostly about functional quality of their electronic products, not about operational quality and sensory quality. This corresponds with our well-known anticipation that ease of use is important for the old generation. However, it is interesting that young generation does not complain about sensory quality considering that they are most familiar with portable gadgets (as products much exposed to sensory quality) among others. It is also interesting that high educational level is related to operational quality problems. Supposedly, highly educated people would have no difficulty in finding out how to operate a complex product. However, considering that operational quality involves logical reasoning in case of finding a function or maintaining a product, they are probably so sensitive to any illogical or strange operation of an electronic product that it easily leads to their complaints. These findings are partly different from our previous studies. While age was a factor in our earlier survey study (Chapter 4), it was not in the experimental study described in Chapter 5. An in both the previous survey and the experimental study educational background did not show significant correlations with particular soft problems (Chapter 4 & 5). The small size of the sample in the experimental study and its difference

in the character might explain this discrepancy.

Culture also influences the occurrence of specific types of soft problems. The findings in this study are to a large extent similar to those in the previous experiment except for some differences in percentages and for the difference in number of complaints on functional quality (very low in the experiment). South Koreans complain mostly about sensory quality problems and least about operational quality. Dutch people are the lowest in complaints on sensory quality but the highest on operational quality. American people complain about operational quality as much as Dutch people.

Although only three countries were considered in this study, we think that the findings are applicable to a wider range of countries in case of developing an electronic product for a particular cultural group and to anticipate on soft problems with electronic products.

Among cognition-related factors, only memorizing ability affects the occurrence of specific types of soft problems. It makes sense that the lack of memorizing ability is very likely to lead to problems related to operational quality.

Personality factors do not show strong relationships to the problems except for uncertainty avoidance. People who take risk for any unexpected events are likely to complain about sensory quality, whilst those who like everything planned complain about operational quality. A possible explanation is that considering that operational quality is about a procedural step-by-step interaction people with high uncertainty avoidance easily are annoyed when something is wrong intentionally or unintentionally.

Uncertainty avoidance is one of the key dimensions in Hofstede' s research on cultural differences. His Uncertainty Avoidance Index gives the following ranking: South Korea > USA > the Netherlands. However, the ranking found in our survey shows a slightly different sequence: South Korea > the Netherlands > USA. It implies that cultural dimensions could change and thus referring the dimensions would be dangerous without revalidating the indexes.

6.4.3 Product properties and soft problems

Soft problems are partly dependent on the product properties interaction density, operational transparency, use frequency, and perceived performance. The properties are closely related to particular types of soft problems. Especially the finding in interaction density and operational transparency corresponds with that of the previous study: high interaction density products are likely to lead to more sensory problems and on the contrary, low interaction density products are likely to lead to more operational problems. Operationally non-transparent products are likely to lead to more operational quality problems, while operationally transparent products to more sensory quality problems.

Overall, people complain mainly about electronic products having high interaction density and low operational transparency. Age and gender difference do not lead to significant differences in complained products. It seems that electronic products are more and more

losing the boundary between young and elderly users as well as between male and female users. For instance, elderly people also use smart devices these days as much as young people. And while in the past mainly females used kitchen appliances, nowadays also males take up the same household tasks. Together with interaction density and operational transparency, use frequency and perceived performance also make differences in particular types of soft problems. Namely, frequently used products are related to sensory quality problems, and better-performed products are related to problems on sensory or operational qualities. It is obvious that people would complain about functional quality, when the performance of an electronic product is worse than user' s expectation. The assumption was that the more usability is seen as important by the participants, the more complaints there would be about operational quality. However, this relation was not found.

Culture makes a difference as far as the product properties are concerned. American people complain about electronic products with relatively higher interaction density but relatively lower operational transparency. They are also more likely to complain about electronic products with frequently used and usability-critical products. South Korean people' s complaints are focused on electronic products with high operational transparency. They are also more likely to complain about often-used or performance-poor products. Dutch people have soft problems with products having relatively low interaction density and relatively higher operational transparency. Interestingly their complaints are most about not frequently used electronic products.

6.4.4 Soft problems and follow-up (re)actions

The previous experiment concluded that almost half of the participants who experience soft problems would return the products, and even more of them would never buy the product again. However, in the experiment the relationship between follow-up reactions and soft problems was different form the survey study because the products in the experiment were not chosen and bought by the participants, who as a consequence could only express their attitude about what they would have done in case of problems with these two products. In the survey participants were asked to tell what they had done after experiencing the problem. Overall, according to the survey results experiencing soft problems does not necessarily lead to strong follow-up reactions. However, they indicate that the majority of the people (about 80%) who experience any kind of soft problems would not be disloyal to the brand (81% of the participants) and they would give negative comments (73% of the participants). A decrease in brand loyalty resulting from soft problems would end up with negative purchase intentions (84% of the participants). One of interesting findings is that 30% of the participants are not intended to return the product although they are annoyed by soft problems. This can be explained by the aforementioned assimilation theory regarding user' s expectation (Peyton (2003). According to the theory, people seek to minimize the discrepancy between expectation and actual experience. Therefore, they distort expectations or minimize the relative importance

of the disconfirmation. Another finding is that 43% of the participants are willing to actively communicate their dissatisfaction to the helpdesk but not to any consumer organization.

Interestingly, these follow-up reactions correlate with particular types of soft problems. People who complain about sensory quality are unlikely to return products but likely to make negative comments about the brand due to such problems. People who experience functional quality problems are likely to make even more negative comments about the products to their friends and, interestingly, actively likely to wait until the problems are worked out than the other cases. Functional quality problems are also closely related to word-of-mouth complaining behaviour. People who complain about operational quality are unlikely to give negative comments to their friends, but more likely not to wait until the problems are improved. It turned out that product properties, physical interaction density and operational transparency, have no relation with any follow-up reactions. This implies that the product property dimensions are useful to anticipate soft problems but they are not to estimate user' s follow-up reactions.

Experiencing soft problems leads to different follow-up reactions between countries. Soft problems hardly affect brand loyalty to Dutch people but such problems could damage brand loyalty to South Korean and American people. It implies that South Korean and American people associate soft problems with brand identity more directly than Dutch do. South Koreans are also as active in spreading negative word-of-mouth as Dutch people. A possible reason might be that South Korean and Dutch people are more collective cultures than Americans (Hofstede, 2003) and as a result, people use word-of-mouth as a means of active follow-up reactions. In terms of seeking redress, American people do not directly contact the company or the shop. Rather, they seem to prefer an indirect way such as sending a mail/email to the company while South Koreans prefer to take direct actions such as going to the shop or complaining to the company directly. A possible explanation is that the American commercial transaction system is friendlier to customers in case of any complaints than that in the other countries. For instance, in the US people can return products until three months after they purchase regardless of any reasons. Meanwhile, American, South Korean and Dutch people are overall inactive in taking reactions through public organizations. Compared to American and Dutch people, South Koreans seem to become more active complainers in case of experiencing soft problems.

Preferences

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PART C

AN INTERACTION MODEL,
METHOD
AND ITS VALIDATION

ABSTRACT

In this chapter, the empirical findings in the previous chapters are compared and discussed, which leads to an interaction model, called PIP (Persona Interaction with Product) model, showing a overall picture of the interaction between user characteristics, product properties and soft problems. This chapter answers the last research question, “How do the interactions between user characteristics, product properties, and use problems contribute to the product development process?” This PIP method includes two approaches, an interactive tool and a workshop. For the interactive tool a framework was proposed as a first step in the development of an interactive knowledge database system. Second a workshop approach was set up, proposed as a method for companies. In order to validate this method two workshops with companies were conducted, the evaluation of which will be discussed.

CHAPTER 7 METHOD AND ITS VALIDATION

7.1 Introduction

In the chapters in Part A and part B, research on the key variables in user characteristics, product experience, complaining behaviour and product type was described. The main conclusion was that user characteristics, product experience, complaining behaviour, and product type are partly related to soft problems. These findings need to be translated into a design language that can be used in design practice. The main question of this chapter therefore is how the findings can be translated in such a way as to assist designers in identifying anticipated soft problems and preventing them in the product development process.

This chapter will introduce the creation of the PIP (Persona Interaction with Product) method, meant as an answer to the question posed. The method presents the interaction between persona and use problem as a relational concept in which soft problems, user characteristics, product experience, and complaining behaviour are jointly effective. PIP includes two approaches, an interactive tool and a Workshop. The introduction of the interactive tool is only meant as a first step. The workshop approach will be explained as well as the trials and its validation.

7.2 Persona Interaction with Product (PIP) method

Although the findings are a way of understanding the interaction between user and product, it is not such easy to apply directly to the new product development process under time-to-market pressure. With the consideration a framework was developed so that these interactions between user and product found in the project need to be transformed into a practical and handy use for companies. For instance, a designer can obtain the information about anticipated soft problems related to a product in the development process through defining a product type and a target group. Persona, one of typical design techniques to understand the characteristics of a user is not enough to show the real interaction between user and product. The main contribution of the interactive tool is on the stage of analysis in the product development process (Figure 56). The framework consists of an interactive tool and a workshop. The interactive tool working on the computer helps designers understand their target user group and products as a desktop study.

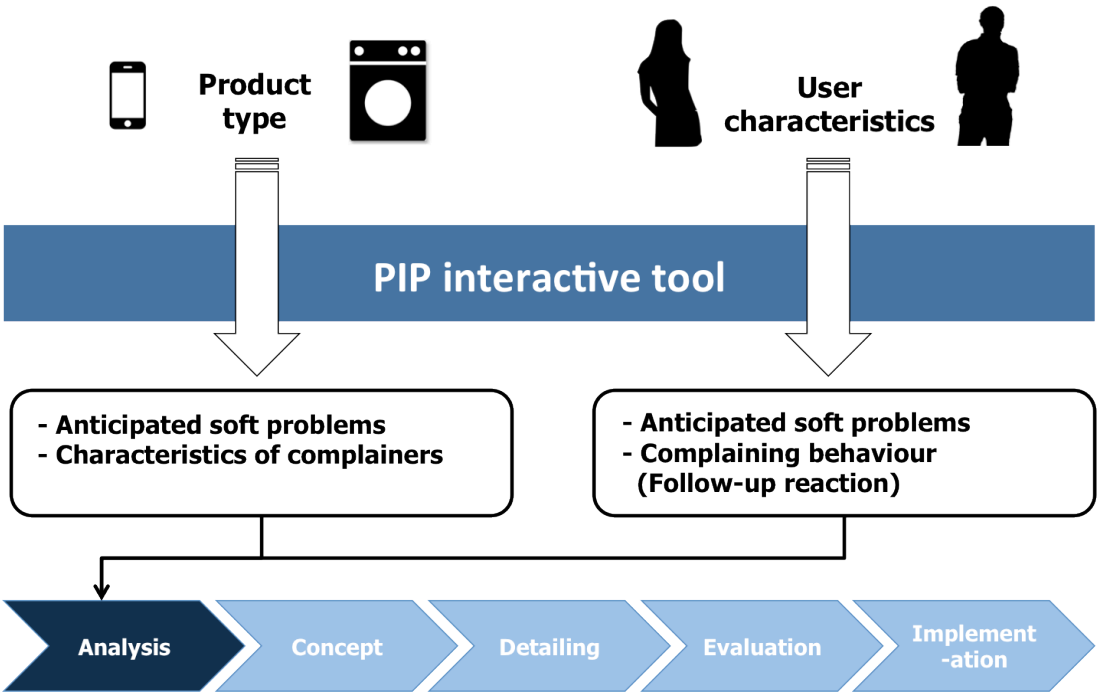

Figure 56 The role of PIP interactive tool in the new product development process

Apart from the interactive tool, a workshop is also developed as part of the method. Considering that the interactive tool is relevant for desktop study, the workshop aims to get individuals within a product development team involved in the product development process and let them figure out the interaction between a product they are developing and a user group they are designing for. Through the interactive tool and the workshop a product development team can better understand their product and user group and this will lead to an increase of user satisfaction in using the product.

7.2.1 Development of the interactive tool framework

As this project indicates, soft problems are the outcome of the interaction between product type and user characteristics. Likewise, the interactive tool had to take product type and user characteristics into account as the starting point of the tool use: namely, there are two ways to use the interactive tool, starting either from defining a product type or from defining characteristics of a target user group. When a product development team knows what kind of product they are developing, they can choose a product type that they are interested in. This leads to three information sources related to the selected product type: frequency of complaints between three countries, percentages of soft problems with quotes, and characteristics of complainers with regard to each type of soft problems (Figure 57). In frequency of complaints between three countries, it is presented how many percentages soft problems related to the selected product are reported between three countries. Designers can gain information about the influence of culture and the differences between cultures as example specifically as to the selected product. The

percentages of soft problems with quotes provide anticipated soft problems for the product regardless of cultural background, giving examples of complaints. In the last source, the characteristics of complainers, designers are able to figure out what kinds of people are likely to complain about particular soft problems.

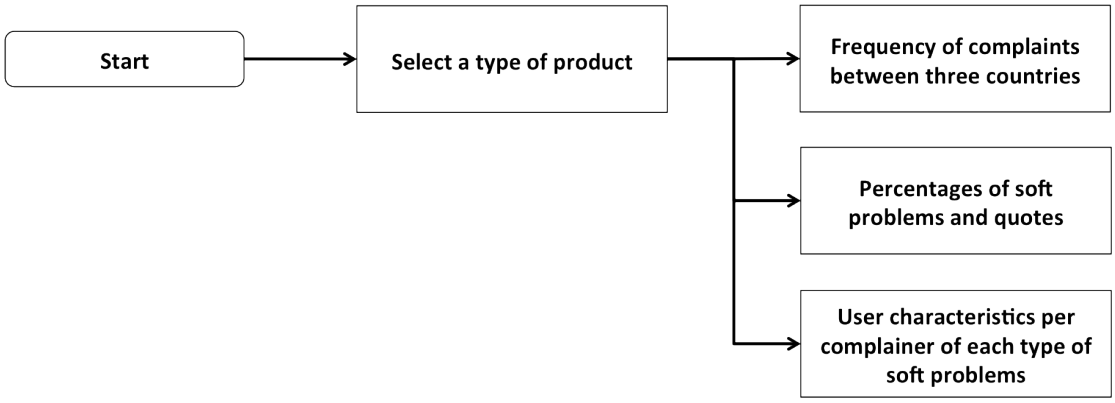

Figure 57 Flow diagram for selecting a type of product

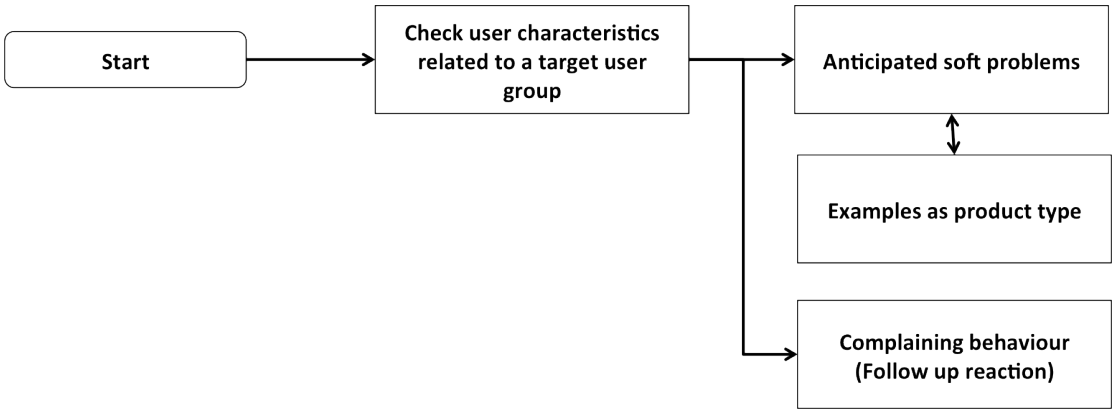

Figure 58 Flow diagram for inserting user characteristics

On the other hand, the interactive tool can start with defining the characteristics of a target user group if a product development team has. By checking related characteristics of their target user group in terms of demographics mostly, the interactive tool presents two types of information: anticipated soft problems from the target user group and their complaining behaviour in case of experiencing soft problems. In the meantime, the source of anticipated soft problems also provides examples of related soft problems for the target group to help designers understand the interaction between the problem and the user (Figure 58).

On the basis of the logic, the interactive tool is being developed. In the thesis, schemes of the interactive tool are presented as example. The interactive tool is designed to always show diverse examples of soft problems on the front page in order to invite and inspire the

tool users. For instance, a picture where a person uses the electronic dictionary appears with a soft problem related to the product. There are three menus on the page: product type, user characteristics, and keyword (Figure 59). Designers can start to use the interactive tool from either product type or characteristics of their target users. They can also search information specific to keywords they type in. Figure 60 shows the case of starting from defining a product type that is being developed. Once the area of product type is clicked, a list of consumer electronic product types is shown. A product type is selected (vacuum cleaner here as an example). Together with a picture showing the use of a vacuum cleaner, three menus (frequency of complaints, anticipated soft problems, and who complains about the problems?) appear on the top (Figure 61). The ‘ Frequency of complaint’ shows the percentages of soft problems of vacuum cleaners between USA, South Korea and the Netherlands as examples (Figure 62). Designers can first see if use problems of the product are influenced by cultural background and if so, how different the problems are between three countries. In the ‘ anticipated soft problems’ , designers get to know which kind of soft problems are dominant in using vacuum cleaners regardless of cultural difference. In case of vacuum cleaners, sensory problems are most reported. The quotes help them figure out specifically what use problems users have experienced (Figure 63). The ‘ Who complains about the problems’ presents user characteristics of those who complain about each type of soft problems, and factors which have no influence, which thus can be neglected as well (Figure 64). People who complain about sensory problems of vacuum cleaners can be characterized by being low educated and having low uncertainty avoidance. Gender does not make any difference in the case.

When the area of ‘ Target user’ is clicked, user characteristics such as age, gender and use experience, founded out as influential factors in the study, are presented with two menus appear on the top, which are ‘ Anticipated soft problems’ and ‘ Complaining behaviour’ . By checking factors to be taken into account for a target user group (Figure 65 and 66), the ‘ Anticipated soft problems’ bring what kind of soft problems such type of users are likely to meet with what type of product as reference (Figure 67). For instance, young people are more likely to complain about functional quality while elderly people are more likely to complain about operational quality. Young people are also very likely to complain about electronic products with high interaction density and complex products. Elderly people are likely to experience problems with low interaction density and simple-to-use electronic products. By clicking ‘ [Examples]’ , detailed complaints with specific products are given as examples to help their better understanding of use problems (Figure 68). Figure 69 provides information about in what way given user characteristics are related to particular complaining behaviour. For instance, young people spread negative words-of-mouth about the brand, and elderly people directly complain to the shop manager but they are still loyal to the brand in case of experiencing soft problems.

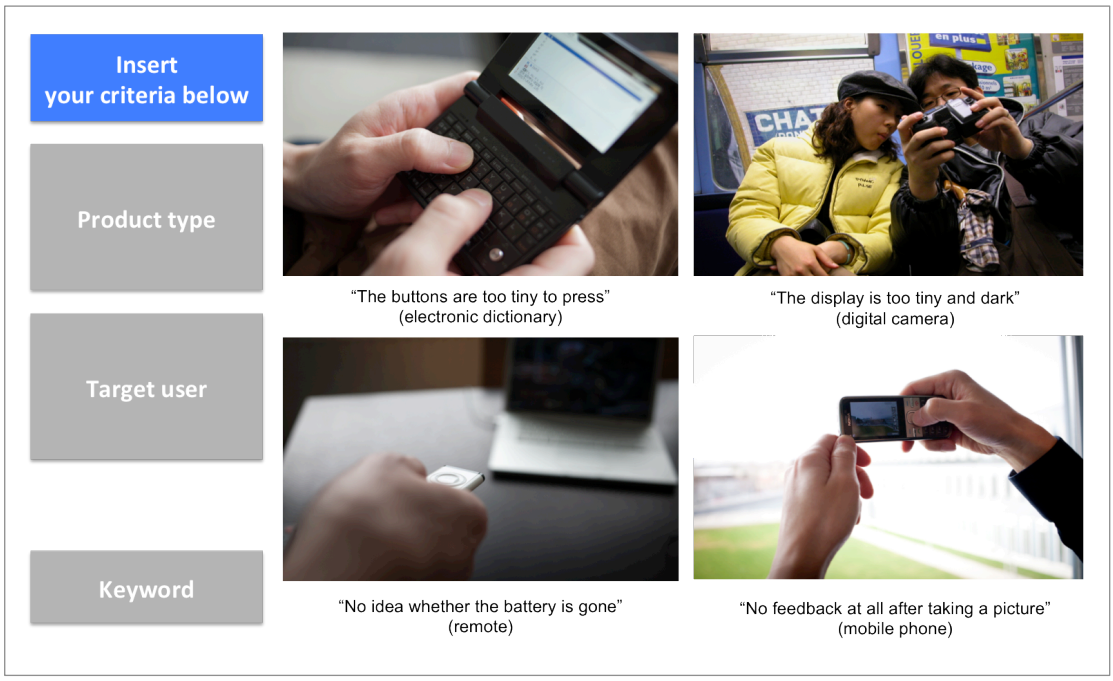

Figure 59 The front page of the interactive tool

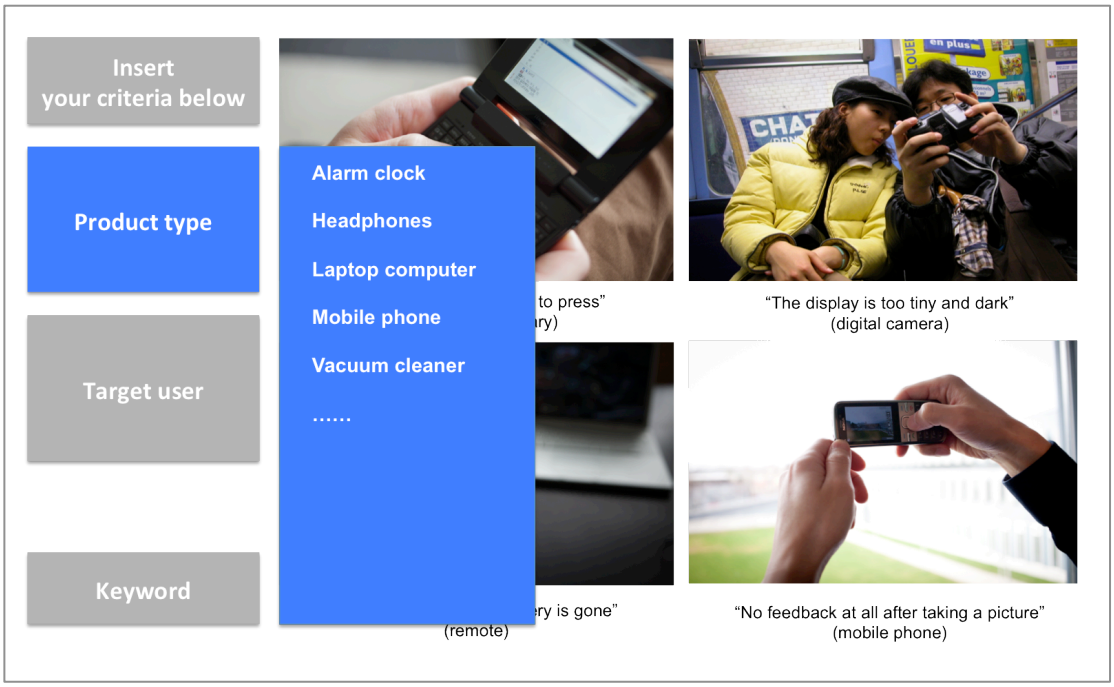

Figure 60 The page for selecting a product type

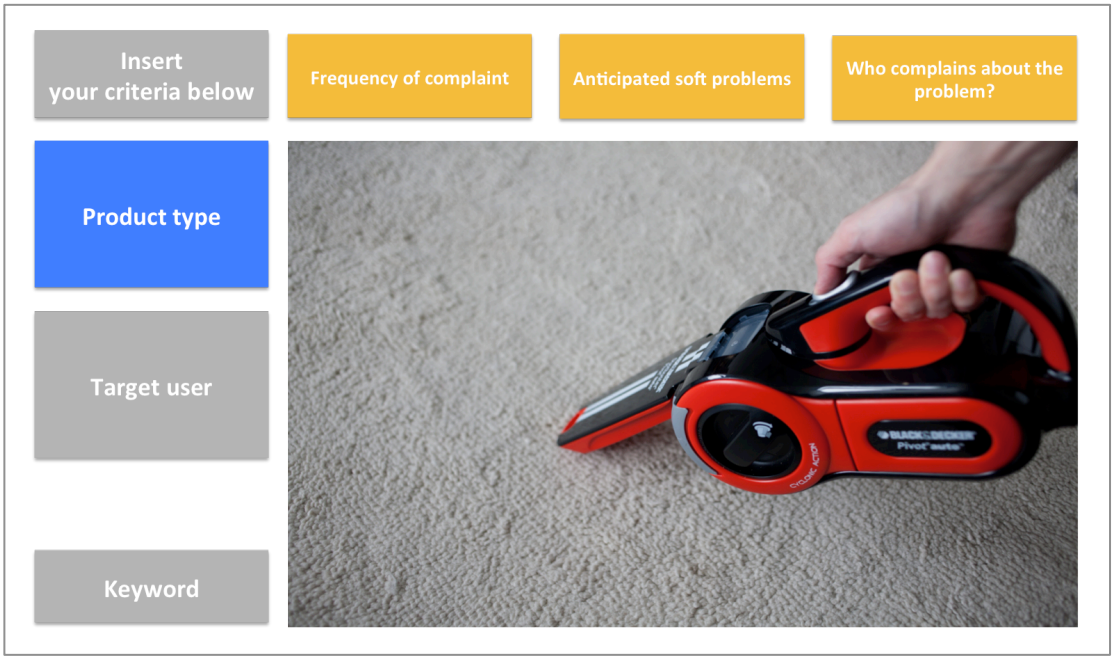

Figure 61 The page after selecting a product type (vacuum cleaner as an example here)

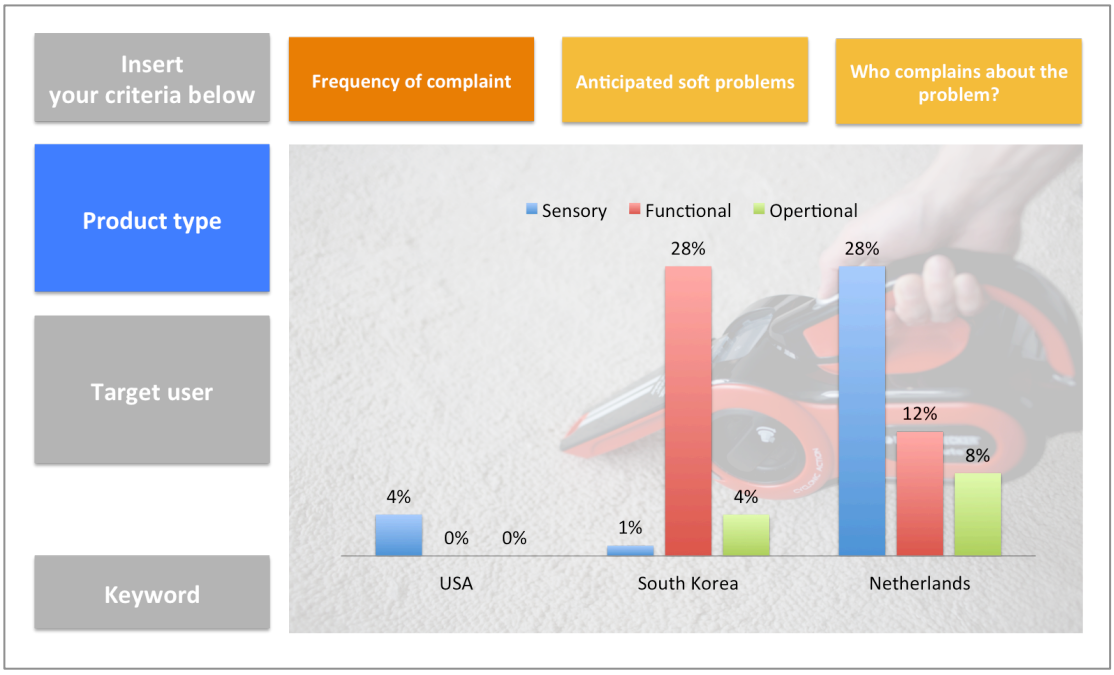

Figure 62 The page for ' frequency of complaints'

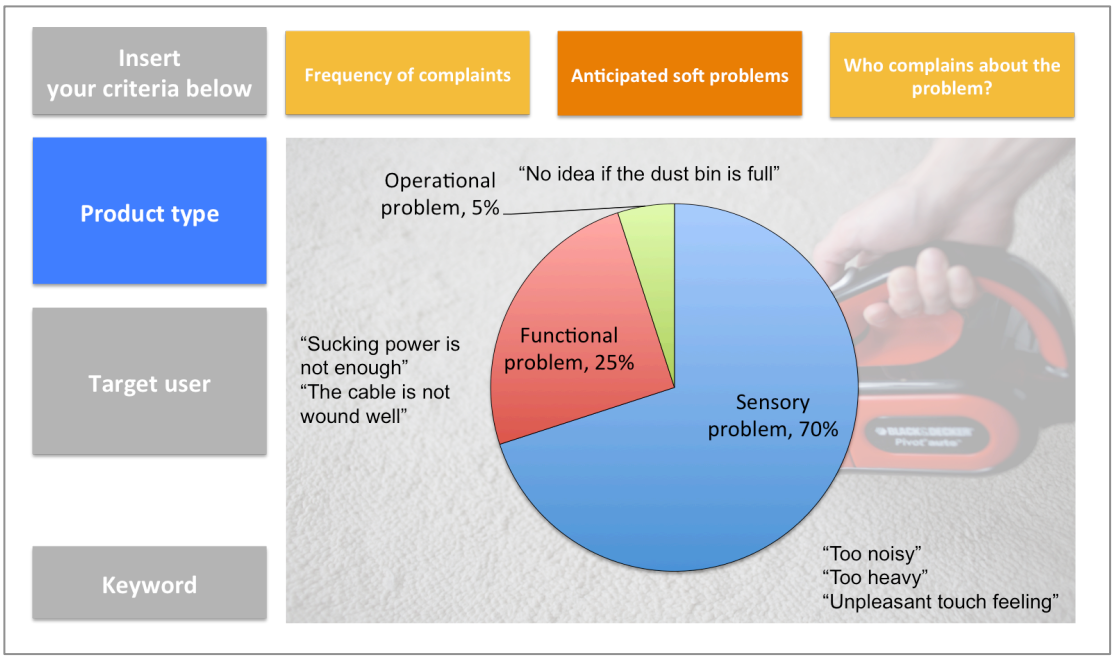

Figure 63 The page for ' Anticipated soft problems'

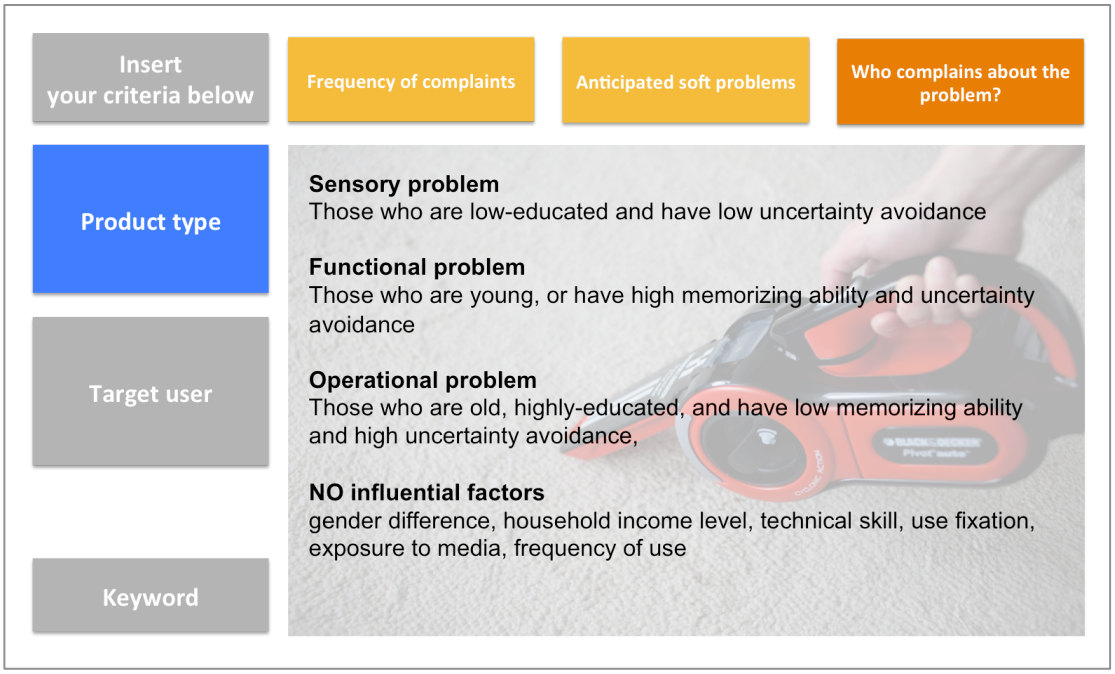

Figure 64 The page for ' who complains about the problem?'

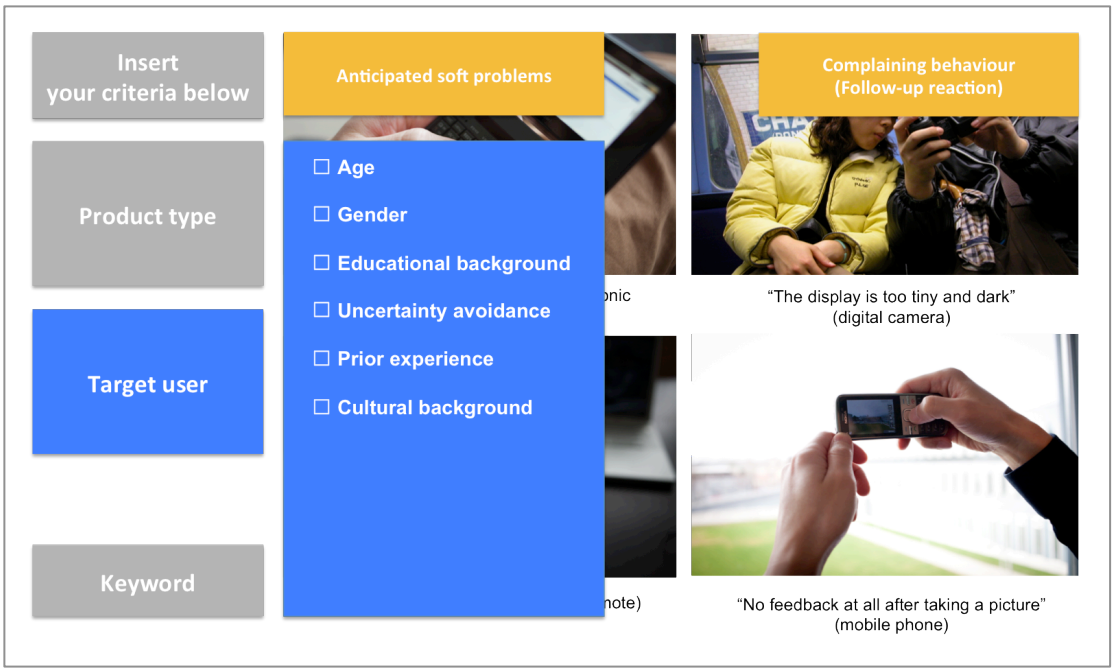

Figure 65 The page for defining target user

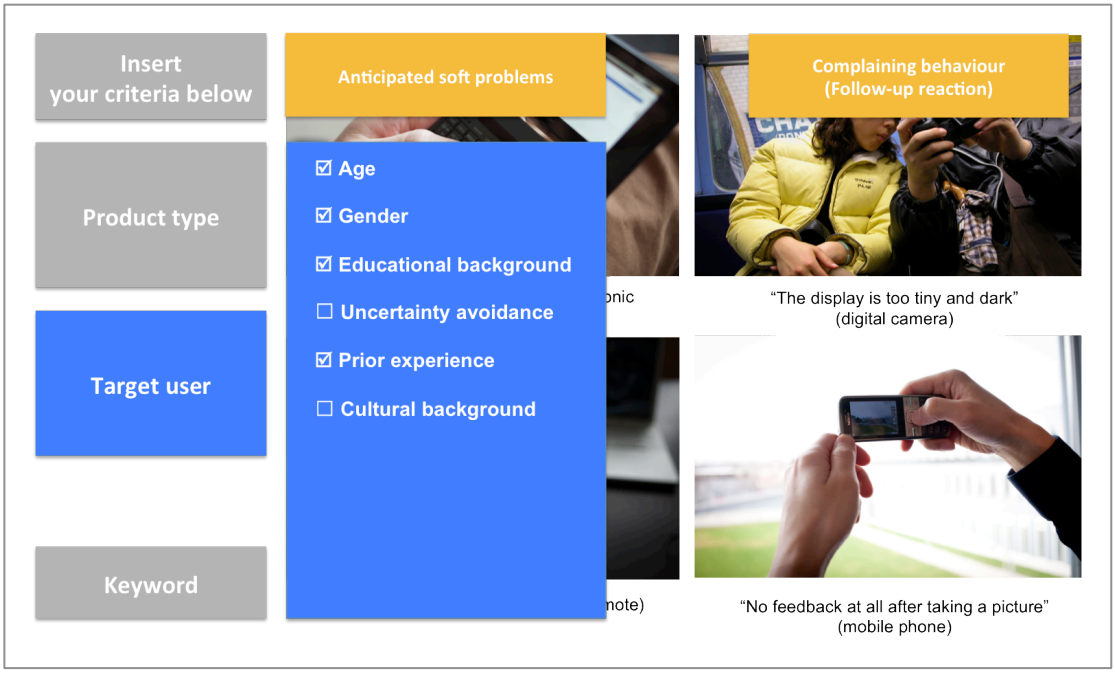

Figure 66 The page after marking related user characteristics

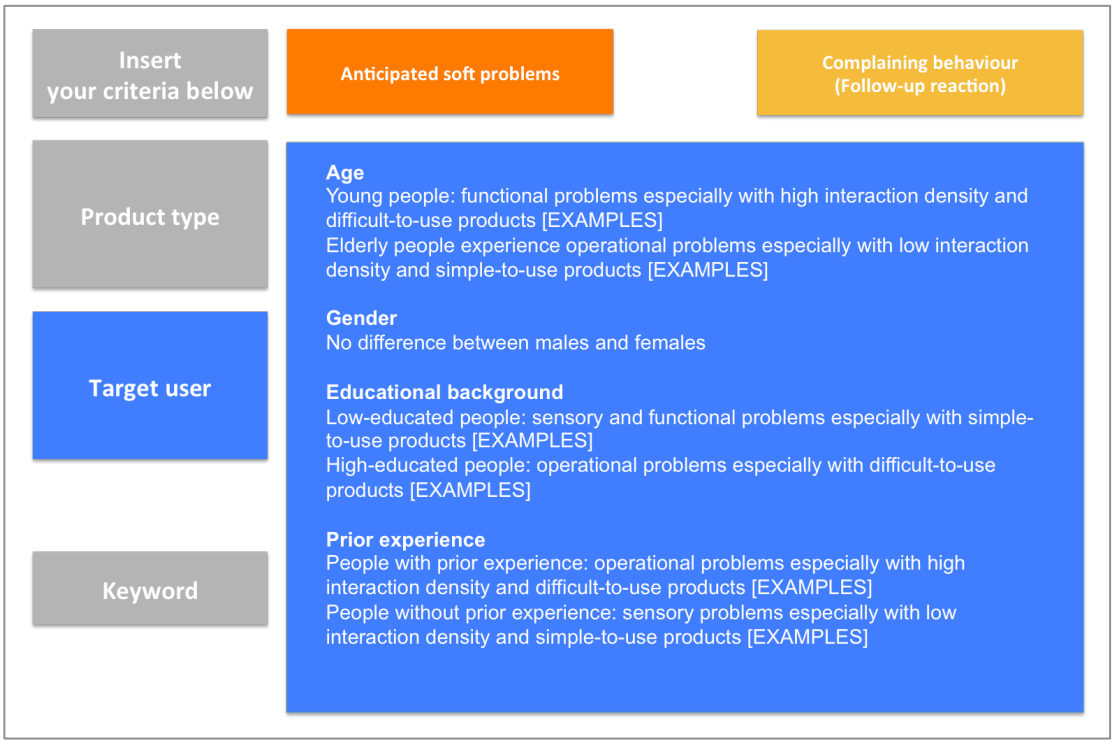

Figure 67 The page for 'Anticipated soft problems'

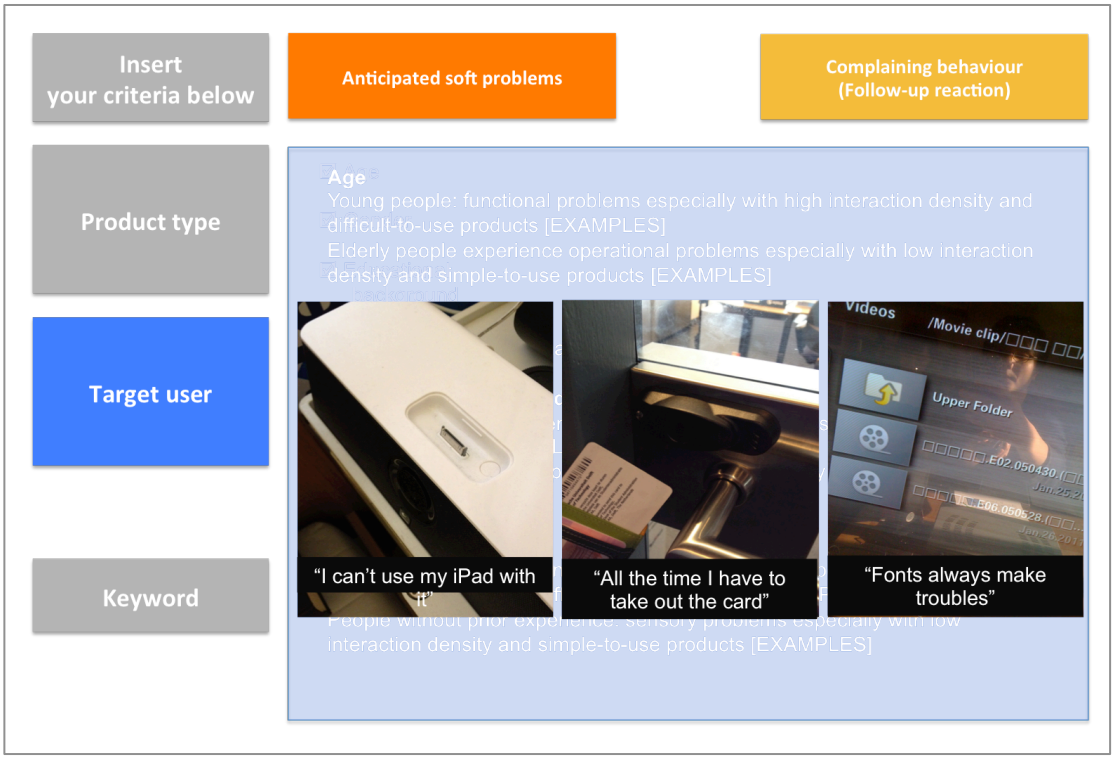

Figure 68 Example cases related to anticipated soft problems

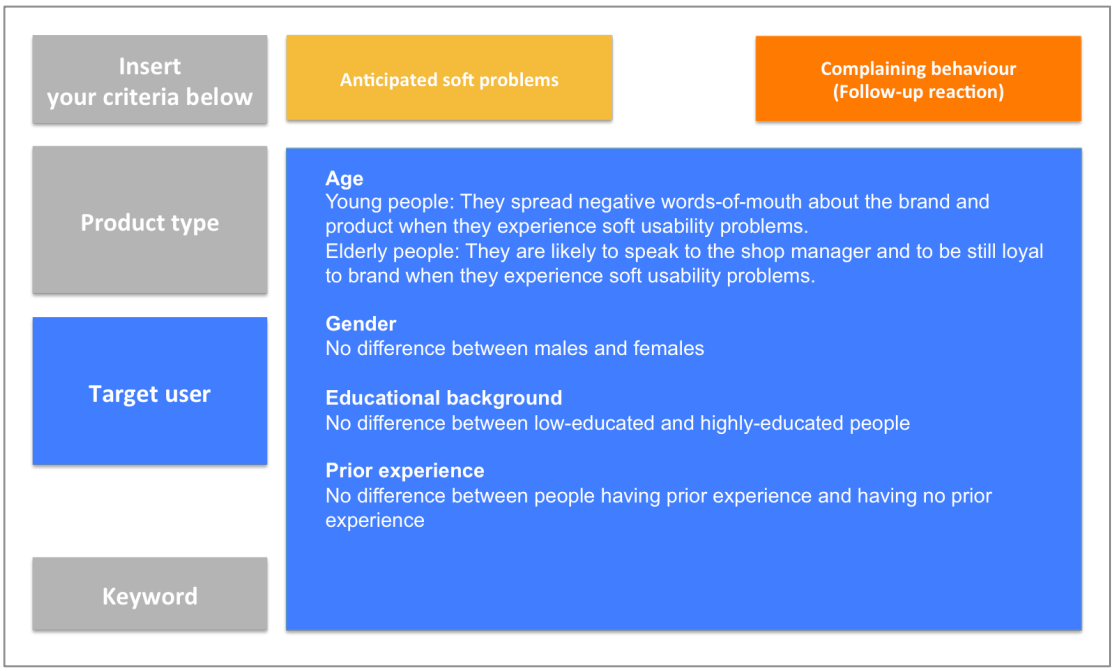

Figure 69 The page for 'Complaining behaviour (Follow-up reaction)'

7.2.2 Development of the workshop

Considering that the interactive tool provides existing information and knowledge on the interaction between user characteristics, product type and soft problems, an active way of understanding the interaction had to be created, with which all stakeholders in a product development team can interact and share knowledge and experience. Among many ways, a workshop within a product development team was taken into account. It is described here how the workshop was developed and how it works. The workshop aims to arouse stakeholders in product development process to the importance of soft problems and also provide a better understanding of their target users and products they are developing in terms of soft problems. The workshop consists of a series of activities and lectures: sensitizing session, lecture about definition of soft problems, problem identification session, lecture about the interaction model, and handing out a card set.

Sensitizing session

While the aim of workshop is introduced participants form a group of 2 to 5 people. Each group receive a bunch of post-it on which the figure of an electronic product (Figure 70) is present. They are asked to guess usability problems of the product they receive and write down them on the post-its. After they finish this assignment, the post-its are posted on the wall according to type of product and soft problem category.

Figure 70 Post-it set for Sensitizing session

Lecture: definition of soft problems

A lecture is given after the sensitizing session. In this lecture, the definitions of soft problems are introduced together with examples. The usability problems collected in the sensitizing session are mentioned here in order to help them understand soft problems related to the electronic products.

Soft problem identification session

This session aims that participants identify anticipated soft problems of one of electronic products they developed or are developing. An electronic product is chosen within a group. Participants discuss anticipated usability problems in two particular cases: when the product is designed for a target group with specific user characteristics and when it is designed for all regardless of user characteristics. For the first case, they describe who their target group is in terms of user characteristics. For the other case, description of any target group is unnecessary. Each group comes up with anticipated soft problems and write them down on the paper. The results are presented and discussed in turn.

Lecture: the interaction model

In this lecture, it is explained how specific user characteristics are related to soft problems and then how product type is associated with the problems. The former is for the case that an electronic product is designed for a specific target group: people could guess anticipated soft problems based on user characteristics of their target user group. The latter is for the case that an electronic product is designed for all: people could guess anticipated soft problems based on product type such as operational non-transparency and physical interaction density.

Handing out a card set

The workshop ends with handing out a card set in which the information given during the

workshop (conceptual framework, definition of soft problems, examples, and the interaction model) is summarized for participants' practical use (Figure 71).

Figure 71 Picture of Card Set

7.3 Validation

Through two workshops at Design for Usability symposium and Océ in the Netherlands, a global leader in digital document management and delivery technology where company people in product development participated, the workshop only was validated since the interactive tool is still being developed for company use. However, the participants to the workshops gave their comments about what the interactive tool should be like during the discussion session. There were some differences between the two workshops in that participants at the symposium came from diverse companies while those at Océ were people from the product development team. As a consequence, products targeted in the workshop were different: in the symposium a broad rage of electronic products were discussed, while printers and copiers were targeted in the workshop at Océ. The number of participants in the symposium workshop was 30 and 10 at Océ. Post-its at the symposium had several different types of electronic products. However, the post-its session at Océ was only about products they produce such as printers for copy shop, office, and home use. The workshops were done following the order described in the method part. In the sensitizing session, participants worked on identifying anticipated soft problems (Figure 72). The problems were posted on the wall according to type of product and soft problem category for later use (Figure 73).

This session was followed by lecture about the definition of soft problem categories. In the lecture the usability problems guessed by participants were used as examples as well. The lecture led to the soft problem identification session. Participants were given an assignment in the session. Each team chose an electronic product which was from the company of one of the participants in a group: for Océ they chose a product within their own printing products. As described in the method, they worked on two different cases (designing for a specific target group and designing for all) focusing on chosen products (Figure 74). According to the results of the session, general usability problems were identified in the case of design for all. In the case of design for a specific target user group, the focus was on the characteristics of the user group but the general usability problems had to be taken into account. Therefore, the two approaches seemed useful to figure out anticipated soft problems.

Figure 72 A Picture of sensitizing session at Océ

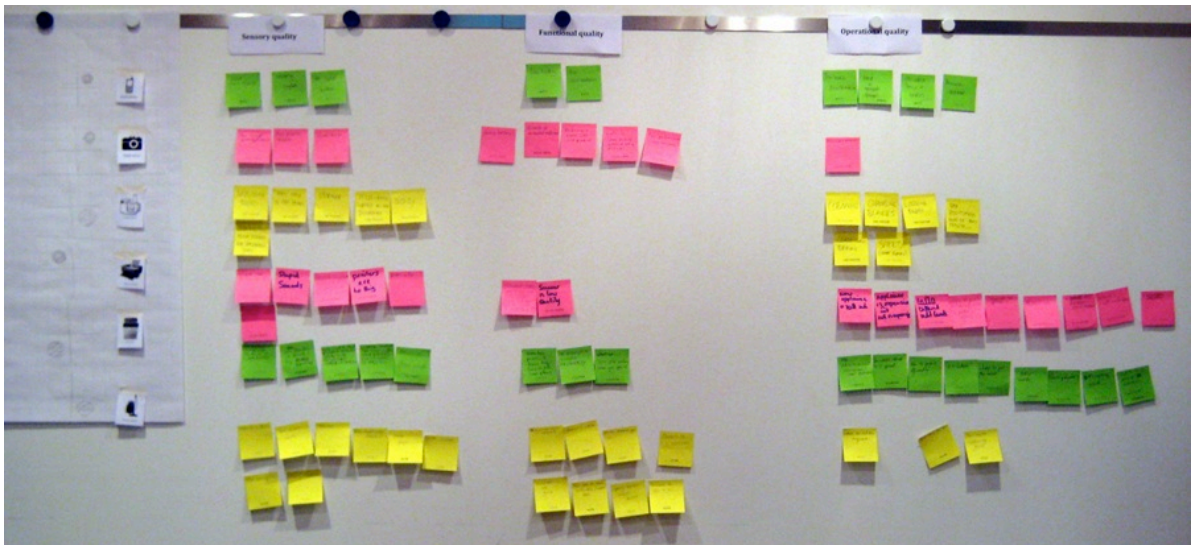

Figure 73 Soft problems from sensitizing session

Figure 74 A Picture of soft problem identification session at the symposium

Figure 75 A Picture of lecture on the PIP interaction model

After the session, a lecture was given again but this time it was about how user characteristics are related to soft problems (for the first case) and then how product type is associated with the problems (for the other case) (Figure 75).

The workshop participants gave many comments on what had been learned and its usefulness in practice. The major comments given by the participants are summarized as follows:

- Soft problems could be continuously changed because user expectations are changing. For instance, since iPhone/iPad were launched in the market people want a touch screen with a swipe function. Therefore, information needs to be regularly updated in order to increase the reliability of the interaction.

- Hitherto, major company concerns in the product development process are about operational quality because an electronic product is being armed with more and more functions. This workshop gives the insight that sensory and functional qualities are as important as operational quality.

- Persona is a tool that designers often use. The major problem that the persona tool has is that it only helps to define a target user but does not provide the information about how the defined user interacts a product. In that sense, this workshop is quite useful. Probably it could add much more value than persona as a design tool than persona do.

- It seems the workshop focuses on hardware mostly although software is getting as much important as hardware. It would be useful if the workshop deals with software as much as hardware.

- It would be more useful if the interaction between user characteristics and particular electronic products is present in depth. For instance, the interaction between user characteristics, cell phone and soft problems. This is because the current information about the interaction seems a bit general and so difficult to apply into a specific product.

Overall, participants liked the workshop structure and they said the workshop had much inspired them since the findings from our project, which were presented in the workshop, provided a better and deeper understanding of how user characteristics and product properties interact in case of use problems. It is particularly interesting because current studies on actual use done by the companies the participants represented were not sufficient to evaluate the whole range of soft problems.

With PIP method, a product development team can already at the beginning of the project identify probable soft problems in terms of product type and target group characteristics. For instance, if any difference in our study would be found between people from different countries – a cultural aspect -, there is reason for a company to believe that they have to take this variable more serious by studying their foreign target groups. Our hypothesis is that when these aspects are taken into consideration in the product development process, the outcome by way of a product will increase consumer satisfaction.

"Am I stupid?
I can't figure out which one indicates a better quality"

Age 24 I Female I Phoenix, USA

CHAPTER 8 CONCLUSIONS AND RECOMMENDATIONS

8.1 Introduction

The group of customer complaints for which no cause can be determined is denoted as No Failure Found (NFF). According to Den Ouden et al. (2006), almost half of product returns are related to complaints of a non-technical nature. Research into this increasing number of customer complaints by Den Ouden (2006) indicates that 85% of these complaints can be traced back to decisions made in the product creation process. In other words, most of these so-called soft problems in consumer electronic products that people complain are about are predominantly caused by a wrong decision in the product creation process. In order to reduce the number of future problems with consumer electronic products, she suggests to improve decision making processes in designing by supporting it with up-to-date and rich information about use preferences. However, as can be seen from practice, just information will not be sufficient.

Among the possible causes the increasing complexity of products is one. According to Geudens (2008), six major market trends can be distinguished that lead to a higher complexity and, therefore, more soft (reliability) problems. These trends are:

- Increasing product functionality (i.e. performing multiple tasks),
- Increasing market globalization (the same products are sold around the world),
- Increasing sales price reduction (high competition causes lower prices),
- Increasing warrant coverage (consumers have a high warranty demand),
- Decreasing time to market (to gain market share a product has to be one of the first on the market),
- Increasing industry globalization (products are developed and realized in factories around the world).

As a consequence of the six major market trends, companies are forced to design their products according to changing conditions. Some of these conditions are the shorter development time and the need for a product that is “adoptable” by a wider variety of consumers, all of whom have different needs. Although these conditions have been changed during the last decade, most companies still use the same approach when developing new products in which the increasing numbers of soft problems are not taken care of. Due to this insufficient approach, companies fail to focus on the specific consumer needs and the individual consumer expectations are not fully known.

We saw in the thesis that soft problems vary among people, and several problems can be anticipated in terms of some user characteristics and product properties. The study in the

thesis shows that users in the designers' mind do not completely represent the experience of actual users: designers often use their gut feelings or their common sense in predicting actual use, as Norman (1988) already wrote. In this way one of the challenges in this study is to bridge the gap between designers in practice and users in reality. Considering that these soft problems result from the gap between intended use by designers and actual use by real users, understanding users and characteristics of products in the product development process will lead to an increase of users' satisfaction in using electronic products.

8.2 Findings and conclusions

The objectives of the research were to explore the user-product interaction leading to dissatisfaction usability in consumer electronic products. Within the interaction, the role of user characteristic and product properties was empirically investigated. With the findings, a method was proposed and validated to bridge the gap between actual use by users and intended use by designers in the product development process. Overall findings are presented and conclusions are drawn by answering each research question in the followings:

8.2.1 What unexpected problems have users faced in interacting with consumer electronic products and services?

Although product returns resulting from non-technical issues have been increased, the reasons for these failures have not been identified other than the complexity factor. Thus, it was necessary to know whether the consumer electronic industry takes non-technical complaints related to their products into account, how they gather those sorts of complaints, and whether the information is implemented in their product development process. According to interviews with product designers working at such companies, they hardly recognize non-technical problems. They even have only few channels to acquire those complaints made by their customers. Consequently, non-technical issues are rarely taken into consideration in their product development process. At most, they regard such problems as hard-to-handle since every aspect of an electronic product could pose those kinds of problems. For a long time non-technical problems were not considered as a critical factor in the industry despite the fact that those problems lead to an increase of product returns. Furthermore, the information available about the returns is not detailed enough to give insight into the cause of the dissatisfaction of the customer.

Enough reason to start a project on ' Design for Usability' financed by the government and four companies. The goal of this project was to reduce usability problems with electronic products by developing and offering companies a coherent design methodology to anticipate expectations and needs of users on the one hand, and product influences on use practices on the other. The integral approach focused on (i) user problems as a

consequence of a mismatch between user and designer expectations about the product (ii) the user characteristics in relation to types of products and use-situations; (iii) product impact on user behaviour; (iv) company processes including product development and after-sales service; and (v) design methodology, expanding the existing approach of scenario-based design to incorporate the interaction between product design, user characteristics, and user behaviour.

This thesis was explicitly focused on research into the influence of user characteristics in interaction with products and product properties. The results are based on four main studies, three of them being survey research while one study used an experimental laboratory method. The last one was meant to offer insight into actual product use as compared to the other studies which were retrospective in nature.

The first attempt in our research was to look into non-technical problems users have experienced when interacting with household electronic products and services. For this aim, we asked in three surveys what people had made them most frustrated in using their electronic products, keeping in mind that these products worked well according to their technical specifications.

The first survey led to 336 complaints (N=155) related to non-technical issues of electronic products, the second to 185 (N=104) and the third to 576 (N=576) complaints. As a summary see Table 41 with all the products complaint about, including complaint frequencies per product. It is a clear demonstration of the existence of usability problems that have nothing to do with technical failure.

On the basis of the reasons why people are frustrated by their product(s) the types of problems were categorized. In the first survey this grouping was done according to nine categories: understanding functions, performance (low efficiency and performance), sensation (unpleasant sensorial input), health (physical fatigue or tiredness), product structure (lack of physical structure such as inconvenient location of the USB slots in the laptop computer), maintenance (product maintenance difficulties), functional limitations, trend (sensitive to the trend of the day), and third party (interruption caused by a third party such as SPAM messages in the mobile phone). The nine categories in the first survey were clustered again into three groups (sensory, functional, and operational qualities) because some categories share similar characteristics with regard to product quality theory: Sensory quality includes sensation, health, product structure and trend; functional quality encompasses performance and functional constraints; problems with operating the product, maintenance, and third party belong to operational quality.

Table 41 Frequencies and percentages of each survey in product type (ranked by required cognitive load). k=number of complaints; N=number of participants

No	Product type	Survey 1 (k=336) N= 155		Survey 2 (k=185) N=104		Survey 3 (k=576) N=576	
		Frequency	%	Frequency	%	Frequency	%
Products requiring high cognitive load							
1	Computer	27	8.0	16	8.6	89	15.5
2	Tablet					4	0.7
3	Mobile phone	100	29.8	53	28.6	142	24.7
4	Remote controller	9	2.7	8	4.3	30	5.2
5	MP3 player	88	26.2	16	8.6	27	4.7
6	Game console	1	0.3	1	0.5	2	0.3
7	Digital camera	19	5.7	9	4.9	6	1
8	DVD player	9	2.7	8	4.3	23	4
9	Hard disk recorder					2	0.3
10	Thermostat					4	0.7
Products requiring intermediate cognitive load							
11	Microwave	6	1.8	5	2.7	11	1.9
12	GPS					12	2.1
13	Car computer system					3	0.5
14	Voice recorder					2	0.3
15	Printer server					1	0.2
16	Printer	12	3.6	8	4.3	14	2.4
17	Home theatre					1	0.2
18	Stereo set	6	1.8	2	1.1	7	1.2
19	Bread maker					1	0.2
20	Cable TV tuner					11	1.9
21	Camcorder			2	1.1	3	0.5
22	Television	12	3.6	3	1.6	18	3.1
23	Scanner	2	0.6	2	1.1	1	0.2
24	Wireless router					5	0.9
25	Answering machine					1	0.2
26	Car audio					1	0.2
27	CD player					4	0.7
28	e-Book reader					2	0.3
29	Electronic dictionary					5	0.9
30	FM signal transmitter					1	0.2
31	Lawn irrigation control					1	0.2
32	Pedometer					2	0.3
33	Pen tablet			1	0.5	2	0.3

34	Digital watch					2	0.3
35	Alarm clock	5	1.5	2	1.1	12	2.1
36	External HDD					2	0.3
37	Air-conditioner	1	0.3	2	1.1	1	0.2
38	Electric sewing machine			1	0.5		
Products requiring low cognitive load							
39	Digital picture frame					1	0.2
40	Washing machine	3	1.5	2	1.1	15	2.6
41	Dish washer	3	0.9	2	1.1	1	0.2
42	Humidifier	2	0.6	2	1.1	2	0.3
43	Blood pressure measure					1	0.2
44	Body steamer					1	0.2
45	Coffee machine			4	2.2	5	0.9
46	Electric steamer					1	0.2
47	Electric fermenter					1	0.2
48	Food processor	1	0.3	1	0.5	5	0.9
49	Hands-free set					1	0.2
50	Monitor	1	0.3			2	0.3
51	Orange juicer					1	0.2
52	Range ventilator					2	0.3
53	Refrigerator	3	0.9	3	1.6	8	1.4
54	Rice cooker	2	0.6	2	1.1	6	1
55	Shaver			1	0.5	3	0.5
56	Speakers	4	1.2	1	0.5		
57	Telephone	1	0.3			4	0.7
58	Toaster	1	0.3	4	2.2	6	1
59	Vacuum cleaner	9	2.7	18	9.7	25	4.3
60	Wake-up light					1	0.2
61	Mouse	1	0.3	1	0.5	2	0.3
62	Curling iron					2	0.3
63	Earphones	4	1.2	3	1.6	5	0.9
64	Electric grill pan			1	0.5		
65	Electric mat					4	0.7
66	Iron	1	0.3			3	0.5
67	Hair dryer	2	0.6			6	1
68	Fan					2	0.3
69	Hand massager					1	0.2
70	Bathroom scale					1	0.2
71	Water cooker	1	1.5	1	0.5		
72	Bike light					1	0.2
73	Lamp					2	0.3

Interesting findings on the basis of types of problems are:

- In the three survey studies most consumers feel dissatisfied with the low performance of products, with functional limitations (both functional quality), and with difficulty in understanding or finding functions (operational quality). Problems with performance might be explained by the phenomenon that people are getting more and more impatient (Brombacher, 2005). Difficulty in understanding or finding functions might be caused by another trend in the electronic industry, i.e. electronic products are getting more and more complex, with a limited number of buttons serving many functions, and have become a black-box-like product.

- In the three surveys the three types of soft problems – sensorial, functional and operational – show the same pattern in terms of frequency. Functional problems are most, operational problems are next, and sensorial problems are least mentioned: in the first study (Chapter 3), 25% sensorial, 41% functional, and 34% operational problems. In the second study (Chapter 4), 32% sensory, 32% functional, and 36% operational problems. In the last survey (Chapter 6), 19% sensory, 50% functional, and 31% operational problems. In the experiment aiming at discovering how soft problems differ between people in actual use when two specific electronic products were given (Chapter 5), this ratio, however, differs from those in the surveys: for the radio alarm clock, 68% sensory, 1% functional, and 31% operational problems; for the MP3 player, 36% sensory, 6% functional, and 58% operational problems. The most obvious reason for this difference was the fact that the two products used did not give any functional problem. They all worked well in spite of the usability problems they gave. In the surveys the same products (alarm clock and MP3 player) are reported as one of the most annoying products, but here functional problems played a role. This implies that there are differences between actual use and retrospective evaluation in soft problems experienced by users.

8.2.2 Which product properties are involved in user-product interactions that lead to dissatisfactory usability?

Cognitive load

As a starting point the products complained about were categorized into the required cognitive load in operating them: products requiring low cognitive load, intermediate cognitive load, and high cognitive load (Chapter 3). This categorization was chosen by the research group: simple products with buttons that have a limited number of functions (e.g. shaver and vacuum cleaner), moderately complex products with several adjustments (e.g. a printer and a sewing machine), and highly complex products with almost infinite functions and adjustments (e.g. desktop (or laptop) computer and smart phone).

As expected, most soft problems in the first study (73%) can be found among the group of

intermediate cognitive load products. They are typical black box products in which many functions are combined and in which one button serves more than one function.

Other findings for cognitive load are:

- For products requiring less cognitive effort product structure, understanding functions, and maintenance are the major soft problems. These problem categories are hardly mentioned for products requiring more cognitive effort. Complaints about product structure and maintenance are closely related to physical inconvenience (sometimes requiring mental effort) experienced while operating or maintaining the product. It implies that simple electronic products have more to do with complaints related to physical inconvenience: in the second survey the vacuum cleaner was frequently mentioned (10%) as one of most annoying products even though it does not require high cognitive load.

- For most complex electronic products such as a computer, complaints related to sensation – for example the heat computers produce and the noise the cooling fan makes - are even more mentioned than performance.

- In the high cognitive load category complaints related to understanding or finding functions takes only a small portion. Its implication is that complexity itself is not considered as a serious problem since users regard it as a natural character of such a complex electronic product.

Operational transparency and physical interaction density

In order to get further insight into the role of product properties two new dimensions were added in the second survey (Chapter 4): operational transparency and physical interaction density. Operational transparency is partly overlapping with cognitive load but is also closely related to both high-tech dependency (i.e. operationally transparent products such as a toaster are much less dependent on high technology such as an iPad and GPS) as well as compatibility (i.e. operationally transparent products such as a washing machine, are hardly interactive with other electronic products). Physical interaction density refers to the frequency and duration of physical interaction between user and product. This product property was derived from the finding that a vacuum cleaner is one of electronic products often complained about by consumers even though it is regarded as an easy-to-use product, requiring little cognitive load. So, the high physical interaction with this product might explain the (type of) problem experienced.

The findings for these two interactive properties are:

- The occurrence of soft problems in the second survey showed a strong relationship with operational transparency of the product. Namely, the less operationally transparent an electronic product (e.g. mobile phone and computer) is the more likely the relation

with soft problems (72% of all the complaints are from products with low operational transparency).

- In the same study the physical interaction density showed a significant correlation with soft problems. The more physically interactive products are the more likely to have soft problems (71% of all the complaints are from high interaction density products).

- In the third survey (Chapter 6) half of the complaints (54%) were related to electronic products having low operational transparency (e.g. mobile phone and computer), while complaints about electronic products with relatively higher operational transparency were much less shown: 24% for highly operational transparency products and 22% for intermediate operational transparency products.

- In the same third survey 60% of all the complaints are related to electronic products with high interaction density (e.g. vacuum cleaner and mobile phone), whereas those related to electronic products with intermediate and low interaction density (e.g. washing machine and coffee machine) were much less reported: 22% for intermediate interaction density products and 17% for low interaction density products.

- In the experiment (Chapter 5), two electronic products were used, which have their own characteristics in terms of operational transparency and physical interaction density: the alarm clock is an operationally transparent and low interaction density product whereas the MP3 player is an operationally unclear and high interaction density product. However, the relationship between those product properties and the number of soft problems were not observed.

Product importance, frequency of use, importance of usability and perceived performance

In the third survey (Chapter 6) four new properties were added in order to see whether they are related to the occurrence of soft problems: product importance, frequency of use, importance of usability, and perceived performance.

- Product importance: 74% of the participants complained about electronic products which they think are important in their life.

- Frequency of use: 84% of the participants complained about their electronic products used more than 3-4 times per week.

- Importance of usability: 84% of the participants complained about products of which they think usability is important.

- Perceived performance: 61% of the participants complained when they perceived that their products have worse performance than their expectations.

A combined view on all properties

Overall the following results could be measured:

- Cognitive load: major complaints in using consumer electronic products are observed in products requiring intermediate cognitive load rather than in low or high cognitive load products. Therefore, cognitive load is not the only dimension to anticipate whether soft problems occur in an electronic product.

- Operational transparency: a majority of soft problems occur in using electronic products with low operational transparency. In other words, the less operationally transparent an electronic product is the more likely to have soft problems. Operational transparency does not only refer to cognitive load but also to high-tech dependency and compatibility issues, which means that the dimension is more consistent to describe soft problems in consumer electronic products than cognitive load.

- Physical interaction density: physical interaction density is a strong factor to anticipate whether an electronic product has soft problems. As an electronic product has a higher physical interaction density, it is the more likely for the user to experience soft problems.

- Product importance: problems in using a product seem to become critical when it is an important product in user' s life. As an electronic product is regarded as the more important, there are the more chances for any problems in the product to lead to soft problems.

- Frequency of use: more soft problems are reported with more frequently used electronic products.

- Importance of usability: whether or not people consider usability an important criterion doesn' t relate in our study to the type of problems they have.

- Perceived performance: it is obvious that people complain when their products performed below their expectations. However, the perceived performance of a product is not as critical a factor as frequency of use in the occurrence of soft problems.

8.2.3 Which user characteristics are involved in user-product interactions that lead to dissatisfactory usability?

Hitherto user characteristics in the field of product design have been hardly dealt with in published research. At most demographic factors such as age and gender or the difference between novice and experienced users are all that can be found in literature. For that reason, this study attempted to study as many user characteristics as possible that are referred to in studies such as psychology, marketing, and complaining behaviour. Most of these variables belong to demographic, cognitive, social and personality factors, such as age, educational and cultural background, technical skill, literacy, memory capacity, patience, self-efficacy, locus of control, sensitivity to marketing, exposure to media, and so on. Through a total of three studies, significant variables in the interaction between user characteristics and soft problems were repeatedly validated, while other variables were filtered out.

In the first survey, cultural background of participants was only used as user characteristic variable. In the second survey (Chapter 4) all the variables found significant in literature were used to explore the relationship between the variables and soft problems.

From our observations during the experiments (Chapter 5) we could conclude that age, gender, familiarity with electronic products, prior experience and culture are related to task completion rate and time taken. Most of these correlations are in the expected direction such as: more time needed for operating the products and less task completion by older and by female participants and persons with less prior experience. However, all the observational data were not necessarily related to the occurrence of soft problems: i.e. gender and familiarity with electronic products made no difference in experiencing soft problems. Although probably obvious, the data should make clear to designers to be aware of the differences in user characteristics.

Together with the findings from the last survey, the summary from all the studies is shown in Table 42.

Not all user characteristics tested in all studies have influence on soft problems. According to the results the influential factors in the interaction between user characteristics and soft problems are age, uncertainty avoidance, prior experience, proneness to complain, and cultural background. However, some characteristics do not have consistent results among the studies. Educational background, cultural background, memorizing ability, use fixation, curiosity, patience, and locus of control belong to such user characteristics: the influential factors in the second survey (e.g. curiosity, uncertainty avoidance, use fixation and patience) showed in the experiment no impact on the occurrence of particular soft problems. The experiment, however, could have come up with biased conclusions due to insufficient sample size. The last survey provides the robust interaction between user characteristics and soft problems considering much bigger sample size of the last survey. For that reason, the correlations from the last survey were taken in any case of conflicting

results between studies.

Table 42 The statistical significance of user characteristics used in all studies (' N/S' = Not Significant and ' -' =Not Used Variable)

Variable	2nd survey	Experiment	3rd survey
Demographic factors			
Age	Significant	Significant	Significant
Gender	N/S	N/S	N/S
Educational background	N/S	N/S	Significant
Household income	-	N/S	N/S
Cultural background	N/S	Significant	Significant
Cognitive aspects			
Technical skill	-	N/S	N/S
Memorizing ability	N/S	N/S	Significant
Use fixation	Significant	N/S	N/S
Familiarity with electronic products	-	N/S	-
Prior experience	-	Significant	-
Task completion rate	-	N/S	-
Personality traits			
Curiosity	Significant	N/S	N/S
Patience	Significant	N/S	N/S
Sloppiness	-	-	N/S
Neuroticism	-	N/S	-
Extraversion	-	N/S	-
Openness	-	N/S	-
Agreeableness	-	N/S	-
Conscientiousness	-	N/S	-
Locus of control	-	Significant	N/S
Self-efficacy	-	N/S	-
Confidence	-	N/S	N/S
Uncertainty avoidance	Significant	Significant	Significant
Sociality	N/S	-	-
Proneness to complain	-	Significant	-
Buy decision	-	N/S	N/S
Reading an instruction	-	-	N/S
Exposure to media	-	N/S	N/S

The findings from all the studies are as follows:

Here we first start with an overview of the influential factors in the interaction between user characteristics and soft problems. In the next section, we give an explanation about how influential user characteristics are related to particular types of soft problems.

Demographic factors

- Age and educational background are related to particular soft problems.
- Gender and household income make no difference in the occurrence of soft problems.
- Cultural background makes a difference in types of soft problems.

Cognitive aspects

- Memorizing ability is related to soft problems.
- Technical skill, use fixation, and familiarity with electronic products make no difference in particular soft problems.
- Prior experience has to do with particular soft problems.
- Task completion rate (in the experiment) showed no statistical significance with any soft problems

Personality traits

- Only confidence and uncertainty avoidance are related to specific soft problems.
- The other personality traits such as curiosity, patience, self-efficacy, big five personality (neuroticism, extraversion, openness, agreeableness, and conscientiousness), sloppiness, and locus of control have little influence to soft problems.
- Buy decision, reading an instruction, and exposure to media are not related to the occurrence of specific soft problems.

The overall conclusion is that the experience of soft problems is related to particular user characteristics mentioned above.

8.2.4 In what way do user characteristics and product properties interact when looking at unsuccessful user-product interaction?

User characteristics and soft problems

In the previous sections, it was separately reviewed which product properties and user characteristics are involved in unsuccessful user-product interaction. This section gives an answer to the question how user characteristics and product properties interact in the context of soft problems.

Demographic factors:

- Young people are more sensitive to functional quality of consumer electronic products than old people. The last group takes operational quality more serious as major dissatisfaction.

- Low-educated people take sensory quality more serious in evaluating their electronic products but high-educated people regard operational quality as a major cause of dissatisfaction. It reveals that the level of education leads to different expectations of electronic product experience.

- Cultural background plays a role in soft problems. Compared to Dutch and American respondents South Koreans complain more on sensory and functional qualities of electronic products, and less on operational quality. Dutch respondents are the lowest with sensory quality complaints but highest with operational quality complaints, while American respondents are lowest with functional quality complaints. Although only three countries were compared, these findings could be a useful example to gain a better understanding of the influence of culture in electronic product use. Interestingly, uncertainty avoidance in the project is not in accordance with what Hofstede measured in his cultural dimension study: South Koreans are supposed to have a much higher score on uncertainty avoidance than the other two countries. This is not confirmed in our study.

- Gender difference and household income have no influence in the occurrence of particular soft problems.

Cognitive aspects:

- Low memorizing ability is related to complaints on operational quality.

- Prior experience is related to operational problems. People who have experienced an electronic product before are more likely to complain about operational quality when using a similar product type again.

- Technical skill, use fixation, and familiarity with electronic products make no difference in the occurrence of particular soft problems.

- Reading an instruction and task completion rate make no difference in the occurrence of particular soft problems either.

Cognitive aspects such as technical skill and use fixation do not seem to affect soft problems: only memorizing ability and prior experience showed a correlation with soft problems. Its implication is that in general cognitive ability is not a strong distinguishing factor in complaints about products and their properties.

Personality traits:

- Only uncertainty avoidance and proneness to complain has to do with particular soft problems. People who have higher scores on uncertainty avoidance are more likely to complain about operational quality. Namely, People who are reluctant to unexpected events dislike unexpected errors or being lost because of problems with finding functions. On the other hand, people who have a lower score are the more likely to complain about functional and sensory qualities. Regarding proneness to complain, people who are prone to complain in any situations are likely to complain about sensory quality of their electronic products.

- The other personality variables make no difference in the occurrence of particular soft problems.

- Social behaviour such as social participation has no relationship with the occurrence of soft problems.

- Buy decision and exposure to media make no difference in the occurrence of particular soft problems.

Although anticipating specific types of soft problems seems difficult through information related to personality factors, major soft problems can be predictable by knowing whether people confront uncertainty and are prone to complain.

Product properties and soft problems

One of the outstanding findings in the study is that soft problems are dependent on not only user characteristics but also product properties. Soft problems are actually the outcome of the interaction between user characteristics and product properties. In the first study (Chapter 3), cognitive load was taken into account and this was again used as a product property in the follow-ups but with the more broadly defined name, operational transparency. In addition to the product property, another product property, physical interaction density was newly created because operational transparency only was not enough to define characteristics of diverse electronic consumer products. This study demonstrates that operational transparency and physical interaction density are related to

particular types of soft problems.

- Cognitive load: major complaints in using consumer electronic products are observed in the products requiring intermediate cognitive load than low or high cognitive load. However, the reason of such complaints cannot be explained only by difficulty to understand or find functions (25%). Performance (32%) and constraint (16%) form almost half among the total complaints in electronic products requiring intermediate cognitive load. On the other hand, complaints with electronic products requiring low cognitive load are mainly related to physical inconvenience such as annoying mechanism (22%) and maintenance (16%). However, difficulty to understand functions (22%) is regarded as important as physical discomfort. This implies that problems related to understanding functions are more seriously taken into consideration with electronic products requiring low or intermediate cognitive load among users.

- Low operational transparency products referring to complex products raise more operational problems, while high operational transparency products referring to simple products cause more sensory problems.

- High interaction density products referring to physically intimate products give rise to sensory problems. By contrast, low interaction density products referring to physically distant products are largely associated with operational problems.

- However, in case operational transparency and physical interaction density are simultaneously taken into consideration, operational transparency is prior to physical interaction density to identify anticipated soft problems (Chapter 5). This implies that soft problems are more dependent on human cognition than human sensory perception.

- In the experiment (Chapter 5), the type of soft problem experienced seems to be related to the operational transparency and the physical interaction density of the product. For the alarm clock, an operationally transparent and low interaction density product, soft problems are dominantly related to sensory quality. Complaints about the MP3 player, an operationally unclear and close interaction density product, are dominantly related to operational quality.

Apart from the two product properties, this project also tackled how product-specific variables such as product importance, frequency of use, importance of usability and perceived performance are related to soft problems.

- Frequently used electronic products are likely to lead to the occurrence of soft problems. Especially, the more often used, the more it is related to sensory problems. It

makes sense since frequent use refers to more contact to our sensorial perception. These product specific variables are not always involved in soft problems.

- When people perceive the performance of electronic products below their expectation, they complain more about functional quality of the products. This is obvious because product performance is one of functional quality factors. On the other hand, people who perceive the performance of their electronic products better than their expectation pay more attention to sensory quality.

- Product importance and the importance of usability (ease-to-use) have nothing to do with soft problems. Functional assistance of electronic products does not provide a complete explanation of why people think their electronic product important. Probably the reason could be aesthetics or ease-to-use. The same answer is possible in case of the importance of usability. Although people think usability of an electronic product is important, this does not always lead to complain about operational quality. At least in this study usability refers to sensory, functional, and operational qualities.

The experiment (Chapter 5) illustrates that soft problems are related to not only user characteristics but also particularly product properties. According to the experiment, the interaction between user characteristics and product properties in soft problems is:

- User characteristics such as age, uncertainty avoidance, locus of control, proneness to complain, and cultural background have to do with particular soft problems but the influence of such user characteristics related with product property: for the alarm clock (high operational transparency and low physical interaction density product), high score in uncertainty avoidance is related to sensory problems, extrovert locus of control are related to operational problems, and high proneness to complain are related to operational problems. For the MP3 player (low operational transparency and high physical interaction density product), older people complain about sensory quality, and people who have high proneness to complain complain about sensory quality.

- User characteristics such as locus of control and cultural background are closely related to type of soft problems with simple-to-use and distant physical interaction products, while prior use experience related to soft problems with complex-to-use and close physical interaction products (Chapter 5).

Soft problems and follow-up (re)actions

Soft problems do not necessarily end up with product return but they negatively influence the intent of future purchase about the same brand (Chapter 5). This finding is consistent with den Ouden' s study (2006). Almost of half of participants in the experiment would like

to return the products due to soft problems which have nothing to do with technical failure. Moreover, follow-up (re)actions in case of the occurrence of any soft problems are more severe according the results of the last survey (Chapter 6): regarding product return, 61.1% of the participants would like to exchange it for one from another brand and 44.8% would like to demand a refund. And regarding negative intention of future purchase, 76% of the participants would like to buy products from another brand next time and 39.1% would never like to buy any products of the brand again. People also would like to be disloyal to the brand or seek redress directly through the helpdesk or the shop without waiting or staying calm. Particular soft problems lead to specific follow-up (re)actions:

- Functional problems lead to negative comments about the brand, replace it for one from another brand, and call the helpdesk. On the other hand, people who face functional problems would least like to wait hoping to sort the problems out compared with the other two problems.

- Operational problems lead to taking follow-up (re)actions in any form. This is particularly the case with simple products.

- Sensory problems in the same kind of products, however, do not always seem to lead to any follow-up (re)actions. Meanwhile, people who are dissatisfied with operational quality with complex products are less likely to take follow-up (re)actions than those who complain about sensory quality.

However, product properties have nothing to do with specific follow-up (re)actions.

8.2.5 What is the optimal way, in terms of methods and techniques, to bring in knowledge of the interaction model into the design process?

The contribution of the present study lay foremost in the emphasis on the importance of considering user diversity related to the occurrence of soft problems. The aim of this study was to find any relationship between soft problems and the personal background of users. We also investigated how soft problems are related to product properties and how user characteristics interact with these properties. These findings must be a useful source for companies to get a better understanding of their target user group and the characteristics of their products in development, which will lead to an increase of consumer satisfaction in product use. Then, the question is: how can these findings be made available and transferrable to design practice? In what ways can designers make use of the information in order to identify anticipating use problems of a product they are developing and its target user group in advance, and prevent them in the product development process?

Among many ways to make these accessible to product development teams, a method was created as a first step, which is called Persona Interaction with Product method (PIP). The method consists of an interactive tool and a workshop. The PIP interactive tool provides them with how a target user (i.e. persona) or a product type in development interacts with

use problems in a fast and easy way as a relational concept in which soft problems, user characteristics, product properties and follow-up (re)actions are jointly effective. For instance, as characteristics of a target user or a type of product are defined, the interactive tool provides anticipated soft problems of the target user group or the type of product, and their follow-up (re)actions related to the soft problems. Basically the tool provides an interactive database with data from the project. However, considering the dynamic characters of consumer electronic products (e.g. products rapidly change and user' s preference change over time), it is required for a company to update the database: data about their products and their properties, target groups, characteristics of their target users, interaction between product properties and user characteristics, anticipated soft problems and follow-up (re)actions by their products and users. This kind of information is useful especially during desktop studies at the very beginning of product development process.

The PIP workshop is a useful way to share a deep understanding and a hands-on experience on the interaction between user and product between product designers and even within a product development team. Especially the workshop aims to arouse stakeholders in the product development process to the importance of soft problems and also to provide an in-depth understanding of their target users and products that are being developed. Through two workshops, of which participants were from product development teams in consumer electronic industry, it turned out that the workshop inspired them enough and provided useful knowledge on how their persona interacts with their products and what use problems are anticipated. Especially the identification of anticipated use problems is useful because they could already at the beginning of the project identify probable soft problems.

When these two ways are combined, a product development team can already identify expected use problems of their products and deal with the problems at the beginning of the product development process.

The study began to figure out what kind of use problems people have experienced with their electronic products. It resulted in nine categories of use problems, constructed from the user' s point of view and at the end they were clustered again into three categories, sensory, functional, and operational qualities according to product quality theory. The three dimensions provide a useful insight into product use in the human-product interaction. Nevertheless, the nine categories (sensation, product structure, health, trend, performance, functional constraint, understanding functions, maintenance, and third party) are still key issues to figure out the character of an electronic product in terms of soft problem in design practice.

8.3 Future research and reflection

Considering the complexity of the interaction between user characteristics, product properties, and soft problems, follow-up studies are necessary.

First, the two ways in the PIP method need to be combined considering that they have their own characters. With the tool working on the computer, product development teams easily and fast gain knowledge on their target user and their use problems just by defining them. In the workshop those within the teams can easily share their knowledge and experience together. On the other hand, the interactive tool does not deal with knowledge and experience gained or shared within a product development team and even within a company, and the workshop usually needs preparation and takes some times and participants in the workshop can only bring their own knowledge and experience to the table, which have shown insufficient. Therefore, it should be taken into account how to effectively combine the interactive tool and the workshop to deliver the best outcome for companies considering those characters. If the tool is used during the workshop to provide more information and examples and help their understanding, product development teams can effectively gain in-depth knowledge about the interaction between their products, their target group and anticipated soft problems.

Second, the interactive tool should be further developed to provide easy-to-access, easy-to-update, and easy-to-use information on the user-product interaction. Especially, ease to update the database is crucial because the consumer electronic market is very dynamic explained above, and the tool does not completely deal with knowledge and experience from a company effectively. Moreover, data from scientific literature should be included in the update. Therefore, the tool should have a platform where a company can easily update themselves.

The study revealed that product properties play an important role in the occurrence of particular soft problems. This is useful in case of developing a new product since there is lack of information for a product which has never existed before. However, in case of redesigning existing products, soft problems identified by product properties do not provide detailed or accurate information of the products. For this reason, a follow-up study should focus on the relationship between user characteristics and major electronic products, especially highly ranked in soft problems such as mobile phone, computer, mp3 player, vacuum cleaner and so on.

Soft problems are rooted from unsuccessful user-product interaction. Users do not always feel dissatisfied with their electronic products. They love to use their electronic products because of many reasons. Figuring out what user characteristics are related to satisfactory use experience would provide useful information with designers as well. In other words, the focus should be on how the three (sensory, functional, and operational) qualities interact with particular user characteristics. This approach is also very interesting in a sense that

most of participants in the study were complainers and people love to buy a product they love to use again.

This study is meaningful in the sense that it gives an overview of how user characteristics interact with product usability. This study can contribute to a better understanding of user profiles in estimating the seriousness of the complaint and in designing better products people love to use.

Although this project delivered methods and conclusions, there are still questions to be asked to myself. Before this study I did not know how many complaints people would have with using consumer electronic products. It was striking how huge the number of problems was and that most of these problems were related to usability. It challenges the question whether soft problems are only related to consumer electronic products. What about our everyday products such as furniture, kitchenware, and clothes?

In the study only three countries were chosen to find out the influence of culture in soft problems. The study showed there are differences between those countries. However, these three countries are not representative for all countries. I defended in this thesis the choice for this limited number by arguing that I just wanted to show that culture is an important factor. It is up to manufacturers to do similar research among those countries where they sell their products and services.

Lastly, people' s preference and behaviour have changed as times goes by. The most obvious example is that in 10 years time the older generation is experienced as well in high-tech electronic products. The question is, when will the findings of my study obsolete and by what method can we keep our knowledge in this area up-to-date?

From social scientists we have adopted the use of questionnaires to measure the psychological status of people. In the same way this study adopted questionnaires to define characteristics of the participants and other variables. Were the characteristics gained in this way identical to their real cognitive competences and personality traits? Would there be any other way to measure those characteristics? All these questions should be taken into account for future study.

“All the time I have to think for a while..... Pretty annoying!”

Age 32 | Male | Aachen, Germany

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APPENDIX

Appendix A: Questionnaire
Appendix B: Examples of Soft Problems from this project
Appendix C: Product type and Soft problems graph

Appendix A: Questionnaire

Design for Usability project: questionnaire

1. What consumer electronic product(s) has (have) irritated you the most in using? And why?

I have complaints about (*mention your problematic electronic device, such as an iron or a mobile phone or a computer, etc.*):

Product	Reason of irritation
1.	
2.	

If you have complained, go to **Question 2**
If you have had no complaint, go to **Question 3**

Please answer the following questions about the irritating product.

2.1 Which product did(do) make you more annoyed?

2.2 Where did you buy the product?

O Off-line shop O On-line shop O Another: _____

2.3 How important is the product for you?

Very Unimportant O O O O Very Important

2.4 Have you ever used this kind of products before?

O Yes O No

2.5 How strong is your irritation about this product?

A little bit Irritated O O O O Strongly Irritated

2.6 How well did the product perform?

Worse than Expected O O O O Better than Expected

2.7 How often do you use the product?

Never	1 -2 times per month	1-2 times per week	Every day
O	O	O	O

2.8 Would you recommend the product to your family and friends?

Very Unlikely O O O O Very Likely

2.9 How important is "usability (easy to use)" to you in selecting the product?

Very Unimportant O O O O Very Important

2.10 Did you already repurchase the product?

O Yes → go to Question 2.10A
O No → go to Question 2.10B

2.10A If you answered YES, did you buy the same brand?

O Yes O No

2.10B If you answered NO, do you intend to repurchase the product of the same brand?

O Yes O No

2. 11 Did you react or take any actions?

O Yes, I went back to the shop
O Yes, I phoned the company's helpdesk
O Yes, I called the company directly
O Yes, I sent an e-mail or reacted on the internet site
O No, I didn't react
O Yes, another reaction: .....

3. For each statement fill in the circle with the response that best represents your opinion. Make sure that your answer is in the correct box.

3.1 Even though a product has many functions (e.g. a mobile phone), I only want to know about the functions I really use.

Strongly Disagree O O O O O Strongly Agree

3.2 I always read a manual when I buy an unfamiliar, complicated electronic product.

Strongly Disagree O O O O O Strongly Agree

3.3 When I buy products, I choose them together with my family member or friends

Strongly Disagree O O O O O Strongly Agree

3.4 When a device like an iron or a coffee machine stops working, I always ask somebody else what is wrong.

Strongly Disagree O O O O O Strongly Agree

3.5 The problem with products such as a video/dvd recorder or a computer is that, when I don't use it for a while I forget how some functions of the product work.

Strongly Disagree O O O O O Strongly Agree

3.6 When I have to replace a household device I usually stick to the same or similar product.

Strongly Disagree O O O O O Strongly Agree

3.7 Everybody who knows you would vouch for the fact that you are a patient person.

Strongly Disagree O O O O O Strongly Agree

3.8 When I receive a bill, I always pay it immediately.

Strongly Disagree O O O O O Strongly Agree

3.9 I rely on the advice of the salesman/woman in a shop.

Strongly Disagree O O O O O Strongly Agree

3.10 I don't like it if something unexpected happens.

Strongly Disagree O O O O O Strongly Agree

4. When your new device doesn't meet your expectations and does not do what they promised, how would you react?

4.1 I would be upset, but not respond in any way.

Not at all Likely O O O O O O Highly Likely

4.2 I would contact the shop/on-line shop and speak to the manager on duty .

Not at all Likely O O O O O O Highly Likely

4.3 I would return the device and would exchange it for one from another brand

Not at all Likely O O O O O O Highly Likely

4.4 I would make negative comments about the brand to other people nearby.

Not at all Likely O O O O O O Highly Likely

4.5 I would wait and hope that things improved

Not at all Likely O O O O O O Highly Likely

4.6 I would call the help desk of the company (brand) and argue with the employee.

Not at all Likely O O O O O O Highly Likely

4.7 I would decide to buy products from another brand next time.

Not at all Likely O O O O O O Highly Likely

4.8 I would complain to a consumer organization, government agency or newspaper.

Not at all Likely O O O O O O Highly Likely

4.9 I would write or send an e-mail to the company to complain.

Not at all Likely O O O O O O Highly Likely

4.10 I would demand an immediate refund

Not at all Likely O O O O O O Highly Likely

4.11 I would remain loyal to the brand.

Not at all Likely O O O O O O Highly Likely

4.12 I would never buy any product of that brand anymore.

Not at all Likely O O O O O O Highly Likely

4.13 I would remain calm and wait for the shop or company to sort things out.

Not at all Likely O O O O O O Highly Likely

4.14 I would tell my friends not to buy that brand product.

Not at all Likely O O O O O O Highly Likely

4.15 I would communicate the reasons for my dissatisfaction to the help desk employee.

Not at all Likely O O O O O O Highly Likely

5. For each statement fill in the circle with the response that best represents your opinion between True and False.
Make sure that your answer is in the correct box.

5.1 I usually get what I want in life.

O True O False

5.2 I need to be kept informed about news events

O True O False

5.3 I never know where I stand with other people.

O True O False

5.4 I do not really believe in luck or chance.

O True O False

5.5 I think I could easily win a lottery.

O True O False

5.6 If I do not succeed on a task, I tend to give up.

O True O False

5.7 I usually convince others to do things my way.

O True O False

5.8 People make a difference in controlling crime.

O True O False

5.9 The success I have is largely a matter of chance.

O True O False

5.10 Marriage is largely a gamble for most people.

O True O False

5.11 People must be the master of their own fate.

O True O False

5.12 It is not important for me to vote.

O True O False

5.13 My life seems like a series of random events.

O True O False

5.14 I never try anything that I am not sure of.

O True O False

5.15 I earn the respect and honors I receive.

O True O False

5.16 A person can get rich by taking risks.

O True O False

5.17 Leaders are successful when they work hard.

O True O False

5.18 Persistence and hard work usually lead to success.

O True O False

5.19 It is difficult to know who my real friends are.

O True O False

5.20 Other people usually control my life.

O True O False

6. Please answer the following questions accurately and honestly.

6.1 What is your birth year?

.....

6.2 What is your gender?

O Male O Female

6.3 What is your educational background?

O Lower than high school
O A high school graduate
O A university (college) graduate
O A master degree
O A PhD degree
O Another, i.e.: .....

6.4 Where did you grow up?

O Countryside
O Small village
O Small city
O Large city/Capital

6.5 How many hours do you watch television a day?

O Never
O 0-1 hour
O 1-2 hours
O 2-3 hours
O More than 3 hours

6.6 How many hours do you surf on the Internet a day?

O Never
O 0-1 hour
O 1-2 hours
O 2-3 hours
O More than 3 hours

6.7 How much annual income do your household earn including taxes on average?

O Less than € 10.000
O € 10.000 – € 30.000
O € 31.000 – € 50.000
O € 51.000 – € 70.000
O More than € 71.000

Thank you for your participation!

Appendix B: Examples of Soft Problems from this project

Sensory quality problems

“ Buttons are fucking tiny” [Electronic dictionary]

“ Difficult to grab it in one hand” [Smart phone]

“ Easily rolling” [Alarm clock]

“ I have to carry the charger as big as the camera on my travels” [Digital camera]

“ It became a visual pollution” [Desktop computer]

“ Why do I have to use two hands?” [Smart phone]

“ I just wanna break them!” [Smart phone]

“ Clink! Clink! while doing dishes” [Dish washer]

“ My hair stands on end with terror whenever I open this” [Laptop].

“ Something seems to be burning” [Television]

“ A Touch screen. still I feel like playing with a piece of glass, though” [Smart phone]

“ Damn! The screen easily gets dirty” [Smart phone]

“ The lampshade is fucking hot” [Electric lamp]

“ Unpacking is damn awesome experience!!!” [Mouse packing]

“ I expected to hold it with my palm. It’ s uncomfortable at all. ..too big. so I use my two fingers it is not comfortable” [Razor]

“ It is supposed to be heavy but it’ s too heavy to carry” [DSLR camera]

“ Too awkward to put it in my bag” [Digital camera]

“ Loose switch. ..it works but I hate the feeling” [Hand blender]

Functional quality problems

“ ’ Press Unlock to activate keypad’ .. but activating is so irritating” [Mobile phone]

“ Because some adapters have a strange shape I can’ t use all the power outlet holes” [Multi-Tab]

“ Bluetooth connection...It pissed me off” [Mobile phone]

“ Flash doesn’ t work...just irritating” [Digital camera]

“ I have a couple of RFID chip inserted cards in my wallet. So annoying to take the card out of my wallet but the electronic lock doesn’ t recognize unless I do so” [RFID card]

“ I took a nice camera to take pictures of this breathless scene...I managed to do so but my camera doesn’ t work properly because it doesn’ t have an anti-dust function, Damn it!” [Digital camera]

“ It has no backlight function...I can’ t check room temperature and humidity at night” [household thermometer]

“ Only one way of inputting texts. Damn!” [Mobile phone]

“ The display is too small and doesn’ t have good resolution...so we have to put our heads together” [Digital camera]

“ Why am I supposed to buy an external keyboard?” [iPad]

“ Promotion promotion!!! even though I checked ‘ Do not show again” [Software]

“ Broken fonts while using internet banking.... So frustrating!” [Computer]

“ Flash...Flash...” [Computer]

“ iPad doesn’ t fit in...Uhmmmm” [External speaker]

“ Two remotes they never shake hands each other at all” [Remote]

“ Which one should I take? It is pretty annoying to think about it all the time” [Remote]

“ Why can my television not recognize my mother tongue?” [Remote]

“ Easily broken” [Mobile phone]

“ I am scared to use this because the plastic has a crack recently” [MP3 player]

“ I don’ t have iron ears” [Mobile phone]

“ It doesn’ t last long...it became like this a day after I bought” [Mobile phone]

“ The magnetic ball leaves a trace on the surface” [Clock]

“ The part where the adapter and the cable meet is easily broken..the cable has its own shape due to the winding function” [Laptop adapter]

“ Worn out” [Mobile phone]

“ All the pictures taken at night are shaking” [Digital camera]

“ Annoying to set a white balance all the time...even doing so is not easy and accurate” [Digital camera]

“ Battery does not sustain more than a day” [Laptop]

“ Connection is lost without any reason” [Mouse]

“ More and more losing the sucking power” [Vacuum]

“ Often breakdown on the road...so embracing!” [GPS]

“ Slow and Frozen” [Software]

“ Sometimes it takes much time to get a proper satellite signal..until then I have to wait or drive without any destination” [GPS]

“ The cover doesn’ t work...split” [Laptop]

“ The width is too wide..so I can’ t plug another USB thing in next to it” [Laptop]

Operational quality problems

“ I can’ t see how much the sound volume is” [Speaker]

“ I had to get used to checking out again when I get off... Until now I have to keep thinking not to forget” [Public transportation chip card system]

“ I thought the light says something but nothing does it... just confusing” [External hard disk]

“ It is supposed to remove a bad smell in the toilette but no idea if it works or out of order” [Automatic air freshener]

“ No feedback whether the picture is taken or not” [Mobile phone]

“ Several LEDs... blinking blinking.. What do I know or Do I need to know it?” [Router]

“ Sometimes I forget the water is heat up because there is nothing to let me recognize” [Water cooker]

“ This doesn’ t say whether it is properly working” [Hand dyer]

“ When it doesn’ t work, I have to check whether the battery is properly mounted or not because it says nothing” [Remote]

“ Because of the colour and shape, difficult to spot it” [Remote]

“ I am clicking right or left arrow buttons.. the cursor(?) moves up and down on the display” [Car stereo]

“ I have to think a couple of seconds before switching on” [Stereo]

“ No idea about what it is and how to use at the beginning” [e-book reader]

“ I have to try and try again to make sure if the cables are correctly connected” [Home theatre system]

“ Unintentionally the previous or next button is pressed” [Smart phone]

“ A keypad is papered with at least three symbols” [Mobile phone]

“ A simple to use washing machine? Maybe..all the little lights make me visually confused” [Washing machine]

“ Due to many connectors, it always takes some time to figure out which is which” [Computer]

“ I am using a simple baby phone but it looks more confusing than my smart phone.

I go to gym for workout not for training my cognitive ability” [Baby phone]

“I have to do either memorizing all the number or going through all from top to button” [Mobile phone]

“I have to press several times to reach the screen which shows fuel consumption per 100km” [Car computer]

“I only need two functions: heating up and oven” [Microwave]

“I only want to see whether it is fully charged or not but there are three other functions” [Batter charger]

“It shows all the menu structure” [Mobile phone]

“No idea which one am I supposed to plug out” [Multi-Tab]

“Only described in texts how to get destinations. It must be organized well but not easily recognized at all” [GPS]

“Several seconds to think about which one should I press” [Remote]

“Thanks to several functions it has I have to press the rubber button 3 or 4 times” [Remote]

“Without the instruction, I can’ t do anything...It looks quite organized but never, indeed” [Digital camera]

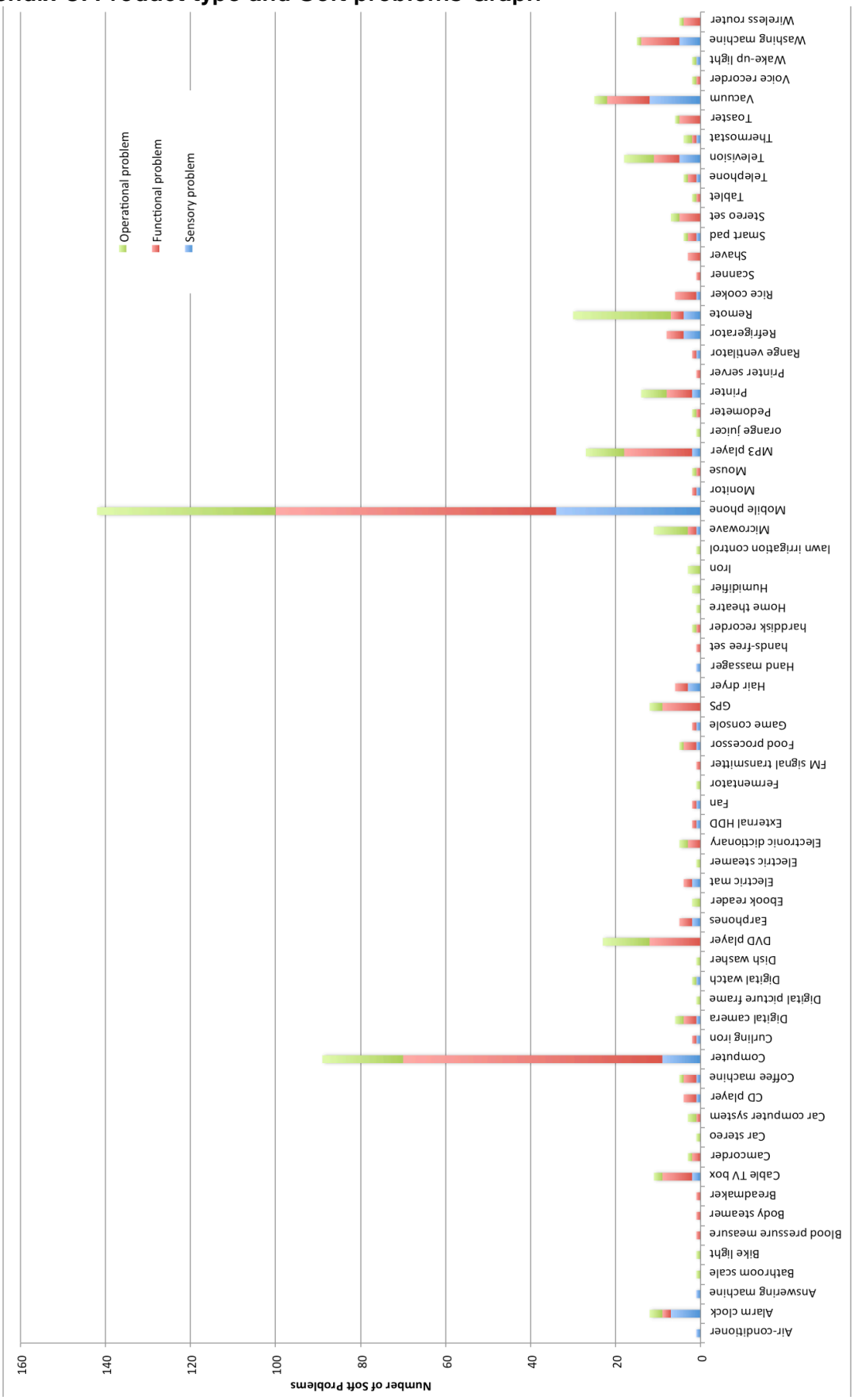
“For removing the dust on the wings, I have to take it apart and then assemble it again” [Fan]

“Look at this annoying cable.. charging would have been pleasant experience without the long cable” [Digital camera]

“White chalky build-up! I started to less and less the appliance” [Baby cooker]

“Impossible to clean the door grip” [Refrigerator]

Appendix C: Product type and Soft problems Graph



Summary

Problem definition

From the time that consumer electronic products were launched on the consumer market, consumers have complained about many of these products. Was it initially about technical failure or malfunction of products, over the years this type of problems slowly decreased, as did the complaints about them. However, from the late 90s this trend bent towards an increase in consumer complaints but this time regardless of the technology.

Interestingly about half of the reasons for product returns have nothing to do with technical problems, but are based on so called ‘ soft problems’ , consumer complaints that cannot be traced back to technical problems. There are several explanations for this phenomenon possible. Product development teams might not take these problems serious, or the current products are becoming more and more complex (product properties) and used by a more and more diverse user groups (user characteristics). Nevertheless, the definite causes of such problems have not been identified. One of the reasons why the causes for such problems kept unknown is that it is common in consumer electronic industry that customer complaints or reasons of product return are dealt with by call centres. There are hardly any direct links between these centres and the product development departments.

Research goal

Despite increased consumer dissatisfaction with electronic products caused by soft problems, there are only a few studies that investigate what soft problems users have experienced. Furthermore, studies are still not sufficient to explain how user characteristics, product properties and soft problems interact with each other because of the lack of theoretical foundation and empirical evidence. Hitherto user characteristics have been hardly dealt with in the field of product design. At most, demographic factors such as age and gender or the difference between novice and experienced users are all that can be found in literature. Therefore, this thesis investigates what kinds of soft problems users have faced in using electronic products, and how those problems are influenced by user-related variables (i.e. user characteristics such as age and personality) and product specific variables (i.e. product properties such as the size of the buttons or maintenance). This study also aims to translate the interaction between soft problems, user characteristics, and product properties into a design language to provide companies with an in-depth understanding of their target user group and product based on feedback from actual users of products.

Conceptual framework

A conceptual framework was developed in order to get a complete overview of the interaction between all these aspects. As a result of the interaction between user characteristics, product properties, use context, and brand identity, a user is supposed to form certain expectations of use and usability of a specific product. However, the initial expectation that the consumer has might be different from what s/he experiences in actual use with the product. Negative disconfirmation leads to feelings of dissatisfaction.

Approach

Because of a lack of studies into the influence of user characteristics our study started with including as many user variables as possible. Most of these variables belong to one of three categories:

A Demographic factor: age, gender, educational background, household income, and cultural background;

A Cognitive factor: technology familiarity, memorizing ability, use fixation, technical skill, and prior experience);

A Personality factor: curiosity, patience, sloppiness, self-confidence, uncertainty avoidance, self-efficacy, locus of control, and the so-called ' big five' personality traits neuroticism (sensitive/nervous vs. secure/confident), extraversion (outgoing/energetic vs. solitary/reserved), agreeableness (friendly/compassionate vs. cold/unkind), openness (inventive/curious vs. consistent/cautious) and conscientiousness (efficient/organized vs. easy-going/careless)

Two other variables were added: behaviour in buy decisions, and the openness to exposure to media).

From the first study into the problems people experience it became clear that product properties play an important role. Therefore, in our follow-up studies seven property dimensions were also taken into consideration: cognitive load, operational transparency, physical interaction density, product importance, frequency of use, importance of usability, and perceived performance. Operational transparency is partly overlapping with cognitive load but is also closely related to both high-tech dependency (i.e. operationally transparent products such as a toaster are much less dependent on high technology than an iPad or GPS) as well as compatibility (i.e. operationally transparent products such as a washing machine, are hardly interactive with other electronic products). Physical interaction density refers to the frequency and duration of physical interaction between user and product. The descriptions of the other four dimensions are literally obvious. For instance, product importance refers to the extent to which a product is important to a user.

For the evaluation of our conceptual framework a total of four studies (three surveys and an experiment) were conducted. The first study aimed to identify soft problems people

have faced in using electronic products. This resulted in a huge pile of very different complaints about very different products. The problems people experienced could be reduced to three types: sensory, functional and operational problems. The second study mainly explored how user characteristics were related to each of these three types of soft problems.

In order to study product properties in relation to user characteristics in a more direct way, an experiment was conducted. In order to offer insight into actual product use as compared to the other studies, which were retrospective in nature, an experiment was conducted with participants from three countries, USA, South-Korea and the Netherlands. In this experiment participants had to get two products functioning, an alarm clock and MP3 player, both products with a known poor use experience. The fourth study, a survey among 500 people, was mainly meant as a validation of the foregoing studies but additionally focused on what follow-up reactions users take when facing soft problems with their electronic products.

Results

The overall results demonstrate the existence of many usability problems in the use of electronic products which have nothing to do with technical failure. People express a huge amount of complaints about a large variety of products, from computers to e-book readers, and from washing machines to vacuum cleaners. On the basis of the reasons why people are frustrated by their product(s) the types of problems were categorized. In the first survey this grouping was done according to nine categories: understanding functions, performance (low efficiency and performance), sensation (unpleasant sensorial input), health (physical fatigue or tiredness), product structure (lack of physical structure such as inconvenient location of the USB slots in the laptop computer), maintenance (product maintenance difficulties), functional limitations, trend (sensitive to the trend of the day), and third party (interruption caused by a third party such as SPAM messages in the mobile phone). Based on product quality theory, they were re-categorised into three groups: sensory, functional and operational qualities. Sensory quality includes sensation, health, mechanism and trend; functional quality encompasses performance and functional constraints; problems with operating the product, maintenance, and third party belong to operational quality.

In all surveys the three types of soft problems show in terms of frequency the same pattern. Functional problems are most mentioned, followed by operational problems and sensorial problems. However, in the experiment, that aimed at discovering how soft problems differ between people in actual use when two specific products were given, this ratio differs from the one in the surveys: problems related to functional quality were hardly reported. The most obvious reason for this difference is the fact that the two products used did not give any functional problem. They all worked well in spite of the use problems they gave in operating. This implies that there are differences between actual use and

retrospective evaluation in soft problems faced by users.

Product properties

A combined view on all properties that are relevant in usability problems shows:

Cognitive load: most complaints in using consumer electronic products are observed in products requiring intermediate cognitive load rather than in low or high cognitive load products. Therefore, cognitive load is not the only dimension to predict whether soft problems occur in an electronic product.

Operational transparency: a majority of soft problems occur in using electronic products with low operational transparency. I.e. the less operationally transparent an electronic product is the more likely to have soft problems. Operational transparency does not only refer to cognitive load but also to high-tech dependency (black box) and compatibility issues, which means that the dimension is more consistent to describe soft problems in consumer electronic products than cognitive load.

Physical interaction density: a strong factor to anticipate whether an electronic product gets soft problems. An electronic product with a higher physical interaction density, such as a mobile phone, is more likely to be seen by the user as problematic.

Product importance: problems in using a product appear to become critical when it is an important product in user' s life.

Frequency of use: more soft problems are reported with more frequently used electronic products.

Importance of usability: whether or not people consider usability an important criteria doesn' t relate in our study to the type of problems they have.

Perceived performance: it is obvious that people complain when the product performs below their expectations. However, the perceived performance of a product is not as critical a factor as frequency of use in the occurrence of soft problems.

User characteristics

According to the results the influential factors in the interaction between user characteristics and soft problems are age, uncertainty avoidance, prior experience and proneness to complain. Some other characteristics do not have consistent results among the studies. Educational background, cultural background, memorizing ability, use fixation, curiosity, patience, and locus of control belong to such user characteristics.

In the context of soft problems user characteristics interact with product properties as follows:

Younger people are more sensitive to functional quality of consumer electronics than older people. The last group take operational quality more serious.

Low-educated people take sensory quality more serious in evaluating their electronic products but high-educated people regard operational quality as a major cause of dissatisfaction. It reveals that the level of education leads to different expectations of electronic products' experience.

Cultural background plays a role in soft problems. Compared to Dutch and American respondents South Koreans complain more on sensory and functional qualities of electronic products and less on operational quality. Dutch respondents are the lowest with sensory quality complaints but highest with operational quality complaints, while American respondents are lowest with functional quality complaints. Although only three countries were compared, these findings could be a useful example to gain a better understanding of the influence of culture in electronic product use. Interestingly, uncertainty avoidance in the project is not in accordance with what Hofstede measured in his cultural dimension study: South Koreans are supposed to have a much higher score on uncertainty avoidance than the other two countries. This is not confirmed in our study.

Prior experience plays a role in that people who have experienced a similar electronic product before are more likely to complain about operational quality when using such type of product again.

People who are prone to complain in any situations complain more about sensory quality of their electronic products.

The project draws the conclusion that user characteristics have to do with particular types of soft problem but the influence of such user characteristics is partly dependent on product properties. Moreover, soft problems do not necessarily end up with product return but they influences negatively the intent of future purchase. Follow-up (re)actions after having experienced problems are more likely: people will be more disloyal to the brand or seek redress directly through the helpdesk or the shop without waiting or taking no action at all.

Application

These findings need to be translated into a design language in order to make them useful for design practice. Among many ways to make these findings accessible, two methods were proposed: (1) an interactive tool and (2) a workshop approach. A first framework for a tool has been proposed. This tool should provide information in a fast and easy way on the interaction between user, product and use problems. This kind of information is useful especially during desktop studies at the very beginning of a product development process. The second method, a workshop approach, was developed and tested. Such a workshop is a useful way to share a deep understanding and a hands-on experience on the interaction between user, product and context. It will make stakeholders in the product development process aware of the importance of avoiding soft problems and also to provide an in-depth understanding of their target users and products that are being developed. The method

was validated through two workshops, one during a Design for Usability symposium and the second at Océ in the Netherlands, a global leader in digital document management and delivery technology. Workshops like these will provide information that goes far beyond the regular usability methods of user trials conducted at the end of a product development process.

Conclusions

One of the outstanding findings in the study is that soft problems are not only dependent on product properties but also on user characteristics. Soft problems are actually the outcome of the interaction between user characteristics and product properties. A product development team can already at the beginning of the project identify probable soft problems in terms of product properties and target group characteristics. For instance, as we found in our study differences between countries – a cultural aspect -, there is reason for a company to believe that they have to take this variable more serious by studying their foreign target groups. Especially, the findings in the project are useful in case of developing a new product since there is lack of information for a product that never existed before. Anticipated soft problems can be identified in advance through defining the product in terms of product properties.

Our study gives an overview of how user characteristics and product properties interact with product use. When these aspects are taken into consideration in the product development process, the seriousness of potential problems can be identified. The outcome by way of the newly developed product will increase consumer satisfaction in using products.

Samenvatting

Probleemstelling

Vanaf het moment dat elektronische consumentenproducten op de consumentenmarkt werden geïntroduceerd, klagen consumenten over veel van deze producten. Ging het in eerste instantie meestal over een technische storing of een defect aan een onderdeel, in de loop der jaren is dit soort problemen langzaam afgenomen net als de klachten daarover. Totdat in de late jaren '90 deze trend ombuigt in de richting van een toename van klachten onder consumenten, maar deze keer niet meer over slechte technologie.

Interessant om te constateren dat ongeveer de helft van de redenen voor retourzendingen niets te maken hebben met technische problemen, maar gebaseerd zijn op zogenaamde soft problems, klachten van consumenten die niet te herleiden zijn tot technische problemen. Verschillende verklaringen voor dit verschijnsel zijn mogelijk. Het kan zijn dat productontwikkeling teams deze problemen niet serieus nemen of dat de huidige producten steeds complexer worden (een producteigenschap) of door een meer gevarieerde gebruikersgroep gebruikt worden (een gebruikerskenmerk). Niettemin zijn de echte oorzaken van deze problemen nog steeds niet volledig geïdentificeerd. Een van de redenen daarvoor is dat in de consumentenelektronica-industrie klachten van klanten meestal worden afgehandeld door call centers; en directe verbanden tussen deze centra en de productontwikkelingsafdelingen van bedrijven bestaan nauwelijks.

Doel van het onderzoek

Ondanks de groeiende ontevredenheid bij consumenten over elektronische producten, veroorzaakt door soft problems, zijn er maar weinig studies bekend met onderzoek naar wat die soft problems nu eigenlijk zijn. Als gevolg van het gebrek aan theoretische fundering en empirisch bewijs is er geen uitsluitsel over de vraag hoe bij deze problemen producteigenschappen, kenmerken van gebruikers en die van de omgeving met elkaar interacteren. Met name kenmerken van gebruikers in relatie tot productgebruik en -ontwerp zijn tot nu toe nauwelijks behandeld. Alleen de meest voor de hand liggende, zoals demografische factoren als leeftijd en geslacht of het verschil tussen beginnende en ervaren gebruikers zijn terug te vinden in de literatuur. Daarom wordt in dit proefschrift verslag gedaan van onderzoek naar de vraag welke soft problems gebruikers hebben ervaren in het gebruik van elektronische producten, en hoe deze problemen worden beïnvloed door gebruiker-gerelateerde variabelen, zoals persoonlijkheid, demografische en cognitieve kenmerken, en productspecifieke variabelen, d.w.z. producteigenschappen als te kleine bedieningsknoppen of moeilijk te onderhouden. Deze studie beoogt tevens om de bevindingen op het gebied van de interactie tussen de ervaren problemen,

gebruikerskenmerken en producteigenschappen om te zetten in een ontwerptaal voor ontwerpers en bedrijven, en ze daarmee te voorzien van een diepgaande kennis van gebruikersdoelgroepen voor hun elektronische producten.

Conceptueel kader

Een conceptueel kader werd ontwikkeld om een volledig overzicht van de interactie tussen al deze aspecten te krijgen. Op resultaat van de interactie tussen gebruikerskenmerken, producteigenschappen, gebruikscontext en merkidentiteit zal een gebruiker bij een product bepaalde verwachtingen scheppen over het gebruik en de bruikbaarheid ervan. Nochtans, zou de aanvankelijke verwachting dat de consument anders kunnen zijn dan wat hij/zij ervaart in het feitelijke gebruik van het product. Negatieve weerlegging leidt tot gevoelens van ontevredenheid.

Aanpak

Vanwege een gebrek aan studies naar de invloed van gebruikerskenmerken startte onze studie met zo veel gebruikerskenmerken als mogelijk en zinvol. De meeste van deze variabelen behoren tot een van de drie volgende categorieën:

Een demografische factor: leeftijd, geslacht, opleiding, inkomen en culturele achtergrond;

Een cognitieve factor: bekendheid met technologie, memoriserend vermogen, gebruiksfixatie, technische vaardigheid, en eerdere ervaring;

De factor persoonlijkheidstrek: nieuwsgierigheid, geduld, slordigheid, zelfvertrouwen, onzekerheidsvermijding, self-efficacy, locus of control, de zogeheten ‘ big five’ dimensies van de persoonlijkheid: emotionele stabiliteit vs. neuroticisme, extraversie vs. introversie, openheid voor ervaringen en creativiteit, goedaardig en warm vs. kwaadaardig en kil, en zorgvuldigheid vs. laksheid en gebrek aan motivatie.

Naast deze drie factoren werden de variabelen beslissingsgedrag in het kopen van producten en de mate waarin men zich blootstelt aan mediaboodschappen toegevoegd.

Uit de eerste studie naar de problemen met producten die mensen ervaren, werd duidelijk dat producteigenschappen een belangrijke rol spelen. Daarom werden in de diverse studies een aantal van die dimensies van producteigenschappen in beschouwing genomen: cognitieve belasting, operationele transparantie, fysieke interactiedichtheid, belangrijkheid van het product, gebruiksfrequentie, belangrijkheid van gebruiksvriendelijkheid en de gepercipieerde prestaties. Operationele transparantie is deels overlappend met cognitieve belasting, maar is ook nauw verwant aan zowel de high-tech afhankelijkheid (d.w.z. operationeel transparante producten, zoals een broodrooster, zijn veel minder afhankelijk van geavanceerde technologie dan een iPad of GPS) als compatibiliteit (d.w.z. operationeel transparante producten zoals een wasmachine zijn nauwelijks interactief met andere elektronische producten). Fysische interactiedichtheid

verwijst naar de frequentie en duur van de fysieke interactie tussen gebruiker en product. De beschrijvingen van de andere vier dimensies kunnen letterlijk worden genomen.

Voor de evaluatie van het ontwikkelde conceptueel kader werden in totaal vier studies (drie surveys en een experiment) uitgevoerd. De eerste studie had als doel om soft problems die mensen in het gebruik van elektronische producten ervaren, te identificeren. Dit leidde tot een enorme berg aan zeer verschillende klachten over zeer verschillende elektronische producten. De tweede studie onderzocht vooral hoe gebruikerskenmerken zijn gerelateerd aan specifieke typen problemen. Omdat drie van de vier studies survey studies zijn en daardoor enkel retrospectieve informatie over problemen met producten prijsgeven, werd besloten om ook een experiment uit te voeren waarin problemen met producten konden worden bestudeerd in een actuele gebruikssituatie zelf. Deelnemers aan het experiment waren mensen uit drie landen, USA, Zuid-Korea en Nederland. In dit experiment moesten de deelnemers twee producten bedienen, een wekker en MP3-speler, beide producten met een gekend matige gebruiksvriendelijkheid. Het vierde onderzoek, een survey onder 500 mensen, was vooral bedoeld als een validatie van de voorgaande studies, maar bovendien gericht op wat de follow-up reacties mensen nemen wanneer ze geconfronteerd worden met soft problems met hun elektronische producten.

Resultaten

De resultaten van onze studies wijzen op het bestaan van een groot aantal soft problems in het gebruik van elektronische producten die niets te maken hebben met technische onvolkomenheden. Mensen uiten een enorme hoeveelheid klachten over een grote verscheidenheid aan producten, van computers tot e-book readers, en van wasmachines tot stofzuigers. Op basis van de redenen waarom mensen gefrustreerd zijn konden de problemen in het eerste onderzoek worden ingedeeld in negen categorieën: inzicht in functies, prestaties (lage efficiëntie en prestaties), beleving (onaangename sensorische input), gezondheid (fysieke vermoeidheid), product structuur (gebrek aan fysieke structuur zoals lastig locatie van de USB-sleuven in de laptop), productonderhoud, functionele beperkingen, trend (gevoelig voor de trend van de dag), en derde partij (probleem veroorzaakt door een derde partij, zoals SPAM-berichten in mail of mobiel). Overeenkomstig de theorie op het gebied van productkwaliteit werden de problemen teruggebracht tot drie categorieën: Sensorische, Functionele en Operationele kwaliteit. Sensorische kwaliteit omvat beleving, gezondheid, productstructuur en trend. Functionele kwaliteit omvat de prestaties van het product en de functionele beperkingen. Problemen met de bediening van het product, het onderhoud en met interruptie door derden behoren tot de Operationele kwaliteit

In termen van frequentie van de drie soorten soft problems vertonen alle survey-onderzoeken hetzelfde patroon. Functionele problemen worden het meest genoemd, gevolgd door operationele en zintuiglijke problemen. Echter het experiment, dat gericht

was op onderzoek naar verschillen tussen deelnemers in soft problems door middel van feitelijk gebruik van twee gebruiksonvriendelijke producten, levert een ander beeld op: problemen gerelateerd aan de functionele kwaliteit werden nauwelijks gerapporteerd. De meest duidelijke reden voor dit verschil was dat de twee gebruikte producten geen functioneel probleem geven. Beide werken technisch goed ondanks de gebruiksproblemen. Dit houdt in dat er verschillen zijn in ervaren soft problems tussen werkelijk gebruik en de retrospectieve evaluatie ervan.

Producteigenschappen

Een gecombineerd zicht op alle producteigenschappen die van belang zijn in usability problemen geeft de volgende resultaten:

Cognitieve belasting: de meeste klachten in het gebruik van elektronische consumentenproducten worden geuit over producten die tussen producten met hoge en met lage cognitieve belasting in zitten. Daarom is cognitieve belasting niet de enige dimensie in het voorspellen of zich bij een bepaald product soft problems zullen voordoen.

Operationele (of bedienings-) transparantie: een meerderheid van de soft problems doen zich voor bij het gebruik van elektronische producten met een geringe transparantie. Operationele transparantie heeft niet alleen betrekking op cognitieve belasting, maar ook op high-tech afhankelijkheid (black box) en compatibiliteitsproblemen.

Fysieke interactiedichtheid: een sterke factor om te anticiperen op de vraag of een elektronisch product tot soft problems leidt. Een elektronisch product met een hogere fysieke interactiedichtheid (zoals een mobiele telefoon), zal eerder door de gebruiker als problematisch ervaren.

Productbelang: problemen bij het gebruik van een product worden meer als kritisch ervaren indien het een belangrijk product is in het leven van de gebruiker.

Frequentie van gebruik: het aantal soft problems is groter met vaker gebruikte elektronische producten.

Belang van bruikbaarheid: het belang dat men hecht aan gebruiksvriendelijkheid heeft geen relatie met het type probleem dat men noemt.

Gepercipieerde prestatie: het is duidelijk dat mensen klagen wanneer het product onder hun verwachtingen presteert.

Gebruikerskenmerken

De resultaten laten zien dat de meest invloedrijke gebruikerskenmerken in de interactie met soft problems zijn: leeftijd, onzekerheidsvermijding, eerdere ervaringen en neiging tot klagen. Enkele andere kenmerken vertonen geen consistente resultaten in de studies: opleiding, culturele achtergrond, het memoriserend vermogen, gebruiksfixatie,

nieuwsgierigheid, geduld en locus of control.

Gebruikerskenmerken interacteren met producteigenschappen als volgt:

Jongere mensen zijn gevoeliger voor de functionele kwaliteit van consumentenelektronica dan ouderen. De laatste groep neemt operationele kwaliteit serieuzer.

Laag opgeleide mensen nemen de sensorische kwaliteit serieuzer bij de evaluatie van hun elektronische producten, maar hoog opgeleide mensen zien operationele kwaliteit als een belangrijke oorzaak van ontevredenheid. Het laat zien dat opleidingsniveau tot verschillende verwachtingen van elektronische producten leidt.

Culturele achtergrond speelt zoals eerder vermeld een rol in soft problems. In vergelijking met Nederlandse en Amerikaanse respondenten klagen Zuid-Koreanen meer over sensorische en functionele eigenschappen van elektronische producten en minder over operationele kwaliteit. Nederlandse respondenten scoren het laagst met klachten over sensorische kwaliteit, maar het hoogst over operationele kwaliteit; Amerikaanse respondenten scoren het laagst met klachten over functionele kwaliteit. Hoewel slechts drie landen werden vergeleken, toch zijn de bevindingen nuttig voor een beter begrip van de invloed van cultuur in productgebruik. Interessant in dit verband is dat onzekerheidsvermijding in het project niet in overeenstemming is met wat Hofstede heeft gemeten in zijn theorie over culturele dimensies. Zuid-Koreanen worden op basis van die studie geacht een veel hogere score op onzekerheidsvermijding te hebben dan de andere twee landen. Dit wordt niet bevestigd in onze studie.

Eerdere ervaring speelt een rol in die zin dat mensen die ervaren hebben met een vergelijkbaar elektronisch product meer klagen over de operationele kwaliteit bij het wederom bedienen en gebruiken van een dergelijk type product.

Mensen die een algemene neiging tot klagen hebben, hebben meer klachten over de sensorische kwaliteit van hun elektronische producten.

De algemene conclusie van onze studies is dat gebruikerskenmerken invloed hebben op het type soft problems dat mensen ervaren, maar dat deze invloed mede afhankelijk is van producteigenschappen. Bovendien hoeft het ervaren van soft problems niet per se te leiden tot het terugbrengen van het product; wel beïnvloedt het de intentie van toekomstige aankoop in negatieve zin. Follow-up (re)acties na ondervonden problemen zijn wel waarschijnlijker: mensen zullen meer ontrouw zijn aan het merk of rechtstreeks verhaal halen via de helpdesk of de winkel.

Toepassing

De bevindingen uit het onderzoek dienen te worden vertaald in een ontwerptaal zodat ze toegankelijk zijn voor de ontwerppraktijk. Onder de vele manieren worden in de thesis twee methoden voorgesteld: (1) een interactieve tool en (2) een workshopbenadering. Een eerste aanzet voor een dergelijke tool wordt gegeven. Deze moet informatie op basis van

een uitgebreide database over de interactie tussen gebruiker, product en gebruiksproblemen op een snelle en eenvoudige manier overdragen. Dergelijke informatie is vooral nuttig tijdens desktop studies aan het begin van een productontwikkelingsproces.

Als tweede methode is een workshop ontwikkeld en getest. Een workshop is een goede manier om zowel een diep begrip te delen als een hands-on ervaring betreffende de interactie tussen gebruiker, product en context. Het zal stakeholders in het productontwikkelingsproces bewust maken van het belang om soft problems te vermijden en ook om een diepgaand inzicht in de beoogde gebruikers en producten die worden ontwikkeld te bieden. De methode werd gevalideerd door middel van twee workshops, een tijdens een Design for Usability symposium en de tweede bij Océ in Nederland, een wereldleider op het gebied van digitaal documentmanagement en delivery technologie.

Beide methoden zullen informatie opleveren die veel verder gaat dan de reguliere user trials die aan het einde van een van productontwikkelingsproces worden uitgevoerd.

Conclusies

Een van de opmerkelijke bevindingen in het onderzoek is dat soft problems niet alleen afhankelijk zijn van producteigenschappen, maar ook van gebruikerskenmerken. Soft problems zijn in feite het resultaat van de interactie tussen gebruikerskenmerken en producteigenschappen. Een productontwikkelingsteam kan al aan het begin van het project identificeren welke soft problems zich waarschijnlijk in het gebruik zullen voordoen. Bijvoorbeeld, zoals we in ons onderzoek verschillen tussen landen vonden - een cultureel aspect -, dit zou genoeg reden voor een bedrijf moeten zijn om aan te nemen dat het belangrijk is deze variabele meer serieus te nemen door het bestuderen van hun buitenlandse doelgroepen. De bevindingen in het project zijn vooral nuttig in het geval van het ontwikkelen van een nieuw product, vanwege het gebrek aan informatie over een dergelijk nieuw product. Verwachte soft problems kunnen op voorhand worden geïdentificeerd door het definiëren van het product in termen van producteigenschappen.

Onze studie geeft een overzicht van hoe gebruikerskenmerken en producteigenschappen bij productgebruik interacteren. Wanneer deze aspecten in aanmerking worden genomen in het product ontwikkelingsproces, kan de ernst van mogelijke problemen worden geïdentificeerd Het resultaat in de vorm van een nieuw ontworpen product zal de tevredenheid van de consument in productgebruik verhogen.

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About the author

Chajoong Kim (1973) was born in Jinju, South Korea and completed a bachelor degree in Mechanical Engineering from Chung-Ang University (South Korea). After his graduation in 1997, he worked as mechanical engineer at JASSTECH Corporation. He was mainly involved in developing theatre mechanical systems and services, and redesigning the product development process in the company.

While six years working in the company, he became interested in the interaction between human and product. This brought him to Delft in 2003 and he obtained a master' s degree in Industrial Design Engineering from Delft University of Technology, where he specialized in Design for Interaction. His graduation project focused on the influence of culture in human-product interaction. In this project, he created a Do-It-Yourself tool, with which designers can get a better understanding of user' s preference in user interface design.

In 2006 after his graduation, he started as a PhD candidate on the cultural influence in interface design as a follow-up study of his master graduation research. In 2007 his research became a part of the Design for Usability project, funded by the Netherlands Ministry of Economic Affair. In the project, his research was expanded to diverse user characteristics encompassing personality, human cognition, and culture. He studied how user characteristics and product properties affect use problems with consumer electronic products. He organized and participated in workshops to assist design professionals create successful and satisfactory electronic products for a target user group. In 2009 he spent four months as a research fellow at School of Design, Arizona State University.

Apart from the project, he also supervised many master graduation projects and collaborated on many design projects with companies such as Philips, Bang & Olufsen, KPN, Alcatel-Lucent, SKF, and Canon.