

USABILITY PROBLEMS: THE INFLUENCE OF USER DIVERSITY

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ABSTRACT

In spite of the enormous progress over the last decades in technology and design consumer dissatisfaction is increasingly mainly caused by *soft* usability problems people experience. The mismatch between expectations and real use is influenced on the one hand by product characteristics and on the other hand by user characteristics. Therefore, this study focuses on how user diversity is related to the occurrence of soft usability problems in terms of user characteristics. To investigate how user characteristics interact with soft usability problems in actual product use an experiment was conducted with 23 American, 33 South Korean and 22 Dutch people. The study concludes that participants' background including culture influences the kind of soft usability problems and they differ per product. On the basis of these data user profiles are formulated which in relation with electronic consumer products provide design guidelines to a design team.

Keywords: usability, user characteristics, culture

INTRODUCTION

The consumer electronic market is in a rapid evolution phase and the manufacturers are under tremendous competitive pressure to be first-to-market. This competition does not always end up with consumer satisfaction due to the fact that consumers' expectations on product quality and usability deviate from their experiences with those products, and users differ in terms of preferred product properties. Unfortunately, faster time-to-market makes it even worse by hindering manufacturers from taking those aspects of users

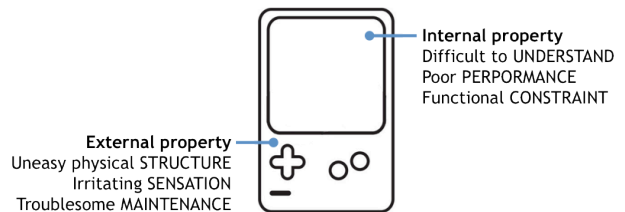


Figure 1. Soft usability problems of consumer electronics

into account in the product development process. In addition to that, concept and form of consumer electronic products have been changed thanks to advances in science and technology. For instance, the Walkman popular in 1980's has been replaced by a digital audio player, which is much more compact and has more functions. However, this advancement doesn't necessarily ends up with positive user experience. According to recent studies (Kim & Christiaans, 2009; Koca et al., 2009; Thiruvendakam et al., 2008; Söderholm, 2007; den Ouden et al., 2006), consumer dissatisfaction is increasingly caused by soft usability problems people experience. As opposed to hardware-related problems soft problems have almost nothing to do with technical failure. In an earlier study usability problems users had met with electronic consumer products were identified and categorized into six categories: product understanding, performance, sensation, structure, maintenance, and constraint (see for an extensive explanation Kim et al., 2007). Some of these categories can be related to external and other to internal properties of a product as an example shows in Figure 1. The question is: Are these problems caused by the products and their characteristics or can we blame people for their inexperience or clumsiness? To begin with, as our earlier studies showed are soft usability problems mainly influenced by product characteristics such as functional complexity and lack of structural elements. However, the kind of problems is partly

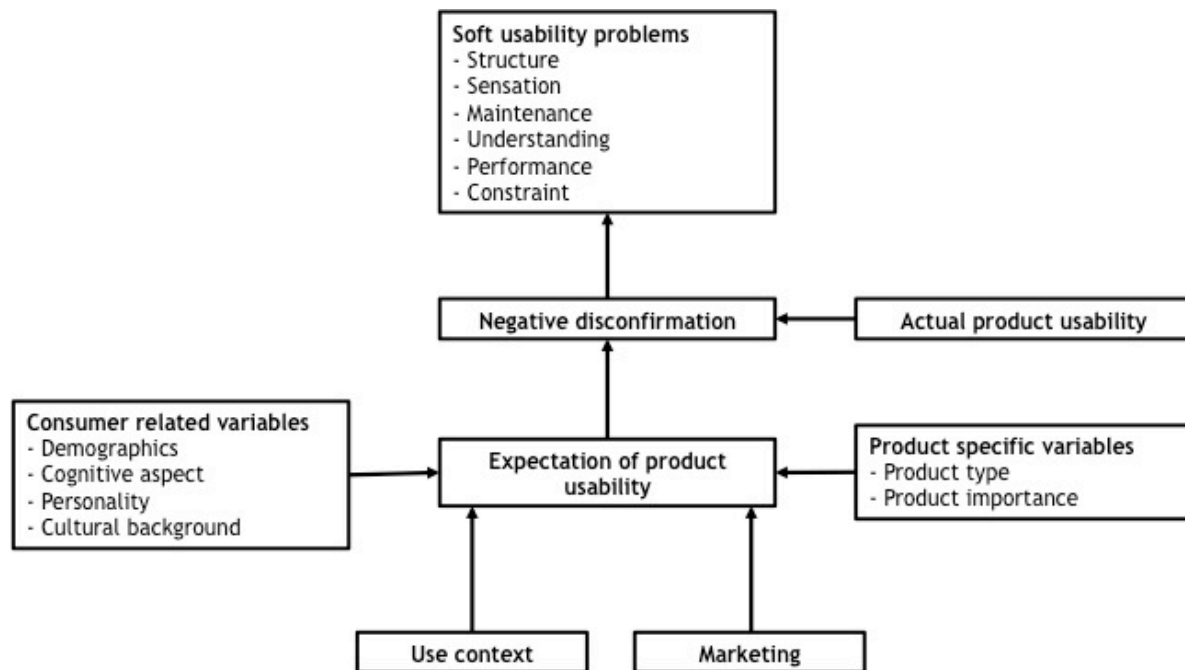


Figure 2. Conceptual Framework of the study (based on Donoghue & De Klerk, 2006)

dependent on user characteristics such as age and culture (Kim & Christiaans, 2009; Law et al., 2009; Donoghue & De Klerk, 2006). Secondly, studies show that this rather new phenomenon particularly on the individual user level results partly from the discrepancy between user expectations and product capabilities (Koca et al., 2009).

However, these studies are still not sufficient to explain the interaction between user characteristics, product features and usability problems. In order to get a complete overview of all aspects involved in this interaction a conceptual framework was developed (Kim & Christiaans, 2009), as is presented in Figure 2. In our previous study the focus was on how 'consumer related variables' are related to specific soft usability problems. Respondents in the survey were asked to choose any household electronic products with which they felt most annoyed. As a result, product characteristics were only indirectly considered in the study by way of problems people have with products. In order to study product characteristics in a more direct way in relation to consumer related variables including consumers' expectations an experiment was set up. In this experiment the actual product operation was a starting point for studying the influence of product characteristics and consumer related variables. Two products were selected that induced some serious soft usability problems.

Hence, this study aims at investigating how soft usability problems are related to product specific variables such as product type, consumer related variables such as demographic factors, personality, cognitive aspects and culture, and expectation. With knowledge on this interaction, a product development team can already at the beginning of the project identify probable soft usability problems in terms of product characteristics and target group characteristics. When a product is designed taking these aspects into consideration, it will end up with an increase of consumer satisfaction.

METHOD

The experiment has been carried out in three countries, USA, South Korea and the Netherlands. The choice for these three countries was that they are very different in culture. If any difference in our study would be found, there is reason to believe for a company that they have to take this culture variable more serious by studying their foreign target groups. In order to find out the relationships between user characteristics and soft usability problems, this study looks into differences between young and old users, male and female users, and culture. These user characteristics were measured by a questionnaire. Then, the focus was on how different each individual is with regard to actual product use and soft usability problems. This was

Demographic factors	Frequency			Total	Percentage
	American	South 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	0	9	10.7
60+	3	4	0	7	8.3
Gender					
Male	10	20	13	43	51.2
Female	13	13	15	41	48.8
Highest education level completed					
Middle school grad	0	0	4	4	4.8
High school grad	4	12	3	19	22.6
University grad	11	12	8	31	36.9
Postgraduate	8	9	13	30	35.7
Annual 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	

Table 1. Demographic characteristics of the participants (N = 84)

done through an experiment in which a participant individually had to operate two electronic consumer products. Before, during and after this product use questionnaires and a debriefing interview were taken.

SAMPLE

This experiment was carried out with 23 Americans, 33 South Koreans and 28 Dutch people, who lived in their home country at the moment they participated in the experiment. They were recruited through an ad. Their age ranged from 20 to 60. Considering the percentage distribution in demographic variables, the samples seem to be representative of the population. Detailed demographic characteristics of the participants are shown in Table 1.

INSTRUMENTS

To measure user characteristics such as demographics, personality, cognitive aspects, and consumer complaining behavior, a questionnaire was developed. To induce soft usability problems while looking into actual product use, a radio alarm clock as a representative of simple and less emotionally intimate electronic products and an mp3 player as a representative of complex and more emotionally intimate electronic products were selected (Figure. 3). Both electronic products were reported to have



Figure 3. Radio alarm clock and MP3 player

many consumer complaints related to soft usability problems.

PROCEDURE

The American and South Korean participants were invited where they felt convenient such as their homes, public places such as cafeterias or library meeting rooms. The Dutch participants were invited to the Product Evaluation Laboratory in the Delft University of Technology where the researchers worked. First, the aim of the experiment was introduced to them by one of the researchers. This was followed by filling out the first part of the questionnaire. Next, they were asked what expectations they had about the radio alarm clock before using it. Then they were asked to do several tasks with the radio alarm clock, which aimed at letting them experience it and to observe their use behaviors. After this, they filled out the last part of the questionnaire. Next, the MP3 player followed.

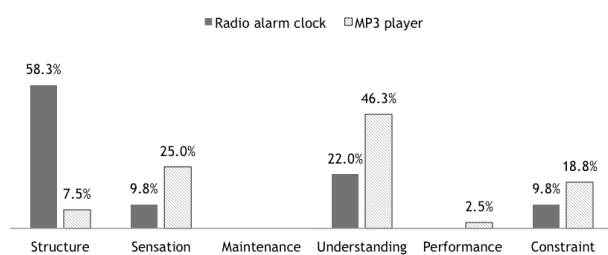


Figure 4. Percentage of soft usability problems between radio alarm clock and MP3 player

First, expectations were asked and after several tasks for the MP3 player were given to them like what they did with the radio alarm clock. This was finally followed by a retrospective interview to find out their overall experience, complaints, problem severity, and purchase intention. All the sessions were videotaped for analysis afterwards.

RESULTS

The complaints reported by the participants were translated into one of six categories of soft usability problems, defined as product understanding, performance, sensation, structure, maintenance, and constraint. The user characteristics and their expectations were coded in a datasheet for statistical analysis. The percentage of soft usability problems in the radio alarm clock and the MP3 player is shown in Figure 4. With the radio alarm clock the participants mostly complained about Structure followed by problems with Understanding. In the experiment with the MP3 player, problems related with Understanding were most reported followed by Sensation and Constraint. There were no complaints about Maintenance of the two products and Performance of the radio alarm clock. A possible explanation on this result is that the experiment was too short to experience any problems related to Maintenance and no one will complain about performance of the radio alarm clock as long as it works. The analysis consists of four parts: the relationship between soft usability problems and product type, between soft usability problems and user characteristics including cultural background, between soft usability problems and user expectation, and finally the influence of soft usability problems to user behavior.

SOFT USABILITY PROBLEMS AND PRODUCT TYPE

The radio alarm clock and the mp3 player, which are different from each other in terms of functional complexity and emotional intimacy, were chosen to see how soft usability problems are related to product type. Statistically there are significant differences in problems with Structure ($\chi^2(1)=4.846$, $p=.028$) and Understanding ($\chi^2(1)=7.379$, $p=.014$) between the two products (Figure 4). This means that whereas problems related to Structure are dominant in the radio alarm clock, which represents simple and less intimate products, those related to Understanding are dominant in the MP3 player, which represents complex and intimate products. Although there are differences in complaints about Sensation and Constraint between the two products (more for MP3 player), their differences are not statistically significant.

SOFT USABILITY PROBLEMS AND USER CHARACTERISTICS

To see what user characteristics are related to the occurrence of each soft usability problem and in which way they interact the perceived product characteristics based on soft usability problem categories are described in Table 2. Only a few user characteristics prove to have statistical significance with specific soft usability problems. This might be because the percentage of complainers and non-complainers about a specific soft usability problem is not evenly distributed. For instance, there are almost 50% complainers and 50% non-complainers about Structure in the radio alarm clock while there are about 10% complainers and about 90% non-complainers about Constraint in the product. Considering this unbalance of the complainers, it is more logical not to limit the correlation between soft usability problems and user characteristics within statistical significance but to expand variables showing some correlation. The relationships are presented in the form of 'profiles' based on each soft usability problem category.

Radio alarm clock

Structure: participants who complain about Structure belong to the older generation, having higher household income while not having any

Soft usability problems	Perceived product characteristics	User characteristics
Radio alarm clock		
Structure	<ul style="list-style-type: none"> • Hard to press buttons because of the size and the location • Tricky to put batteries in • Hard to read time because of it rotates as the position of the clock • It looks a round toy 	Age ($t(82)=-1.810, p=.074$)* Gender ($\chi^2(1)=.168, p=.682$) Educational background ($t(82)=-.319, p=.751$) Household income ($t(82)=-1.394, p=.167$)* Uncertainty avoidance ($t(82)=-1.947, p=.055$)* MP3 player Understanding ($\chi^2(1)=4.252, p=.039$)** Culture: KR>NL>US ($\chi^2(2)=14.423, p=.001$ ***)
Sensation	<ul style="list-style-type: none"> • The feeling to press buttons is not pleasant • Some other bothering noise or sounds • Too tiny letters next to buttons 	Age ($t(82)=.191, p=.849$) Gender ($\chi^2(1)=1.407, p=.236$) Educational background ($t(82)=1.389, p=.169$)* Household income ($t(82)=-.161, p=.872$) Perfectionism ($t(82)=-2.185, p=.032$)** MP3 player Purchase intention ($t(82)=2.634, p=.020$)** Radio alarm clock frequency of use ($t(82)=.546, p=.000$ ***)
Maintenance Understanding	--- <ul style="list-style-type: none"> • Extreme multi-functional • Hard and confusing to set between time and alarm • Revolving system is not clear 	--- Age ($t(82)=1.399, p=.166$)* Gender ($\chi^2(1)=.000, p=1.000$) Educational background ($t(82)=-.707, p=.482$) Household income ($t(82)=1.455, p=.149$)* Uncertainty avoidance ($t(82)=1.951, p=.054$)* Locus of control ($t(82)=2.496, p=.015$)** Complaining behavior ($t(82)=2.320, p=.023$)** MP3 player Understanding ($\chi^2(1)=5.996, p=.014$)** Culture: US>NL>KR ($\chi^2(2)=14.035, p=.001$ ***)
Performance Constraint	- <ul style="list-style-type: none"> • I don't like the change of directions of alarm sounds • Pressing the button two times to set the time • Unfriendly manual 	- Age ($t(82)=.737, p=.463$) Gender ($\chi^2(1)=.000, p=1.000$) Educational background ($t(82)=.538, p=.178$)* Household income ($t(82)=1.204, p=.232$) Buy confidence ($t(82)=2.260, p=.026$)** Radio alarm clock frequency of use ($t(82)=-3.806, p=.000$ ***)
MP3 player		
Structure	<ul style="list-style-type: none"> • Hard to press button 	Age ($t(82)=1.505, p=.136$)* Gender ($\chi^2(1)=.000, p=1.000$) Educational background ($t(82)=.575, p=.564$) Household income ($t(82)=.636, p=.527$) Radio alarm clock purchase intention ($t(82)=3.130, p=.011$)** Radio alarm clock frequency of use ($t(82)=-3.797, p=.000$ ***)
Sensation	<ul style="list-style-type: none"> • The buttons are invisible because it is all black. • It's not clear where you have to push. • Letters are too tiny 	Age ($t(82)=-4.419, p=.000$ ***) Gender ($\chi^2(1)=.418, p=.518$) Educational background ($t(82)=.494, p=.622$) Household income ($t(82)=-1.464, p=.147$)* Buy decision ($t(82)=-2.921, p=.005$ ***) Uncertainty avoidance ($t(82)=-2.204, p=.030$)** Radio alarm clock price ($t(82)=-2.080, p=.041$)** Radio alarm clock success rate ($t(82)=2.117, p=.037$)** Culture: KR>NL>US ($\chi^2(2)=8.471, p=.014$ **)
Maintenance Understanding	--- <ul style="list-style-type: none"> • Hard to find a song • Hard to learn how to use buttons • Hard to find functions 	--- Age ($t(82)=1.564, p=.122$)* Gender ($\chi^2(1)=1.151, p=.283$) Educational background ($t(82)=.079, p=.937$) Household income ($t(82)=-.442, p=.660$) Radio alarm clock Understanding ($\chi^2(1)=5.996, p=.014$)** Radio alarm clock Structure ($\chi^2(1)=4.252, p=.039$)** Culture: US>NL>KR ($\chi^2(2)=14.056, p=.001$ ***)
Performance Constraint	<ul style="list-style-type: none"> • Slow reaction • Unfriendly use manual • No game • Too small screen • Not enough feedback 	--- Age ($t(82)=1.541, p=.127$)* Gender ($\chi^2(1)=.219, p=.640$) Educational background ($t(82)=-.149, p=.882$) Household income ($t(82)=1.611, p=.111$)* Uncertainty avoidance ($t(82)=1.982, p=.051$)* Patience ($t(82)=-3.378, p=.002$ ***) Expose to ads ($t(82)=-3.157, p=.002$ ***) Familiarity ($t(82)=-2.199, p=.036$)** Radio alarm clock success rate ($t(82)=-2.075, p=.041$)**

Between brackets: t-value of t-test, continuity correction value of chi-square and the significant values with the problem category
 *Variables considered as related to soft usability problems. **p < .05. ***p < .01.

Table 2. Soft usability problems and related user characteristics in radio alarm clock and MP3 player

Understanding problems with the MP3 player. The occurrence of this kind of soft usability problem has little to do with gender and educational background.

Sensation: participants who complain about Sensation are in general lower educated people, seeking for perfectionism, being more frequent users of a radio alarm clock, and having no intention of purchasing the MP3 player. The occurrence of this soft usability problem has little to do with age, gender, household income, and uncertainty avoidance.

Understanding: participants who complained about Understanding are characterized by belong to the younger generation, having lower household income, stronger internal locus of control, passive complaining behavior, and having the same problem with the MP3 player. However, the occurrence of this soft usability problem is not related to gender and educational background.

Constraint: the participants who had problems on Constraint are lower-educated people, more trusting others' opinion when buying products, having less openness, and being more frequent users of a radio alarm clock. Differences in age, gender, household income, or uncertainty avoidance do not influence the occurrence of the soft usability problem.

MP3 player

Structure: participants who complained about Structure belong more to the younger generation, having less intention of purchasing the radio alarm clock, being more frequent user of radio alarm clock, and evaluating the radio alarm clock cheaper than the others. The occurrence of this complaint has little to do with gender, educational background, household income, and uncertainty avoidance.

Sensation: participants who complain about Sensation belong more to the older generation, having higher household income and uncertainty avoidance, deciding to buy products together with family, evaluating the radio alarm clock more expensive than the others, and having no Structure problem with the radio alarm clock

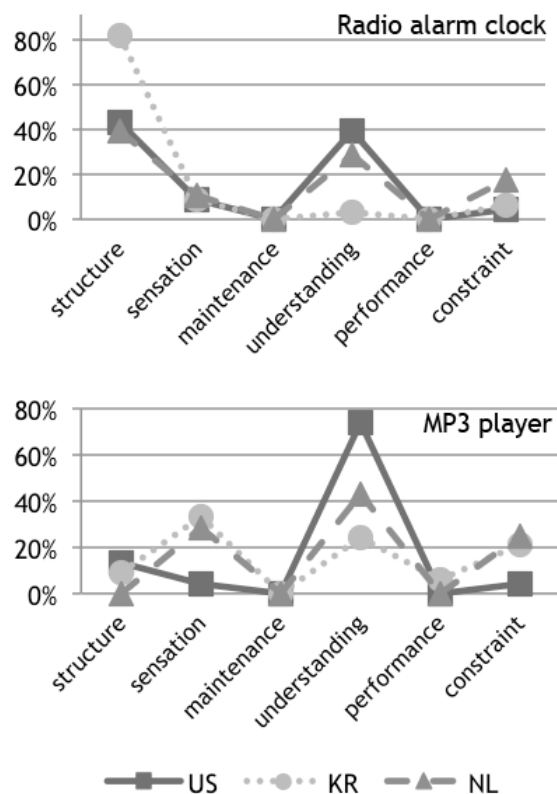


Figure 5. Percentage of soft usability problems of the two products among the United States, South Korea, and the Netherlands

Understanding: participants who complain about Understanding belong more to the younger generation, having more Understanding problems but having less Structure problem with the radio alarm clock. Differences in gender, educational background, household income, and uncertainty avoidance do not show the relationship with the occurrence of the soft usability problem.

Performance: there is no user-related variable that correlates with the occurrence of this soft usability problem although there are some complaints related to this problem.

Constraint: participants who complain about Constraint belong more to the younger generation, having less household income and lower uncertainty avoidance, being more patient, more exposed to ads, and more familiar with electronics, and having higher success rate in given tasks with the radio alarm clock. The occurrence of this soft usability problem has little to do with gender and educational background.

Chi square analysis indicates whether there are significant differences in soft usability problems

Expectation category	Radio Alarm Clock Expectation	MP3 Player Expectation
Structure	<ul style="list-style-type: none"> • One with the large display • One with big buttons • Small size one 	<ul style="list-style-type: none"> • Small and thin one • Not too small one and buttons • Easily portable one • One with a built-in speaker
Sensation	<ul style="list-style-type: none"> • Good design • Soft or natural sound (music) for alarm • One with big numbers • Loud enough sound for alarm • One giving a gentle touch feeling 	<ul style="list-style-type: none"> • Readable letter size on the display • Light weight • Good design • Good and clear sound reproduction • Touch based manipulation
Maintenance	<ul style="list-style-type: none"> • Durable and not fragile one 	<ul style="list-style-type: none"> • Durable one
Understanding	<ul style="list-style-type: none"> • A similar one like what I've used • Easily programmable • Not too complicated one • Not many functions 	<ul style="list-style-type: none"> • Simple and basic functions • Easily understood buttons • Easy operation and navigation • Easy to move music from pc • Consistent interface between pc and the device • Same functions as iPod
Performance	<ul style="list-style-type: none"> • Waking up well on time • Keeping accurate time 	<ul style="list-style-type: none"> • Working well • Playing music well
Constraint	<ul style="list-style-type: none"> • Not only battery but also power on the wall • Multiple functions such as multi alarms, radio, and music player • Attachable to the wall • Adjustable volume of alarm sound • Vibration function as an alarm • One with wake-up light or backlight function 	<ul style="list-style-type: none"> • Compatible format supported one • Long battery life • Compatibility between home and car • Large memory space • Multiple functions such as radio, rating, watching movies and subtitle

Table 3. User expectations of radio alarm clock and MP3 player

between the three countries. The results show that in the operation of the radio alarm clock there are significant differences in both Structure and Understanding between the countries (Figure 5). Korean participants are most frequent complainers about problems related to Structure. American participants are the second, followed by Dutch participants. In the experiment with the MP3 player, statistically significant differences were found in both Sensation and Understanding (Figure 5). Complaints related to Sensation are mostly reported by South Korean participants. Dutch participants are second and Americans complain the least on this aspect. Regarding problems related to Understanding in both products, American participants are the most frequent complainers and Korean participants are the second. Dutch participants hardly experience problems with Understanding.

SOFT USABILITY PROBLEMS AND USER EXPECTATION

To measure user characteristics such as Users' expectations were translated into the categories of soft usability problems in order to see how expectations are related to these problems as Table 3 shows the expectations are all related to one of the problem categories. For instance, the

expectation, 'not many functions' of radio alarm clock was categorized as an expectation related to Understanding. 'Light weight' in MP3 player was categorized as an expectation related to Sensation. Comparing participants' expectations with their soft usability problems (Table 2), expectations are formulated in a relatively quite general way while their complaints are very specific. For instance, some participants said they expected 'easy to use' but their complaint was 'confusing between setting the time and setting an alarm'. There are some differences in expectations between the radio alarm clock and the MP3 player, and also the expectations differ between the three nationalities in terms of expectation categories (Figure 6). For example, with the radio alarm clock expectations related to Sensation are dominant while in the MP3 player this was the case with expectations related to Constraint and Understanding. In the radio alarm clock most of the expectations from Korean participants are about Sensation while the major expectation of Dutch participant is about Performance. Interestingly, soft usability problems the participants reported in the experiment are also not always linked to their expectations.

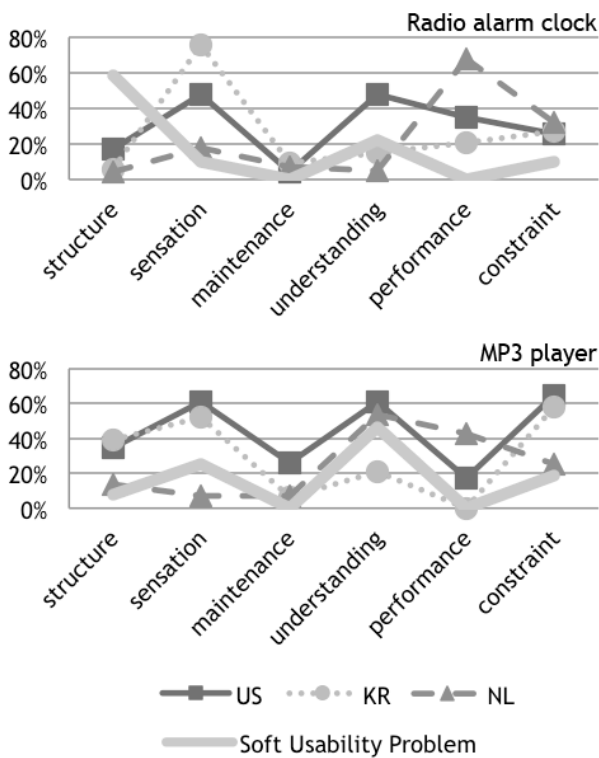


Figure 6. User expectations of two products among three countries

THE INFLUENCE OF SOFT USABILITY PROBLEMS TO USER BEHAVIOR

In the previous studies, it proved that people are very irritated by soft usability problems. But it was questionable whether experiencing soft usability problems ends up with product return and if not how the complaints influence the purchase intention of the product. To answer these questions, two questions were asked to the participants in the retrospective interview: whether they want to return the product because of the soft usability problems they met, and whether they would like to buy this sort of product in spite of the soft usability problems. The results indicate that the experience of soft usability problems did not necessarily lead to the return of the two electronics but more than half of the participants would not buy the products if they bought a radio alarm clock and an MP3 player (Table 4).

User behavior	Radio alarm clock	MP3 player
Product return	38.1%	46.4%
Negative purchase intention	69%	70.2%

Table 4. Percentage of user behaviors between radio alarm clock and MP3 player

CONCLUSIONS AND DISCUSSION

The contribution of the study lies foremost in the emphasis on the importance of considering user diversity related to the occurrence of soft usability problems. The aim of this study was to find out any relationship between soft usability problems, product characteristics, expectation, and the personal background of the participants. The study concludes that the kind of soft usability problems differs per product type according to the extent to which it is functionally complex and emotionally intimate. Second, the kind of problems people experience has to do with their backgrounds. Especially the experience of specific soft usability problems is much related to cultural background. Third, user expectations in using electronics vary between cultures. Although problems occur when there is a discrepancy between expectation before actual use and actual experience of users, soft usability problems are not necessarily related to the expectations they had before experiencing the products. Another interesting finding is that soft usability problems do not always end up with product return although it negatively influences the intent of future purchase.

Although these relationships were identified, all the six categories of soft usability problems were not taken into account in the study. This is because few participants experienced problems related to Maintenance and Performance of the two products. Probably this implies that soft usability problems such as Maintenance and Performance can be hardly experienced in a short-term interaction between user and product. There is an interesting correlation between Understanding among soft usability problems and Age among user characteristics. The correlation concludes that problems related to Understanding are more frequent among younger people rather than among older people in both the radio alarm clock and the MP3 player. This is contradictory to the well-known common sense that elderly people have more difficulty in using functionally complex electronics than young people. A possible explanation of this result is that elderly people seem to already recognize and admit that consumer electronics are complex to use, and thus to focus on other aspects such as Sensation and Structure rather than Understanding. This might

imply that easiness to use would be a critical factor but other factors should be seriously taken into consideration in the product development process when designing electronics for elderly people. To effectively reduce the number of soft usability problems and increase user satisfaction, companies have to obtain a proactive approach before putting their product in the market. This could be done with user profiles according to product characteristics, which intend to provide design guidelines to a design team. By referring to these guidelines, they can identify probable usability problems by estimating the product type that they are developing in terms of complexity and intimacy. Furthermore, they can gain a better understanding of those who are expected to have probable usability problems. However, the current study is not enough to hold a complete picture of the interactions between soft usability problems, product characteristics, expectations and user characteristics. More study is on the way to come up with robust and reliable user profiles.

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