UNIVERSITI PUTRA MALAYSIA

DEVELOPMENT OF A FAMILY PRODUCT USABILITY MODEL FOR OLDER MALAYSIANS

HASSAN ZAREEI

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DEVELOPMENT OF A FAMILY PRODUCT USABILITY MODEL FOR OLDER MALAYSIANS

By

HASSAN ZAREEI

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Doctor of Philosophy

February 2015

DEDICATION

To

My wife, *Fereshteh*, with *love*,

And

My brother-in-law, *Haji Hassan Ameli*, for his endless encouragement

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Doctor of Philosophy

DEVELOPMENT OF A FAMILY PRODUCT USABILITY

MODEL FOR OLDER MALAYSIANS

By

HASSAN ZAREEI

February 2015

Chairman : Professor Rosnah bt. Mohd Yusuff, PhD
Faculty : Engineering

Products, systems, and environments should be designed based on the needs and capabilities of the elderly. Various usability models including intelligence usability model, individual and integrated usability model, and multi-level hierarchical model are currently available but none provide an integrated evaluation and fail to assess usability in various products at the same time. Since the elderly are more engaged with their daily living activities, the usability of the family products of the daily living should be considered. The aim of this study was to develop an integrated usability model to measure and rank common family of products based on the level of usability. This model can assist the elderly to identify user friendly products and provide a guideline for the producers to design and improve their products based on the needs of the elderly.

Seven Focus Group Discussions (FGD) were conducted to identify the characteristics affecting the usability of each related family of products based on Instrumental/ Enhanced Activities of Daily Living (I/EADL). The FGD sessions revealed seven I/EADL categories as well as six essential family of products. A total of 126 characteristics affecting the usability of I/EADL family products were generated based on the FGDs, market survey, and literature review of the current family of products. A questionnaire was then designed based on these usability characteristics. A total of 303 interviews were conducted among the elderly in the state of Selangor based on stratified random sampling from three main ethnic groups in Malaysia.

The interviews revealed that the most frequently used I/EADL family of products were Television (TV) (95%), TV Remote (TVR) (91.7%), Rice Cooker (RC) (82.3%), Mobile Phone (MP), and Washing Machine (WM) (72.6%) while Online Transactions (97.4%), Internet/E-mail (89.4%) and ATM (71.3%) posed handling problems to the elderly. Safety features and durability were found to be the most crucial criteria of all family of products except for ATM, WM, and TVs. Ease of learning criterion was highly ranked for ATM and TV, while 'Easy of cleaning parts' was found to be the most important criterion for WM.

Factor analysis was carried out to identify the number of latent factors for all the products. The relative weights for the extracted factors were then evaluated by six experts using Group-AHP technique. 'Progressive feedback and alert' for ATM, 'adjustability to user needs and abilities' for MP, 'ease of operation' for HT, WM, EI, VC, and TV, 'ease of use' for CO and TVR, and 'durability and safety features' for RC was weighted most.

A total of 60 products representing 10 family of products were assessed by five respondents. The usability index for each member of the family of product was then obtained by Group-AHP/TOPSIS which was used to select the best product within each family based on the usability index. Whirlpool WM and Side-Cutter CO had the highest usability index. None of the four common designs of HT complied with the usability factors indicating that the design of current HT family is unsuitable for the elderly for communication. The design of products should be based on the identified weighted factors to provide more usable products for the elderly.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

PEMBANGUNAN MODEL KEBOLEHGUNAAN PRODUK

KELUARGA BAGI WARGA TUA MALAYSIA

Oleh

HASSAN ZAREEI

Februari 2015

Pengerusi : Professor Rosnah bt. Mohd Yusuff, PhD
Fakulti : Kejuruteraan

Produk/sistem dan persekitaran perlu direka berdasarkan keperluan dan keupayaan orang tua. Pelbagai model kebolehgunaan termasuk model kebolehgunaan perisikan, model kebolehgunaan individu dan bersepadu, dan model hierarki pelbagai peringkat kini boleh didapati tetapi tidak memberikan penilaian bersepadu dan gagal untuk menilai kebolehgunaan pelbagai produk dalam satu masa yang sama. Memandangkan warga tua lebih terlibat dengan aktiviti-aktiviti harian mereka, kebolehgunaan produk keluarga untuk kehidupan seharian perlu dipertimbangkan. Tujuan kajian ini adalah untuk menghasilkan model kebolehgunaan bersepadu untuk mengukur dan mengenalpasti tahap produk keluarga yang biasa berdasarkan tahap kebolehgunaannya. Model ini boleh membantu warga tua untuk mengealpasti produkyang mesra pengguna dan menyediakan garis panduan bagi pengeluar untuk merekabentuk dan meningkatkan produk mereka berdasarkan keperluan warga tua.

Tujuh Perbincangan Kumpulan Berfokus (FGD) telah dijalankan untuk mengenal pasti ciri-ciri yang mempengaruhi kebolehgunaan setiap keluarga berkaitan dengan produk yang berasaskan Instrumental/dipertingkatkan aktiviti kehidupan harian (I/EADL).Sesi-sesi FGD mendedahkan tujuh kumpulan I/EADL serta enam keperluan produk keluarga. Seramai 126 ciri-ciri yang mempengaruhi kebolehgunaan produk keluarga I/EADL telah dijana berdasarkan FGD, tinjauan pasaran dan ulasan karya produk keluarga terkini. Selepas itu, satu soal selidik telah direka berdasarkan ciri-ciri kebolehgunaan itu. Seramai 303 temubual telah dijalankan di kalangan warga tua di negeri Selangor berdasarkan persampelan rawak berstrata dari tiga kumpulan etnik utama di Malaysia.

Hasil temuramah mendapati bahawa produk I/EADL yang paling kerap digunakan adalah televisyen (TV) (95%), alat kawalan jauh TV (TVR) (91.7%), periuk nasi elektrik (RC) (82.3%), telefon bimbit (MP) and mesin basuh (WM) (72.6%), manakala, transaksi atas talian (97.4%), internet/e-mel (89.4%) dan ATM (71.3%) menimbulkan masalah untuk dikendalikan oleh warga tua. Ciri-ciri keselamatan dan ketahanan adalah kriteria yang paling penting dalam semua produk kecuali ATM, WM dan TV. Kriteria kemudahan pembelajaran adalah ciri penting untuk ATM dan TV, manakala

kemudahan mencuci bahagian-bahagian pula didapati menjadi krteria paling penting untuk WM.

Analisis faktor telah dijalankan untuk mengenalpasti bilangan faktor terpendam untuk semua produk. Faktor yang telah diekstrak yang dititik berat secara relatif telah dinilai oleh enam pakar. Maklum balas progresif dan amaran bagi ATM, kemampuan untuk malaras kepada keperluan dan kebolehan pengguna untuk MP, kemudahan operasi untuk HT,WM, EI, VC dan TV, kemudahan penggunaan untuk pembuka tin (CO) dan TVR, dan ketahanan dan ciri-ciri keselamatan untuk RC adalah paling dititik berat kan.

Sejumlah 60 produk yang mewakili 10 keluarga produk telah dinilai oleh lima responden. Indeks kebolehgunaan untuk setiap ahli keluarga produk telah diperolehi dengan AHP-TOPSIS yang digunakan untuk memilih produk terbaik dalam setiap ahli keluarga berdasarkan indeks kebolehgunaan. Whirlpool WM dan Side-Cutter CO mempunyai indeks kebolehgunaan yang tertinggi. Tiada satu pun daripada empat reka bentuk biasa HT mematuhi faktor-faktor kebolehgunaan yang menunjukkan bahawa reka bentuk keluarga HT semasa tidak. Sesuai untuk warga tua untuk komunikof. Reka bentuk produk hendaklah berdasarkan kepada faktor-faktor terpilih untuk menyediakan lebih banyak produk yang dapat digunakan oleh warga tua.

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I certify that a Thesis Examination Committee has met on 26 February 2015 to conduct the final examination of Hassan Zareei on his thesis entitled "Development of a Family Product Usability Model for Older Malaysians" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Doctor of Philosophy.

Members of the Thesis Examination Committee were as follows:

Zulkiflle bin Leman, PhD
Associate Professor
Faculty of Engineering
Universiti Putra Malaysia
(Chairman)

Norzima binti Zulkifli, PhD
Associate Professor
Faculty of Engineering
Universiti Putra Malaysia
(Internal Examiner)

Tengku Aizan binti Tengku Ab Hamid, PhD
Professor
Institute of Gerontology
Universiti Putra Malaysia
(Internal Examiner)

Sara J. Czaja, PhD
Professor
Mental Health Hospital Center
United States
(External Examiner)

ZULKARNAIN ZAINAL, PhD
Professor and Deputy Dean
School of Graduate Studies
Universiti Putra Malaysia

Date: 13 May 2015

This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Doctor of Philosophy. The members of the Supervisory Committee were as follows:

Rosnah Bt. Mohd Yusuff, PhD
Professor
Faculty of Engineering
Universiti Putra Malaysia
(Chairman)

Mohd Sapuan bin Salit, PhD
Professor, Ir
Faculty of Engineering
Universiti Putra Malaysia
(Member)

Sharifah Norazizan Bt. Syed Abd. Rashid, PhD
Associate Professor
Institute of Gerontology
Universiti Putra Malaysia
(Member)

BUJNANG BIN KIM HUAT, PhD
Professor and Dean
School of Graduate Studies
Universiti Putra Malaysia

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LIST OF ABBREVIATIONS

FGD	-	Focus Group Discussion
ADL	-	Activities of Daily Living
I/EADL	-	Instrumental/Enhanced Activities of Daily Living
TV	-	Television
TVR	-	TV Remote
RC	-	Rice Cooker
MP	-	Mobile Phone
HP	-	Home Telephone
WM	-	Washing Machine
OT	-	Online Transactions
I/E	-	Internet/E-mail
ATM	-	Automated Teller Machine
EI	-	Electric Iron
VC	-	Vacuum Cleaner
CO	-	Can Opener
PAR	-	Personal Ability Rating Score
MPAR	-	Mean Personal Ability Rating Score
TAM	-	Technology Acceptance Model
HCI	-	Human-Computer Interaction
GAHP	-	Group Analytic Hierarchy Process
TOPSIS	-	Technique for Order of Preference by Similarity to Ideal Solution
DOSM	-	Department Of Statistics Malaysia
IT	-	Information Technology
IG	-	Institute of Gerotology
U3A	-	University of Third Age
FA	-	Factor Analysis
EFA	-	Exploratory Factor Analysis
PCA	-	Principal Component Analysis
DM	-	Decision Maker

CHAPTER 1

INTRODUCTION

1.1 Background of the study

The ageing population is increasing globally in both developed and developing countries (United Nations, 2012). Therefore it is estimated that a given society might reach a phase where a reasonable percentage of its population is elderly should serve the needs of elderly individuals. The elderly comprise a mixed age group. In Malaysia, the age for retirement is 55 years for civil servants. Elderly individuals in the age range of 55 to 65 years are considered as young-old adults groups. Although the older olds are found to have problems in their daily living activities, the young old adults are still productive and active in diverse areas (Wong et al., 2008). Majority of the elderly at this age range are capable of living their life independently. Senior citizens generally experience a decline of their physical, cognitive, motor and memory abilities. Apart from the constraints due to the dysfunctions related to the increased age, the elderly also face psychological stress due to their inability to perform daily tasks independently or being sent to elderly care institutions. One of these negative effects is depression, a feel of more solitude and lower motivation for self-care (Mynatt et al., 2000). As the population of the elderly increases expectations arise as well for improving their quality of life with the aim of enabling them having their functional living with minimal care from their families.

In order to manage these issues, research is being conducted worldwide on human ageing to identify the needs of the elderly to achieve a good quality of life. Adoptions of new technologies can play pivotal roles in the quality of life of the handicapped and the dysfunctional elderly who wish to further their independent daily activities (Sagawa, 2011). Environmental and product design should be conducted in such a way that allows the elderly maintain a healthy daily living. In order to achieve this goal, the issues related to hinder and diminish elderly functions must be sought and incorporated in the product design. Hence, different models and standards have been proposed for the assessment of usability (Federici & Borsci, 2010; Seffah et al., 2006; Winter et al., 2007).

In order to assess the acceptance of a product by the elderly, usability of the product should be considered. The term usability refers to "a set of multiple concepts, such as execution time, performance, user satisfaction and ease of learning, taken together" (Abran et al., 2003). According to Holzinger et al. (2008) due to the rise in diversity of the elderly population, educationally and culturally, development of a specific set of criteria is required. Moreover, they also focused on two different aspects of usability for the elderly including passive and active interactions in information technology. This is supported by Abdullah et al. (2011) which evaluated the use of an auxiliary system to aid the elderly overcome their fear and knowledge deficits in using products that were related to information and communication technology. The active product category not only requires known standards but also those usability criteria are applicable to people with special needs. For instance, various issues in relation to the interface, language criteria and level of interactions somehow discourage local senior citizens from obtaining and further exploring features of the mobile phones (Wong et

al., 2008). Senior citizens have been classified as being novice, regular and explorer in relation to the eagerness towards using new technologies (Rogers & Fisk, 2010). Although elderly with specific personality and with higher education levels are more eager in using and adopting new technologies, generally senior citizens are considered as late-comers when it comes to adoption of new technologies compared with younger generation (Rogers & Fisk, 2010; Chen & Chan, 2013). Therefore, provision of services and products which were designed based on the requirements of the elderly users with special needs will, in return, lead to more prevalent usage of products.

Majority of the aged people should be able to live independently due to the fact that their families are always away from home in the daytime. Usable family of products are capable of assisting the elderly to be self-reliant and age in place in everyday activities. In addition, technology is capable of enhancing the quality of life of the elderly as well as the handicapped. In order to implement the necessary changes to each product, in-depth research should be done in that specific area. The aim of research should focus on maintaining the independence of the elderly especially at their basic domestic activities, such as bathing and cooking. The results of these researches will lead to production of instruments that assist the elderly in their daily life and prevents them from moving to the institutional care centers where negative effects for the elderly are inherent (Helvik et al., 2011).

Nowadays, majority of businesses require the use of automated instruments such as automated telephone menus, instead of the traditional operators for answering phones, or the online search engines for majority of the libraries instead of a card catalog (Ortiz et al., 2011). Moreover, automaticity has made its way into basic living activities such as credit cards that have replaced the paying cash. Therefore it is inevitable to interact with modern technology. Thus elderly are amongst the people who are obliged to familiarize with the new technology in order to fulfill their needs as evidenced by the observed increasing trend in usage of modern technology by the elderly in developed economies. For example, the largest growth in online banking service users was observed amongst the seniors in developed economies (Rogers et al., 2004). Therefore rapid growth of the elderly population in a large number of countries has imposed a significant challenge to firms and society.

Technology has made a significant influence on the quality of life of the elderly by enhancing the daily activities including communication, transport and engagement in societal lifestyle (Abdullah et al., 2011). However, the entire elderly population may not be able to successfully adopt technology in their everyday activity due mainly to problems and barriers that hinder them from using the modern technology. Some of these obstacles include income level, geographical constraints, difficulty in the use of the new technology as well as the disabilities related to the elderly life (Roupa et al., 2010). Different models and standards have been proposed for the assessment of usability (Federici & Borsci, 2010; Seffah et al., 2006; Winter et al., 2007). One of the most powerful models in the field of usability assessment is the Technology Acceptance Model (TAM) (Lee et al., 2003). TAM, which has long been utilized in information system filed, has been adapted from the theory of Reason Action in 1986 (Davis Jr, 1986). The primary variables in this model were perceived usefulness and perceived ease of use (Davis Jr, 1986). Later, two more variables were included in the model resulting in a final four variables as follows; perceived usefulness (PU), perceived ease of use (POU), behavioral intention (BI) and behavior (B). Since PU can predict B and BI and on the other had is predicted by PEOU, it can be used as both

dependent and independent variable in the TAM. Behavior is measured based on the frequency of usage, amount of time spent using the product, number of usage and diversity of usage. TAM has been used in various fields of information systems including communication systems, general purpose systems, office systems and specialized business systems (Lee et al., 2003).The main limitation of TAM is the assessment of self-reported usage but not the actual usage (Oliveira & Martins, 2011). Other major limitation of TAM include assessment of only one homogenous group in the information system at a time (Oliveira & Martins, 2011). Overall, the problem with current usability models is that none of them provide a universal assessment of all the aspects and rules of usability. Furthermore, manufacturers do not use a guideline or specific usability model to design their products at all or in case of using a model; they are not applied properly and correctly in the designation. This condition is more prominent in Human-Computer Interaction (HCI) field (Seffah et al., 2006).

Amongst the proposed methods of assessing usability the following method has less errors and higher accuracy. In order to assess the independence of the elderly in daily life, a list of activities has been suggested regarded as Activities of daily living (ADL) (Lawton, 1990), Instrumental Activities of Daily Living (IADL), and Enhanced Activities of Daily Living (EADL) (Rogers et al., 1998). ADLs are the basic daily activities that an individual can perform without assistance including walking, bathing, dressing, toileting, brushing teeth, and eating. IADLs on the other hand, encompass main tasks which the elderly should do themselves in order to live independently. These activities include cooking, driving, using telephone or computer, shopping, keeping track of finance, and managing medication. Moreover, EADLs include participation in social and enriching activities. Evidence shows that usage of technology by the elderly will improve the quality of life by enhancing the capabilities of the elderly in communication, comfort transport as well as engagement in social life. Therefore, it will be of benefit to provide adaptable tools and appliances related to IADL and EADL, which is capable of assisting the elderly in their self-reliance. The designing and implementation process is linked to the improvement in the life expectancy of the elderly.

1.2 Problem statement

As the age of an individual increases, the cognitive and physical abilities reduce. The design of the products should be in line with the decreasing functions and physical abilities of the elderly to facilitate their everyday living actions. In addition, IADL represents the main elderly activities which are needed to independently adapt to the public and private environmental conditions. Therefore, designed products that match the needs and capabilities of the elderly will assist them in using the product with ease, comfort and efficiency while abandoning them may result in failure.

The prevalent patterns in deciding to use or forgo products or tools by the elderly are described as follows. When the elder individual uses the product and finds out that it lacks the sufficient characteristics to fulfill his or her needs even after making the suggested adjustments, the individual may either continue to use the products until it is no longer usable or forgo the product at the initial stage and decide on choosing another product. This pattern is usually repeated two or three times before selecting an acceptable product. During this process the consumer is subjected to frustration or discouragement as well as wastage of financial resources (Batavia & Hammer, 1990). Therefore, in the process of developing evaluation criteria based on the choices of the

elderly consumers, a number of important factors should be considered as a guide for designers (Arthanat et al., 2007).

Various standards and criterion exist for usability analysis for the elderly (Demirbilek & Demirkan, 2004; Iwase & MURATA, 2003; Winter et al., 2007). These standards are presented as usability models (Winter et al., 2007). These models have three major problems (Winter et al., 2007). They are not able to assess general or specific usability of a product for the elderly, do not explore the rational reasons about the properties of the product as well as mixing the abilities or disabilities of the user to the assessment of the usability (Winter et al., 2007).

As far as one can tell from literature, no assessment method has been suggested for the evaluation of usability of products for the elderly in Malaysia. Moreover the current existing assessment methods are mostly related to specific fields of technology especially computer science. Therefore there is a need for a holistic assessment of usability which encompasses all or at least most of the areas of usability, not only in computer and information technology but also in all major fields that the elderly deal with in their daily life. Therefore, it is hypothesised that personal, social and cultural factors may contribute to the usage of family of products in the elderly. This study was conducted in order to suggest a usability assessment method for the elderly in terms of their daily interactions with family of products used in I/EADL.

1.3 Objectives of the study

The aim of this study was to develop a usability model to measure usability of common family of products, such as communication, meal preparation and entertainment, which are utilized in I/EADL by the elderly. This model was used to identify and weigh the criteria which were of high importance to the elderly regarding the usability of the products. The research question of the study was whether usability assessment model is capable of assessing the usability of main families of products defined in I/EADL amongst the elderly population. The following objectives are considered:

1) To determine the usability criteria for the family of products used in I/EADL;
2) To classify the usability criteria and determine the relative weights of the usability factors;
3) To develop a ranking scale model for products within a family using the weighted usability factors.

1.4 Research contributions

One of the outcomes of this research was the list of 126 usability criteria based on FGDs, comprehensive literature review and market survey for seven families of products. The obvious output of the principal component analysis was a total of 23 factor structures, which summarized in Table 5.1 as the summary of research. Another output was to determine weights of extracted factors by pairwise comparisons from the view point of usability experts. The model could rank each preferred I/EADL family of products into high, good, and poor based on the level of usability.

This study will be beneficial to improving knowledge on method, output and model of designing usability assessment studies. Moreover, this research will provide recommendations on how to evaluate the usability of products using the systematic

approach to build usability model tailored based on the adopted-I/EADL family of products. It will also serve as a future reference for researchers on the subject of developing rating scale models based on combined AHP-TOPSIS method which could rank each preferred I/EADL family of products into high, good and poor, and importantly, this research will support the elderly in deciding on whether a chosen product is suitable for domestic use and helping designers identify the usability problems in the design and development of products.

1.5 Scope of the research

The scope of this research can be classified into the following three major aspects:

The subjects were limited to the fit elderly Malaysians whose age ranged from 55-74, inhabited in the state of Selangor, and did not appear to be disabled, nor considered themselves as disabled, and had normal age-related cognitive status. This age range was used due to the following reasons. Firstly, most of the elderly Malaysians are not well educated therefore they may not be able to use technology due to their low literacy level. Secondly, the retirement age in Malaysia is defined as 60 years old and above. The recently retired population is estimated to be of higher education levels compared with older seniors. Thirdly, a relatively small number of Selangor district has a higher mean age for the elderly compared with other states of Malaysia (mean age of the elderly is 65 years in Selangor while the mean age of the elderly in other states is 55 years old) (Swee-Hock, 2015). Finally, WHO has defined a global cut-off of 50 years and older for old age due to the wide differences of the prevalence of the characteristics of elderly in different regions and countries (WHO, 2012). Regarding the fact that older elderly Malaysians are less educated compared with younger elderly, the cut-off age of 55 years old was used for identifying the elderly in this study to reduce the effect of low education level as well as obtaining a sample that represent the target population In addition, since both nationality and ethnicity convey cultural factors with them, therefore subjects were selected based on the three major ethnicities in Malaysia (Malay, Chinese, and Indian) from both rural and urban sectors of Selangor area.

The study is also limited to Adopted-Instrumental/Enhanced Activities of Daily Living (I/EADL) categories as the Focus Group Discussion (FGD) outcome by the elderly Malaysians. Other family of products as well as built environments based on needs and preferences of the elderly are out of the scope of this research.

Some mentioned family of products in this report may not be available simultaneously in all the areas. For example, ATM was launched in the urban cities for a good number of years but at present, have not got to the rural areas or perhaps have been recently installed. This has affected the rural people's ability to use such technologies.

Finally, this study did not assess some fine motor skills including the dexterity capability of the elderly by gender, right-handed or left-handed on the use of I/EADL family of products.

1.6 Structure of the Thesis

The first two chapters include introduction and literature review. The focus of chapter three is on the method used in analysis, and data collection. The areas covered in this study were research design, statistical population and methodology followed by the

procedure of sampling and sample size for FGDs, pilot study, questionnaire and data analysis methods. This study was carried out to provide in-depth knowledge, using theoretical and empirical procedures. Data were collected from the elderly population in the state of Selangor whose age ranged from 55-74 years and are staying in their own homes. The focus of chapter 4 was on FGD study results, survey questionnaire, and the development of ranking scale model. FGD was used to show support for Adopted-I/EADL family products, and finally, list of characteristics affecting usability of I/EADL's family products for older Malaysians. Questionnaire survey was used to determine the problems encountered while using I/EADL family products, as well as obtaining ranked usability criteria by the respondents. Moreover, Principal Component Analysis was used to reduce and classify usability criteria for a few representative factors and develop the Ranking Scale Model. The Ranking Scale Model was used to classify each family of products into high, good, and poor level of usability and to determine which extracted factors contributed more to the level of usability. The final chapter presents summary of the main findings at the beginning, and thereafter, focuses on discussing the results based on related researches followed by recommendations for future researches and lastly the conclusion.

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