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INCLUSIVITY IN MOBILE SHOPPING APPS: AN EMPHASIS ON LEARNABILITY CHECKLISTS IN CONDUCTING A HEURISTIC EVALUATION

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ABSTRACT

Studies on heuristic evaluation of mobile applications have been an emerging domain. However, existing checklists are too general and unable to clearly define the measurements for evaluating mobile shopping applications. This paper proposes suitable heuristics under the learnability measure for a checklist in conducting heuristic evaluation in supporting the inclusivity of a mobile shopping application. This study was conducted in two phases: generate the learnability measures based on heuristics and sub-heuristics from content analysis and verify the proposed heuristic evaluation checklist from the learnability measures through expert reviews. As a result, a verified Learnability checklist consisting of three heuristics was selected: recognition rather than recall, user control and freedom and match between the system and the real world. For each heuristic, suitable sub-heuristics and evaluation questions were identified. Through the learnability checklist, usability experts and analysts can consistently perform their evaluation during heuristics evaluation on other mobile shopping apps. This is to ensure that the apps have all relevant features that enhance the learning ability of their users, using the apps confidently and proficiently, providing their contentment in every usage scenario.

Keywords: Learnability Checklists, Heuristic Evaluation, Mobile Shopping Apps.

INTRODUCTION

Inclusivity in mobile shopping apps refers to designing and developing mobile applications that are accessible and user-friendly for all users, regardless of their abilities, ages, cultural backgrounds, and other diverse characteristics. Inclusive design aims to ensure that everyone can use mobile shopping apps quickly

and conveniently and that no one is excluded from accessing products and services due to application design barriers. There are several methods for assessing usability have been created. One such method is the systematic mapping review, which includes various approaches like Heuristic Evaluation, Survey/Questionnaire, User Testing, Thinking Aloud/Thinking Out Loud, Software Metrics/Usability Metrics, Interviews, Focus Groups, Automated Evaluation through Software Tools, Cognitive Walkthrough, Prototype Evaluation, Checklist Verification, Cognitive Task Analysis, Eye Tracking, and more. The research primarily emphasises the heuristic evaluation (HE) technique, as it is dedicated to thoroughly examining and explaining each identified usability issue based on established usability standards (Nielsen, 1994).

According to a systematic mapping study by Roda et al. (2018), inclusive mobile app design should consider various aspects, such as cognitive, physical, and sensory impairments and cultural and linguistic diversity. This can be achieved by incorporating intense contrast colours, large font sizes, audio and haptic feedback, and support for multiple languages. Inclusivity in mobile shopping apps not only improves the user experience for diverse users, but also increases the applications market reach and potential revenue, but also increases the applications' market reach and potential revenue. The inclusive design acknowledges the diversity of users and ensures that everyone has equal access to the app's features and services.

Usability, as indicated by Nielsen (1994), "is a quality characteristic that decides how advantageous the User Interface (UI) may be during the structure procedure". Nielsen (1993) and Nielsen (2012) additionally expressed usability attributes as learnability, efficiency, memorability, errors, and satisfaction. It is a significant factor in advancing numerous innovative items, and software applications are not a particular case. Due to the significance of these quality traits, a few usability evaluation methods have been developed. Usability evaluation is a precise investigation of the feasibility and usefulness of a framework or software (Petrovčič et al., 2018), and it centres around how well users can learn and utilise an item to accomplish their objectives (Sagar & Saha, 2017). Among these evaluation methods are Heuristic Evaluation, Survey/Questionnaire, User Testing, Thinking Aloud/Thinking Out Loud, Software Metrics/Usability Metrics, Interview, Focus Group, Automated Evaluation through Software Tool, Cognitive Walkthrough, Prototype Evaluation, Checklist Verification, Cognitive Task Analysis, Eye Tracking, and so on.

The HE technique is considered a primary focal point of this study since it focuses on appropriately inspecting and clarifying each observed usability issue regarding built-up usability standards (Jakob Nielsen, 1993). Although there are various heuristics, the Heuristics for User Interface Design, proposed by Nielsen (2012), are the most often used criteria in usability inspection. The heuristics are (1) Visibility of system status, (2) Match between system and the real world, (3) User control and freedom, (4) Consistency and standards, (5) Error prevention, (6) Recognition rather than recall, (7) Flexibility and efficiency of use, (8) Aesthetic and minimalist design, (9) Help users recognise, diagnose, and recover from errors, and (10) Help and documentation. Consequently, most of the studies centred on heuristics proposed by Nielsen and mapped with additional heuristic categories, subcategories, and evaluation questions for similarity and application, which include easy-to-learn, support users' tasks and goals efficient, effective, satisfying, and engaging to use, and others. Heuristics can be broken down into categories and subcategories and later into evaluation questions.

The content presented in this paper is from a larger project, that is, a Heuristic Evaluation Checklist for Mobile Shopping Applications (Uzoma, 2022), which has identified seven measures: learnability, operability, user error protection measure, User interface aesthetic, functionality, reliability, and security. In this paper, the focus is only on one of the usability factors: Learnability measures. Learnability determines how simple it is for users to execute a task the first time they encounter it and how many times

they must repeat it before becoming used to it (Nielsen, 2012). Learnability is defined as "the capability of the software product to enable the user to learn its application" in ISO 9126-1 as a sub-characteristic of usability. Learnability is defined in ISO 9241-11 as a single attribute that signifies a "period of learning." According to ISO 9126-1, learnability has numerous characteristics that can prompt a system to learnable. Because usability and learnability are so tightly related, learnability is crucial (Nielsen & Hanseth, 2010). Users must quickly learn how to utilise an application (Panduwiyasa et al., 2021). Learnability metrics evaluate the extent to which specific users can achieve specified learning goals and use the product or system effectively, efficiently, without risk, and with satisfaction in each usage context (Panwiyasa et al., 2021).

Studies on usability evaluation of mobile applications have been an emerging domain. However, appropriate evaluation methods for identifying pertinent usability issues are still lacking since existing checklists and procedures are too general and unable to clearly define the measurements for the evaluation of mobile application interface usability (Coursaris & Kim, 2011; Hussain et al., 2015; Abubakar et al., 2018) such as mobile shopping applications. This is one of the significant concerns in mobile application usefulness (Muhanna et al., 2020). On this note, Swaid and Suid (2019) developed a checklist that tried to recognise the usability heuristics to be applied while evaluating the usability of m-commerce mobile applications. Unfortunately, this investigation was not experimentally tried, involving more usability expert evaluators and utilising diverse kinds of m-commerce applications.

It is, therefore, essential to operationalise every one of the categories or subcategories of heuristics dependent on mobile purchase transactions that the usability expert evaluators will empirically test. In this paper, suitable heuristics under the learnability measure will be identified in creating a checklist for conducting heuristic evaluation in supporting the inclusivity of a mobile shopping application.

Section 2 of this paper describes the related works. While Section 3 elaborates on the methodology used for this study. Section 4 presents the proposed learnability checklist work, and Section 5 contains the discussion section. The last team draws the conclusion, limitations, and future research directions.

RELATED WORK

The following are several related works on heuristics evaluation on mobile shopping applications. The heuristic evaluation approach is generally utilised in the assessment of mobile applications concerning the apparent effectiveness, efficiency, and satisfaction as presented in Hussain et al. (2015), be that as it may, visibility of system status, the match between system and the real-world, user control and freedom, recognition rather than recall, aesthetic and minimalist design heuristics as asseverated by Yáñez Gómez et al. (2014) are viewed as less adequate to be applied for mobile application usability assessment since the significant component to be centred around relies upon the assessment necessities and usability issues. These heuristic classes are increasingly summed up for each interface but fail to produce satisfactory outcomes after the evaluation processes. In addition to these couple of heuristics proposed in Yáñez Gómez et al. (2014), there are likewise accessible categories and subcategories of heuristics that could be used on mobile applications, for example, security, convenience, error rate, consistency, and so forth. The above studies cover work on heuristics evaluation conducted on mobile applications in general and do not focus on specific mobile apps, like mobile shopping apps.

The mobile application assumes a critical job in regular day-to-day existence for some, including the e-commerce division. Several existing works highlight the need for a rational resolution of usability issues

by strengthening the evaluation criteria (Panduwiyasa et al., 2021; Dourado & Canedo, 2018; Hussain et al., 2018; Salman et al., 2019; Shirogane et al., 2018). Also, suggestions were made on the usability enhancements in the user interface structure according to mobile devices and the heuristic technique for mobiles utilising activity accounts separately. This gives a usable stage and mobile devices with all the essential applications for superior, suitable, and simple shopping because more sites are now optimised for mobile use. There are loosely selected measurements for evaluation in the study by Wangenheim et al. (2016), and the approach adopted by Shirogane et al. (2018) is based on desktop heuristics.

Available heuristics used in Hussain et al. (2018) depend on general mobile applications such as Mobile Print and Design Shopping Applications and utility applications rather than mobile shopping-specific heuristics. In addition, Dourado and Canedo's (2018) study on usability Heuristics for Mobile Applications is a collection of heuristics for mobile applications. To determine the usability, heuristics and heuristic evaluation concentrated on mobile applications (Kitchenham, 2004; Wohlin et al., 2020) and did a thorough literature review. However, only a few papers were reviewed from the numerous selected, which may not cover the effective heuristics for mobile applications and security measures were not considered in this study (Salman et al., 2019) in their work on the heuristics of phone applications in supporting the elderly, have recommended improvements in the design of the user interface. They were ascribed to several flaws with the user interface. However, the solutions advised by experts were not implemented in this study. The heuristics used in this study needed to be adequately defined. Hussain et al. (2018) conducted research that revealed the inconsistency in the standard of the links in the Achik.biz Mobile Shopping Application. The study by Muhanna et al. (2020) centred on proposing a fresh group of heuristics for the usability evaluation of systems that use Arabic interfaces. A comparison was made between the findings of heuristics set by Nielsen and those detailed using the proposed heuristics on three Arabic interfaces. The study did not outline the fresh batch of heuristics into a list of increasingly specific evaluation questions, making it more difficult for non-experts to do a preparatory assessment of Arabic interfaces. (Joyce et al., 2017) aimed to build upon prior studies regarding the heuristic evaluation of mobile applications and the potential impact of the use context. However, the heuristics defined in this research are based on general mobile application characteristics and, thus, are unlikely to apply to specific mobile applications such as mobile shopping applications.

Still, this study should have considered different business locales, and much emphasis should be placed on security measures. As mobile shopping applications deal with customer information and transactions, security factors might be considered in forming the HE of mobile applications.

METHODOLOGY

The following are the steps conducted to achieve the objective of this paper.

GENERATE THE LEARNABILITY MEASURES BASED ON HEURISTICS AND SUB-HEURISTICS FROM CONTENT ANALYSIS

The Content Analysis has been used to distinguish appropriate usability measures that enhanced the identification of mobile-specific heuristic categories and subcategories. These heuristic categories and subcategories are analysed to match their corresponding usability measures. The requirements of mobile shopping applications are also considered to conform appropriately to the usability measures and the

heuristic categories and subcategories. This ensures that the usability measures, heuristic categories, and subcategories focus on mobile shopping applications, emphasising the four usability components: user, technology, task, and environment (Yáñez Gómez et al., 2014). These four usability components are supported in the previous literature (Baharuddin et al., 2013; Harrison et al., 2013; Coursaris & Kim, 2011) to ensure that the identified heuristic categories and subcategories are derived from well-researched and well-established studies that meet the defined needs of mobile shopping applications.

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VERIFY THE PROPOSED HEURISTIC EVALUATION CHECKLIST FROM THE LEARNABILITY MEASURES THROUGH EXPERT REVIEWS

The heuristics and sub-heuristics of the corresponding heuristics for the proposed heuristic evaluation checklist are concurred and utilised in numerous usability evaluation studies, for example, the inquiries by (Hasan, 2009; Hasan et al., 2013; Goh et al., 2013; Mugisha et al., 2019; Sagar & Saha, 2017; Yáñez Gómez et al., 2014).

To verify that user prerequisites have developed the proposed heuristic evaluation checklist for mobile shopping applications and meet the usability proportions of Human-Computer Interaction, it was reviewed by usability and domain experts. The purpose is to guarantee that the user necessities and estimations are utilised as needs and to affirm that the measures are identified with the mobile shopping applications. The expert review is conceivable because it is viably and effectively directed, requiring little effort. Concurrently, heuristic evaluation is considered and acknowledged as a massive route in identifying absconds (Beecham et al., 2005; Komuro & Komoda, 2008), just as assumed significant jobs in both critical thinking and dynamic. The experts contacted include usability experts, software developers, and mobile shopping application designers. From their socio-demographic information, five (5) are usability experts, four (4) are software and mobile application developers, and three (3) are mobile shopping application designers. The experts verified the proposed heuristic evaluation checklist and analysed their feedback through descriptive analysis.

PROPOSED LEARNABILITY CHECKLIST FOR HEURISTIC EVALUATION

Table 1 lists three heuristics related to the Learnability measure derived from content analysis from the literature review. The chosen heuristics are recognition rather than recalled (H1), user control and freedom (H2) and Match between the system and the natural world (H3). For each identified heuristic under Learnability, there are proposed sub-heuristics labelled as HX-SHX. For example, under H1, two sub-heuristics have been placed: Memory load reduction (H1SH1) and General visual cues (H1SH2). Suitable

evaluation questions (HX-SHX-X) are presented for each proposed heuristic and sub-heuristic. With these evaluation questions, practitioners can use them to evaluate the usability of m-shopping apps from the learnability aspect of the users.

Table 1

Proposed Learnability Checklist for Heuristics Evaluation of Mobile Shopping Apps

Heuristics/Sub-heuristics	Evaluation Questions	References
H1 – Recognition rather than recall:	**H1-1:** Is concentrating and remembering information, such as menu selection default throughout the screens in mobile shopping applications necessary?	Yáñez Gómez et al., (2014)
	H1-2: Are available actions (such as navigation options) always clearly presented and easily recognisable using a mobile device?	Jakob Nielsen, (2012)
	H1-3: Is a search history provided in mobile shopping applications?	Nielsen, (2012)
H1SH1 – Memory load reduction	**H1SH1-1:** Are prompts, cues, and messages placed where the eye is likely looking on the mobile device screen?	Pierotti, (1995)
	H1SH1-2: Are items in the mobile shopping applications grouped into logical zones, and are headings used to distinguish between zones?	Pierotti, (1995)
	H1SH1-3: Are optional data entry fields marked in mobile shopping applications?	Nielsen, (2012)
H1SH2 – General visual cues	**H1SH2-1:** Have prompts in the mobile shopping applications been formatted using white space, justification, and visual cues for easy scanning?	Omar et al. (2016)
	H1SH2-2: Has the same colour been used to group related elements in mobile shopping applications?	Salah et al. (2019)
	H1SH2-3: Is colour coding consistent throughout the mobile shopping applications system?	Omar et al. (2016)
H2 –	**H2-1:** Is it always easy to return to the main home page of mobile shopping applications?	Swaid and Suid (2019)

User control and freedom	**H2-2:** Does clicking the "Back" button take the browser application to the previous page it was on?	Pierotti (1995)
	H2-3: Do link labels in mobile shopping applications match the content on the destination pages?	Salah et al. (2019)
	H2SH1-1: If the mobile shopping applications have multiple menu levels, is there a mechanism allowing users to return to previous menus?	Omar et al. (2016)
H2SH1 – Menus control	**H2SH1-2:** If mobile shopping application users can return to a previous menu, can they change their earlier menu choice?	Omar et al. (2016)
	H2SH1-3: Can mobile device users reduce data entry time in the mobile shopping application by copying and modifying existing data?	Omar et al. (2016)
	H2SH2-1: Can mobile device users quickly reverse their actions?	Pierotti 1995)
H2SH2 – Explorable interfaces	**H2SH2-2:** Is the general mobile shopping application structure user-oriented?	Yáñez Gómez et al. (2014)
	H2SH2-3: If the system uses a question-and-answer interface, can mobile device users return to previous questions or skip forward to later ones?	Yáñez Gómez et al. (2014)
H2SH3 – Process confirmation	**H2SH3-1:** When a user's task is complete, does the system wait for a signal from the mobile device user before processing?	Pierotti, (1995)
	H2SH3-2: Can mobile device users edit input data before processing them?	Omar et al. (2016)
H3 – Match between the system and the natural world	**H3-1:** From the homepage, is it clear where to go and how to browse/search pictures on the mobile shopping applications?	Nielsen (2012)
	H3-2: Are tasks described in terminology familiar to mobile device users on data entry screens?	Yáñez Gómez et al. (2014)
	H3-3: Are menu choices ordered most logically, given the user, the item names, and the task variables?	Pierotti (1995)
H3SH1 –	**H3SH1-1:** If the mobile shopping applications use a hierarchical structure, are depth and height balanced?	Yáñez Gómez et al. (2014)

Navigational structure	**H3SH1-2:** Are the items in the navigation area of the mobile shopping applications grouped so that related items are next to each other?	Nielsen and Hanseth (2010)
H3SH2 – Simplicity	**H3SH2-1:** Does the icon in the mobile shopping applications explain itself and make it easy to understand?	Beyk, (2015)
	H3SH2-2: Are the mobile shopping application's menu titles parallel alphabetically?	Beyk (2015)
	H3SH2-3: Is the language of the mobile shopping applications clear and concise?	Omar et al. (2016)

THE RESULT FROM EXPERT EVALUATION OF THE PROPOSED LEARNABILITY MEASURE CHECKLIST

There were 12 experts involved in the verification process, which fulfils the requirements of the study and corresponds with the guidelines in Adler et al. (1996) regarding the number of experts needed to carry out the verification exercise. They were from various fields of usability, software/mobile application developers, and mobile shopping designers who were chosen as respondents for the study. The number was considered optimum and complied with previous suggestions, which required 10 to 15 experts (Adler et al., 1996). The five-point Likert scale scores were used to show the expert's level of agreement for each issue.

Table 2 presents the experts' verification results on the proposed heuristic evaluation checklist. The evaluation questions marked with good (/) signs are appropriate for the proposed heuristic evaluation checklist. In contrast, those evaluation questions with several signs (#) were inconclusive and neither seen as relevant nor irrelevant to the heuristic evaluation checklist and then those evaluation questions with asterisks (*) signs were considered irrelevant and should be dropped from the proposed heuristic evaluation checklist or moved to more suitable heuristic categories or subcategories as per suggested by the experts. However, evaluation questions are selected for the heuristic evaluation checklist based on the experts' consensus or percentage scores obtained by individual evaluation questions and expert comments.

Table 2

Verification of Heuristic Evaluation Checklist by the Experts

	Evaluation Questions	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	%
1	H1 - 1	/	/	/	/	/	/	/	/	*	/	/	*	83
	H1 - 2	/	#	/	*	/	/	/	/	/	#	*	/	83
	H1 - 3	*	/	/	*	/	/	/	/	/	/	/	/	83
1a	H1SH1 - 1	/	/	/	*	/	#	/	#	/	/	/	/	92
	H1SH1 - 2	/	/	/	*	/	/	/	/	/	/	#	/	92
	H1SH1 - 3	/	#	/	*	/	/	/	*	#	/	/	/	83
1b	H1SH2 - 1	/	/	/	#	/	/	/	*	/	/	/	/	92
	H1SH2 - 2	/	/	/	/	/	#	/	*	*	/	#	*	75
	H1SH2 - 3	/	/	/	*	/	/	/	/	/	/	/	*	83
	H2 -1	/	/	/	*	/	/	/	/	/	/	/	/	92
2	H2 -2	/	/	/	*	/	/	/	/	/	/	/	/	92
	H2 -3	/	/	/	*	/	/	/	#	/	/	#	/	92
	H2SH1 –1	/	/	#	/	/	/	/	/	/	/	/	/	100
2a	H2SH1 –2	/	/	/	*	/	/	/	/	#	/	/	/	92
	H2SH1 –3	/	/	/	*	/	/	/	/	#	#	#	/	92
	H2SH2 - 1	/	/	/	*	/	/	/	/	/	/	/	/	92
2b	H2SH2 - 2	/	/	/	*	/	/	/	/	/	/	/	/	92
	H2SH2 -3	/	/	/	*	#	/	/	#	#	/	#	#	92
2c	H2SH3 –1	/	/	/	*	/	#	/	/	#	/	/	*	83
	H2SH3 –2	/	/	/	*	/	/	/	/	#	/	/	/	92
	H3 - 1	/	/	/	/	/	#	/	/	/	/	/	/	100
3	H3 - 2	/	/	/	/	/	#	/	#	/	/	/	/	100
	H3 - 3	/	/	/	*	/	/	/	/	/	/	/	/	92

3a	H3SH1 - 1	/	/	/	*	#	#	/	/	/	/	#	#	92
	H3SH1 - 2	/	/	/	*	/	#	/	/	/	/	/	/	92
3b	H3SH2 -1	/	/	/	*	/	/	/	/	#	/	/	/	92
	H3SH2 -2	/	/	/	*	*	/	/	/	#	/	/	/	83
	H3SH2 -3	/	/	/	*	/	/	/	/	/	/	/	/	92

Consequently, if an item is scored 75% percentage and above based on the experts' agreement, it means the item is accepted, and the possibility of producing meaningful results. Invariably, if an item is scored below 75%, the item is rejected and dropped because they are inefficient in delivering reliable results (Mohamed, 2015). From the above table, all evaluation questions obtained 75% and above, meaning that all experts agreed with the suggested evaluation questions that will be used in the heuristic evaluation checklist, specifically in measuring the learnability aspect of the mobile shopping application.

DISCUSSION

Through this proposed checklist on the learnability aspect (refer to Table 1) for mobile shopping applications, developers and usability practitioners could perform the heuristic evaluation more consistently and progressively precisely across different m-shopping applications. Practitioners can identify strengths and weaknesses of the interface by the learnability aspect. Developers for mobile shopping can use this checklist to ensure that they have developed and included suitable mobile shopping features and page designs that allow them to control their buying transactions quickly to easily control their transactions. This could help users quickly improve their learning experiences, reduce mistakes while performing transactions, and master the usage of mobile shopping applications in a shorter time. By considering heuristics related to recognition rather than recall, user control and freedom and matching between the system and the real world, the learnability of the user can be improved when using a new mobile shopping or for inexperienced users. Through this proposed learnability checklist, partitioners and developers can design and develop mobile shopping applications that are accessible and simple for first-time users to complete their shopping tasks and shorten their learning period for diverse types of users, different ages, abilities, and cultural backgrounds of supporting for inclusivity in mobile shopping applications.

CONCLUSION

This article has focused only on one of the factors in usability evaluation: the Learnability aspect in helping practitioners perform Heuristic evaluation on mobile shopping applications. Three suitable heuristics were identified and later detailed into seven sub-heuristics, later used to derive specific evaluation questions from the literature. The proposed heuristics, sub-heuristics and evaluation questions were verified by 12 usability and mobile shopping experts, who agreed to all items. Usability practitioners later use these evaluation questions as a learnability measure checklist for mobile shopping applications. The work could be improved by including other relevant factors in the heuristic evaluation checklist. The practitioners should test the verified checklist on actual mobile shopping applications. The accessibility factor needs to be also considered in the extended checklist to ensure that diverse user characteristics are included in supporting achieving inclusivity in mobile shopping applications.

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