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Evaluating gender-based mobile shopping application using eye-tracking technology

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ABSTRACT

The mobile applications (apps) development has been gaining popularity for the past few years. Some mobile apps have been failing in its popularity because of the unattractive user interface and bad interaction with the apps. This was proven by previous researchers who have stated that the interaction between a user of mobile application and a graphical user interface could lead to some misunderstandings, errors and frustration from an inability to achieve a goal and could lead to failure of the mobile application. Most of the mobile application developers have been facing proper graphical user interface design recently. There is a noticeable lack of studies and research in the area of mobile application design compared to web application user interface (UI) design. Therefore, this research was done to evaluate the different gender on the mobile shopping application using eye-tracking technology. This research had proposed guidelines based on gender for mobile shopping application. These proposed guidelines can be preferred in the designing process of a mobile shopping application as it could provide a better user interaction and would prevent failure in its popularity by providing fast and user friendly interface.

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1. INTRODUCTION

The use of computers and mobile phone has brought great conveniences and contributions to society in daily activities. Both computer systems and mobile applications (apps) have been built to make people, even more, convenience in many aspects. With continuing penetration of the Internet into daily life, it has changed the definition of computers and mobile phones, and become an essential part of the peoples' communication and daily life. While the web and mobile technologies have become everyday life, in order to face the new market environment which is in constant change, the company must place the customer in the centre of its attention [1]. Developing a website and mobile application makes it possible an excellent communication with the clients, and this leads to a constant adaptation of the company's offer to the continuously changing customers' requests. Due to this, the availability, and adequacy assessment in this situation are becoming increasingly requires. In order to study how users interact with the visual elements within the website and mobile apps, the Eye-tracking technology is increasingly applied to the usability study. Today, many possibilities already exist where the usability of websites and mobile apps, among others, can be assessed with the help of Eye-tracking [2]. Eye-tracking measures where a person is looking, often

used to measure how users interact with the visual elements, with the aims of improving its design and availability [3]. It shows where the user's attention is focused and which paths are followed, provides an unobtrusive means to examine cognitively and attention to deal with.

In general, different gender has different perspectives in most activities including online shopping and user interface design [4]. Recently, online shopping has grown in their popularity in line with growing of the Internet and shopping mobile apps on smartphones [5]. Mobile apps are designed and developed by developers and are available in app stores. Mobile user interface design is an essential in the mobile apps development process. A poor user interaction with mobile apps could lead to failure of apps [6]. User Interface design is a crucial part in mobile apps and website development and had claimed that mental model theory help developers in designing a user-friendly and strong visual hierarchy user interface for a mobile app and website [7].

In recent years, HTML5 has emerged as a very popular way for building mobile apps, called mobile web apps. Mobile web apps looked very much like native apps but built at a much faster and cheaper rate in HTML/CSS. The mobile web apps can be reached the widest range of the devices by only one design. In this study, two different shopping mobile web app interface will be developed based on the existing gender-based users' mental model pattern guidelines. The eye-tracking technology will be used to evaluate the developed interfaces. By analysing participants' eye movement pattern, valuable insight into usability and other issues can be acquired [8]. Besides, the valuable information likes conclusions about the positioning of elements also can be drawn [8].

Nowadays, website and mobile apps developer still facing the problem of limited guidelines for proper user interface design. Vala et al. [6] and [9] mentioned that most of the mobile apps developers have been facing proper graphical user interface (GUI) design recently. Some of the existing guidelines for GUI design are only describing fundamental patterns or use cases [6]. Vala et al. [6] mentioned that there is a noticeable lack of studies in the area of mobile app design compared to web app user interface (UI) design. Moreover, [6] and [9] also stated that the bad interaction between a user's of mobile apps and a GUI could lead to some misunderstandings, errors, and frustration from an inability to achieve a goal and could lead to failure of the mobile. Thus, the UI design is a crucial part of the development process, and it cannot be despised. Besides, [10] suggested that online shopping websites should focus more on female section instead of male section, as their research results shows that female have a higher ratio to shop online. In contrast, [11] identified male customers do more online shopping and outlay more money than women, and they do or are more likely to shop online in the future. Besides, [12] stated, even though most of the shopping is done by women, online purchasing often to be dominance by male consumers. As a result, different users' expectation among users in online shopping is significantly affected by gender. Thus, the interface design for the shopping apps and website should not focus on a single gender, but need to consider both gender.

2. METHODOLOGY

Tobii ProX2-30, a mobile stand device and a Lenovo y400 laptop from SDS Associates has been used in this research. Tobii Pro X2-30 is a screen-based eye tracker that captures gaze data at 30 Hz, compact and affordable system that is perfect for studies outside of the lab and it has been designed to give us instant insights into visual attention in high-level fixation based research. The eye-tracking experiment was conducted at Universiti Teknologi Mara (UiTM), Melaka, Jasin, a public university and University Tenaga Nasional (UniTEN), a private university. A total of 31 participants was involved in the eye-tracking experiment. The participants were random students who were pursuing undergraduate programs from Faculty of Computer Science and Mathematics, UiTM and College of Computer Science and Information Technology, UniTEN. The eye-tracking experiment at UiTM was conducted in a lecturer's room. Whereas, at UniTEN, it was conducted in a computer lab. The eye tracker and mobile stand device in was set up based on the training provided by SDS Associates Sdn. Bhd and lighting conditions were controlled in a way that does not interfere with the eye tracker. Participants were recruited with the help of the lecturers at both of the universities for the user interface testing of adopted Lazada shopping mobile application. The participants who agreed to involve in our research were first given a consent form with the details of the research to be signed in order to confirm that he or she agrees to the procedure of the research. A brief explanation was given on how the experiment is going to be conducted and they were informed that the experiment is going to involve the tracking of their eye movement while they are doing tasks in the particular mobile application. First, the calibration was set for the participants. During this process, some difficulties were found, where some participant's eye cannot be tracked due to various reasons. This is because the eye tracking technology has been developed to work well with people who have healthy eyes and normal visual acuity. In addition, the participants who wore glasses were made sure their lens are in good conditions with less scratches as it can cause difficulties in tracking their eye. After the calibration setup, some tasks were given

to the participants to be done on the adopted Lazada shopping mobile app based on female and male mental model patterns and their eye movement were tracked and recorded. After, they have finished their tasks, the recording was stopped and the participants were given some souvenirs as appreciation for their involvement in the eye-tracking experiment.

3. RESULTS AND FINDINGS

The eye-tracking experiment recorded every eye movement of the participants while they perform the tasks given in both female and male mental models based user interface design. The tasks given were limited to only features that have different location in the user interface design based on identified female and male mental model patterns in [13]. The recorded data were analyzed in the form of gaze plots. Gaze plots visualize a participant's gaze pattern through a series of dots indicating fixation and fine lines indicating saccades. The size of the dots represents the duration of a fixation. Short fixations are indicated by small dots, while larger dots indicate a longer fixation. Gaze plot reveals the order of fixations indicated by numbers in the dots which enables researchers to analyze how a participant perceived an interface and which element were looked at first and which elements were gazed at last. The fixation point while they gazing the particular features when doing the tasks on different user interface design were analyzed based on the gaze data obtained in the eye-tracking experiment.

The Table 1 contains analyzed gaze plot data that was obtained while the participants were performing tasks in female and male based user interface design. There were five invalid data that were found during the analysis of gaze replays. Five participants' eye movement were failed to be detected by the eye tracking device. Those five participant data were coded s 'NT' in the Table 1. There may several reasons for where that the participant's eye movements cannot be tracked at all or that a participant changes her seating position in a way so that her eyes are no longer within the eye tracking box.

Table 1. Gaze Plot Data

Participant	Gender	Internal link		Search		Login		Voice		Product Category		Shopping cart		Wishlist	
		F	M	F	M	F	M	F	M	F	M	F	M	F	M
P01	Female	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
P02	Male	NT	NT	4	NT	NT	NT	6	4	NT	5	NT	NT	4	NT
P03	Male	NT	NT	NT	9	NT	4	NT	4	7	7	5	7	4	7
P04	Female	NT	NT	15	NT	NT	NT	NT	NT	NT	8	NT	NT	NT	NT
P05	Male	NT	NT	3	5	2	5	5	6	9	8	6	5	5	4
P06	Female	NT	NT	7	6	6	5	NT	9	9	4	6	4	7	18
P07	Female	NT	NT	4	NT	5	NT	7	3	4	9	6	2	5	8
P08	Male	NT	NT	NT	5	NT	2	NT	8	8	4	4	6	6	13
P09	Male	NT	NT	3	4	3	5	5	2	4	3	8	NT	7	NT
P10	Female	NT	NT	6	2	2	NT	NT	4	NT	8	7	4	NT	11
P11	Female	NT	NT	7	2	3	NT	NT	5	6	4	5	NT	4	6
P12	Female	8	3	4	7	5	8	3	7	6	4	4	4	7	8
P13	Female	NT	3	NT	NT	NT	5	NT	5	NT	6	NT	5	NT	6
P14	Female	4	NT	2	NT	3	NT	5	NT	4	NT	6	NT	7	NT
P15	Male	7	3	12	8	6	3	3	4	5	6	5	7	4	8
P16	Male	3	5	8	5	4	3	8	6	4	6	5	10	4	4
P17	Male	9	7	7	3	8	5	7	15	3	6	5	6	4	7
P18	Male	5	3	4	4	6	6	6	3	4	6	4	5	6	4
P19	Female	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
P20	Male	5	NT	4	3	4	3	2	3	4	9	8	6	7	4
P21	Female	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
P22	Male	3	6	9	6	4	7	11	4	6	9	6	4	3	5
P23	Female	2	NT	6	NT	2	4	3	NT	4	2	NT	NT	NT	NT
P24	Male	4	4	4	5	2	3	NT	NT	3	3	10	2	6	5
P25	Male	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
P26	Male	NT	6	4	7	NT	3	NT	6	6	4	NT	9	6	7
P27	Female	2	NT	7	8	5	4	6	8	11	6	NT	2	4	9
P28	Male	5	3	7	5	9	7	7	6	9	7	10	4	3	5
P29	Female	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
P30	Female	NT	NT	3	4	2	NT	2	3	6	9	2	6	NT	5
P31	Male	NT	NT	6	3	NT	NT	4	3	3	3	9	2	6	NT

NT = Not Tracked; F = Female Interface; M = Male Interface

Legend:

▨	Correct
▩	Contrast
=	Equal
▨	Same Fixation
=	Fewer Fixation

Seven complete data were obtained, where the eye movement of those participants was successfully tracked completely for all the tasks given. The complete data were from participant 12, participant 15, participant 16, participant 17, participant 18, participant 22 and participant 28. The remaining data were partially tracked for only certain tasks. The abbreviation "NT" indicates the failure in tracking the particular feature. The numbers in the Table 1 shows the fixation point the participants required in order to locate the particular feature in that specific user interface design. The fixation points were compared for the feature in both interfaces in order to evaluate the identified female and male mental model pattern in [13]. The smaller the fixation point participant required in order to locate at the specific feature on the user interface design, the more better is the location of the feature on the interface as they only required few fixations to locate the feature.

Analysis of the gaze plat shows that the majority of the male participants could find the internal link on the male mental model based user interface design as they only required few fixation in order to find and gaze at the internal link. 4 male participants out of 6 male participants with successful gaze data for the internal link were easily found the internal link with the shortest fixation point. Therefore, it justifies the location of internal link in male mental model pattern. Whereas, female only one data has been detected, so no comparison can be made, as shown in Figure 1.

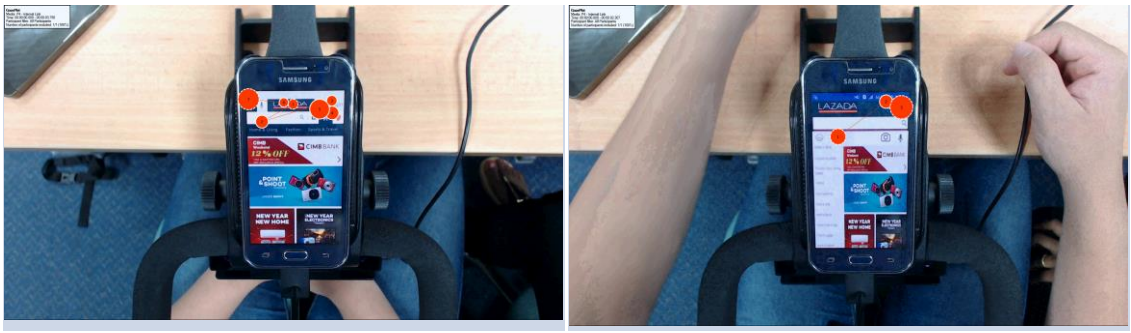

Figure 1. Fixation of participant 15 for internal link on female and male UID

As for the search feature as shown in Figure 2, the majority of the male participants prefers the search button as the correct position as in male mental model pattern as 7 out of the 12 male participants easily located the search with few fixation points. As for female participants, they prefer the search button to be on top as 3 out of the 6 participants easily detected the search location with few fixation points in the male mental model based interface and the remaining 3 participants were able to find the search button with few fixation points in the female mental model based user interface.

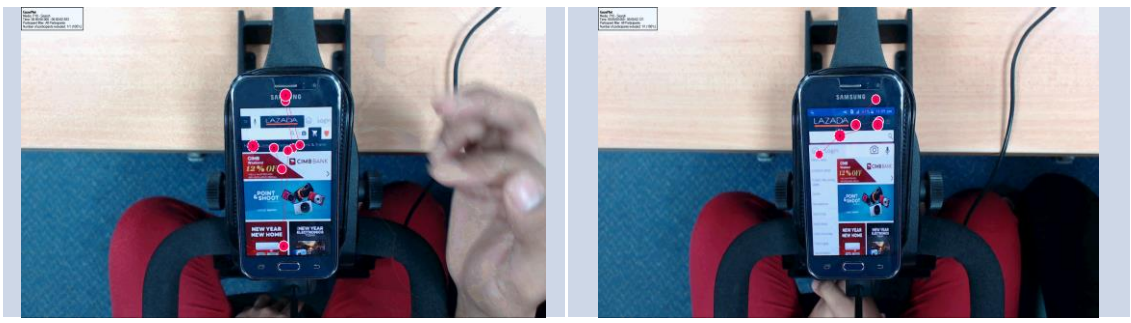

Figure 2. Fixation of participant 22 for search on female and male UID

Based on Figure 3, the majority of the male participants' eye movement towards the login button were better in a male mental model based user interface design. This was proved through the analyzed data which show that the majority of the male participants were able to locate the login easily with the fewer fixations in male user interface design compared to the female mental model based user interface. This justifies the location of the login in the male mental model pattern which is on the top left. As for the female participants, 2 participants required fewer fixations in order to find the login in female mental model pattern based user interface, whereas, the other two prefers the location of login in male mental model based user interface design.

Figure 3. Fixation of participant 15 for login on female and male UID

The majority of the male participants only needed fewer fixations to find the voice recognition button on male user interface design compared to the female user interface design. 6 out of 10 male participants found the voice recognition on male mental model based interface with fewer fixations. For example in Figure 4, participant 22 who is male able to find voice recognition on the male user interface at the 4th fixation point, whereas in female user interface design he only was able to find the button at the 11th fixation point. This reveals that the location of the voice recognition button in the male mental model pattern is in the correct position. The majority of the female participants also only required fewer fixations in finding the voice recognition in user interface that was designed based on the female mental model pattern. This reveals that female prefers voice recognition on top right.

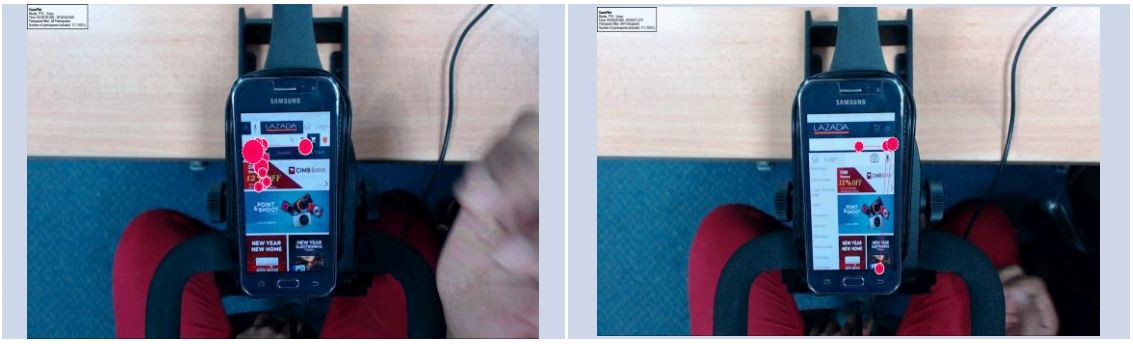

Figure 4. Fixation of participant 22 for voice recognition on female and male UID

Moreover, the analyzed data indicate that the majority of the male participants were able to find and do tasks quickly related to the product category in female user interface compared to the male user interface with fewer fixations, as shown in Figure 5. This indicates that male prefers the product category to be on top which is horizontal. Whereas, on the other hand, female prefers the product category to be on the left as in male user interface design. This was shown from the analyzed data which shows that the female were able to identify he product category in male user interface design with fewer fixations compared on the female user interface design.

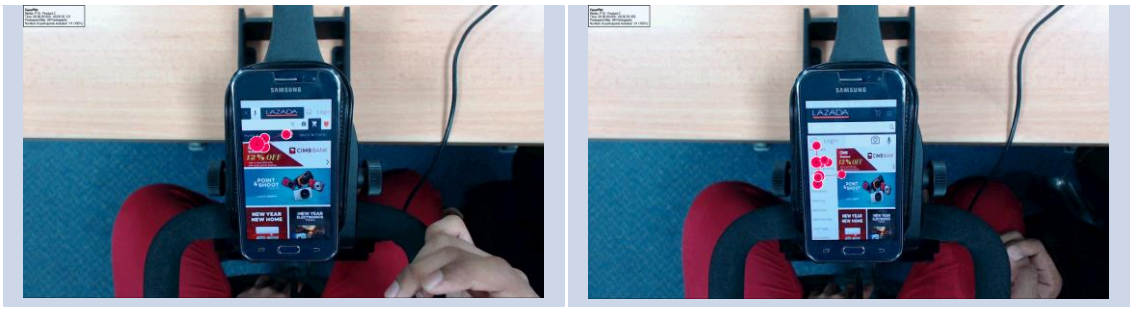

Figure 5. Fixation of participant 22 for product category on female and male UID

As for shopping cart as shown in Figure 6, the majority of the male were able to find the feature in both female and male user interface design at fewer fixations as the shopping cart location in both female and male user interface design is in the top right of the interface. Whereas, the majority of the female participants were preferring the location of the shopping cart on the male user interface design which is near to the internal link. Most of them were successful in finding the shopping cart with fewer fixations in the male user interface.

The majority of the male participants identified the wishlist with fewer fixations on female user interface design as it was located on the main user interface, as shown in Figure 6. On the male user interface design, the wish list is located in internal link which have caused the increase in fixation point in order to find the wish list. The majority of the female participants were able to identify the wish list on the female mental model based user interface with fewer fixations compared to the male mental model based user interface. These analyzed data indicate that the wish list should be on the main user interface instead in internal link.

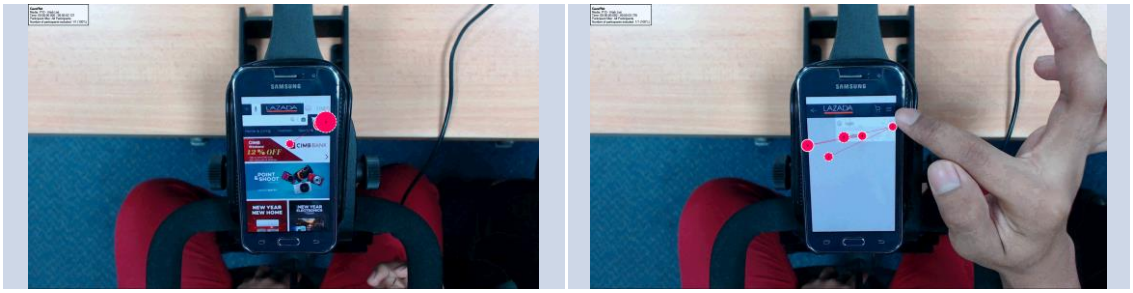

Figure 6. Fixation of participant 22 for wishlist on female and male UID

The eye tracking experiment justifies the identified male mental model pattern [13] as the majority of the male participants' gaze plot reveals that male prefers the male mental model based user interface. This is because the male participants were able to find the most of the features except product category and wish list in male user interface design with fewer fixations compared to the female user interface design. Whereas, female participants were balanced in both male and female user interfaces as most of them could find the most of the features in both interfaces with fewer fixations except for the product category and shopping cart. They prefer the location of product category and shopping cart as in the male user interface design with the success in finding with fewer fixations.

4. CONCLUSION

As a conclusion, the Table 2 shows the number of participants who were able to find the features with the fewer fixations in the particular user interface. The higher number for the particular features in the table justifies the location of the features on a user interface design. This justification identifies a standard guideline that can be utilized by developers in the user interface design process of mobile shopping apps. Most of the features except wish list were found with fewer fixations on the male user interface design by the participants. This confirms the location of the particular features based on male mental model pattern

guideline. Wish list was found easily with fewer fixations on female mental model pattern based user interface design. Therefore, the location of the wish list has been confirmed based on female mental model pattern guideline. Based on the analyzed data, a standard mental model pattern which is acceptable for both female and male was identified for shopping mobile app user interface design.

Table 2. Analyzed Data Based on Physical Features

Physical Features	Female User Interface	Male User Interface
Internal link	3	6
Search	8	11
Login	7	8
Voice Recognition	7	8
Product Category	11	13
Shopping Cart	8	10
Wish list	13	5

The contributions made in this paper help to provide a better understanding of the evaluation of mobile web app interfaces. In particular, the research considerably expands the existing understanding of how users interact with the shopping mobile web app and the impact of Eye-tracking data in re-design the shopping mobile web app interface. These contributions can help to improve the development of more effective commercial shopping app interfaces. Future works could include different Eye-tracking analysis technique including Scanpath Trending Analysis (STA) and AOI may use to analyse the user's eye movement data. In this research, the Eye-tracking analysis technique including Scanpath + Cued RTA and Heatmap have been used to evaluate the user's eye movement data.

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