EVALUATION OF WEB INTERPRETATION ISSUES AND NAVIGATION TECHNIQUES IN FACEBOOK AMONG VISUALLY IMPAIRED USERS

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ABSTRACT

Facebook is an important communication medium among all of us. While Facebook provides an effective way for people to communicate online, it also creates challenges for people with blindness. This causes frustration among visually impaired users who are not able to participate in web interaction. The content arrangement of the Facebook page is the main barrier for Visually Impaired users. Therefore, a detail study is needed to explore the interpretation issue in Facebook. This study aimed to examine visually impaired users' navigation techniques and the reason of having interpretation issues in Facebook. For the comparison purpose, both observation and analysis were based on visually impaired users' navigation activities in the desktop version (represents complex layout) and mobile version (represents non-complex layout) of Facebook. Cognitive Walkthrough (CW) and spectrum was used to observe and analyse visually impaired users' navigation activities during experimental session. This study revealed that visually impaired users overcome their interpretation issues in complex layout by adapting multiple navigation techniques compare to non-complex layout. This study also discovered that information scent has influenced visually impaired users' navigation method. This become the main cause of web interpretation issues in Facebook since the content arrangement does not consistent with their navigation method.

Keywords: Visually Impaired Users, Spectrum, Cognitive Walkthrough, Complex Layout, Facebook, Navigation

1.0 FACEBOOK AND VISUALLY IMPARED USERS

Information and communication technology (ICT) provides opportunities for users to utilize new communication technologies including social networks. The social networking sites (SNS) such as Facebook has become an essential part of life for users to communicate and remain in touch. Similarly, visually impaired (VI) users engage in online social networks with the aid of an assistive technology called screen reader. The most popular screen reader among visually impaired users that interprets the web content is called JAWS (Job Access With Speech) [1]. Unfortunately, VI users encounter major challenges in SNS particularly Facebook [2], [3]. Facebook content designed in form of multi-column layout, which is also known as complex layout [4]–[6]. VI users utilize various types of navigation technique to scan the web content using the screen reader. Besides that, VI users are only able to navigate these web pages without any problems if the design of these web pages is flexible for various navigation techniques employed by web users. For instance browsing, searching techniques in screen reader, and general searching techniques [7], [8]. There are several studies on accessibility issues, user behaviour and experience [9]–[18]. Nevertheless, thorough studies among VI users' navigation activities particularly in web pages with complex layout are needed rather than solely focusing on identifying the incompatible drawbacks of existing web pages for VI users. It is important to explore the impacts of the content arrangement in Facebook towards their navigation activities. This could expand the details of underlying reason behind the interpretation issues occurs.

2.0 VISUALLY IMPARED USERS' WEB NAVIGATION ISSUES IN COMPLEX LAYOUT

Complex layout (also known as multi-column layout) organizes information in web pages based on the grouping of vertical and horizontal shapes. It has a neat appearance, which offers major advertising benefits [4]. However, complex layout is also considered complex because it consists of multi-column layout to organize information in bulk within a web page [4]. The presentation technique applied for Facebook is an example of complex layout, which causes problems to these VI users[12]. Therefore, VI users prefer to stay away from Facebook due to web page complexity[12]. Essentially, the assistive technology such as screen reader vocalizes the web content for VI users [19]. However, the non-dimensional reading pattern of the screen reader on the multi-dimensional layout

presents major challenges for VI users to comprehend the web content. This poses a major issue for VI users to obtain information [6], [20], [21]. There are substantial studies on the issues and impacts of web page layout but studies on VI users' navigation activities and the reason of facing web interpretation issues in complex layout remain limited[4], [6], [7], [20], [21].

3.0 COGNITIVE WALKTHROUGH

Since there are substantial hidden reasons leading to the challenges faced by VI users in navigating the web page of complex layout such as Facebook, an in-depth study on their navigation activities is necessary. The analysis on VI users' navigation activities was carried out through Cognitive Walkthrough (CW) where its effectiveness in obtaining in-depth information on participants' behaviour, affects, and cognition in single usability testing was validated [22]. Moreover, this method has been extensively adapted in various studies usability studies since the 1990s [23]–[28]. In fact, CW is one of the cognitive task analysis (CTA) methods in Family II, which identifies users' behaviour when they perform certain tasks in an interface[29]. Meanwhile, Cognitive Walkthrough for the Web (CWW) is one of the extended CW versions, which is of an improved method in assessing the navigation support and information search for users [30]. However, Cognitive Walkthrough with Users (CWU) is a CW method that focuses on real user involvement. Since this study focused on users' navigation, the incorporation of CWW was deemed appropriate and CWU to have brief understanding of VI users' performance [30], [31]. More specifically, CWW analyses users' behaviour during their navigation activities in a particular web page. Blackmon employed CWW to identify various types of issue related to the design of web page[30]. Accordingly, it was proven that this method is indeed applicable to critique a particular design page and to evaluate web pages since this method identifies characteristics of web pages that differentially affect user performance [26], [30], [32]. CWU is performed in the traditional manner since users are required to perform the assigned task. Following that, users are required to express their experiences and opinions throughout the process of performing the specific task. In particular, users are only provided with brief introduction and expected to perform the task independently without further instruction. At the end of each task, the observer is expected to take note of any detected barrier, which is then viewed by users [33]. Table 1 provides the summary of selected studies in CW.

Table 1: Summary of selected studies in Cognitive Walkthrough (CW)

Author/s	Main Findings
Lewis [23]	Proved that majority usability issues can be detected through CW
Polson [34]	Proposed CW as solution for other cognitive theory proposed by Carroll & Campbell (1986)
Blackmon [30]	CWW was able to recognise features of web pages that impact user performance
Liu [26]	CW detected weaknesses in the interface design when other ergonomic features were involved in the user background settings
Bligard [36]	ECW was established to stabilize the flaws detected in the third version of CW
Khajouei [28]	Proved CW as the ideal method in assessing systems for beginners in usability studies

Notes: CW denotes Cognitive Walkthrough; CWW denotes Cognitive Walkthrough with Web; ECW denotes Enhanced Cognitive Walkthrough

4.0 SPECTRUM AS DATA PRESENTATION METHOD

There are several studies that explored VI users' experiences and navigation activities where the collected data were in form of graphical representation, which is considered a norm particularly in usability studies [37]–[41]. However, it is difficult to identify the underlying behaviour based on data presented in tables. Therefore, it is important to visually encapsulate the obtained information, which ensures that the relationship among the information is visually accessible. Thus, this study particularly adopted Spectrum to present the collected data from the task observation. As revealed in Figure 1, Spectrum, which was developed by Slone [42], presents compilation of related data in a semi-circle pie chart. The data exploration through this method was deemed significant for this study to plot navigation techniques employed by VI users in both complex and non-complex layouts where the obtained data were visually summarized.

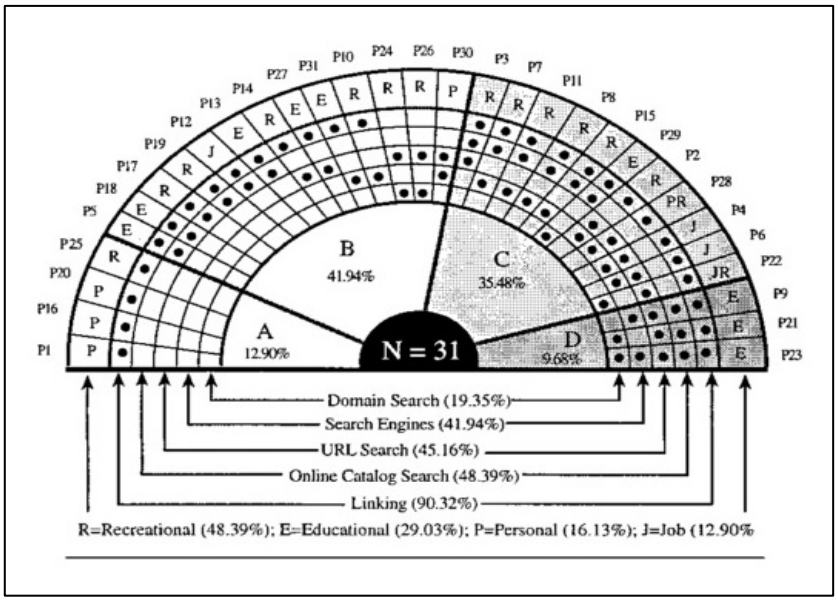


Fig. 1: Spectrum [42]

5.0 METHODOLOGY

5.1 Participant

This study involved twelve VI users. All of them are Facebook users. However, they were carefully chosen based on based on criteria such as their experiences using the internet and screen reader. As revealed in Table 2, these participants were active internet users and familiar with JAWS for their web activities.

Table 2: Participants' details

Participant	Experience with screen reader (Number of years)	Experience with internet (Number of years)
P1	5	10
P2	5	10
P3	10	16
P4	5	10
P5	8	5
P6	10	5
P7	10	5
P8	10	5
P9	16	12
P10	10	10
P11	16	6
P12	5	16

5.2 Purposive sampling

It is particularly challenging to gather a large pool of participants for a study especially when it involves people with disabilities. Moreover, for generalization and validation purposes, a study is typically expected to gather a minimum number of participants, which ranges at least between 20 and 30 users. However, such expectations may not be realistic for a study that involves VI users. Considering that this study focused on behaviour of VI users, the participants were selected based on certain criteria such as their experiences with the internet and screen reader. Therefore, compared to the number of participants involved, the characteristics of participants were critically considered for this study. VI users with high competency level especially with the internet and screen reader were selected for this study. This is to ensure that these participants were able to perform navigation activities for this

study without the influence of incompetency in using internet and screen reader. According to Kurniawan [43], incompetency in using the internet and screen reader could influence their web navigation activities, which would affect the main objective of this study. Therefore, purposive sampling strategy [42] was employed in this study where participants were selected based on the information provided by Head of Information Technology Department, Malaysian Blind Association (MAB).

5.3 Facebook Page as Observation Platform

Facebook is used as an observation platform for this study. Desktop (URL: https://www.facebook.com/) (Figure 2) and mobile (URL: https://m.facebook.com/) (Figure 3) are the two versions of Facebook page. The desktop version Facebook page consists of complex layout given that the presentation of information is of multi-column to present large amount of information within a single page [6]. Meanwhile, the mobile version of Facebook is designed for mobile users. Mobile version of Facebook page consists of non-complex layout given that the presentation of information in a single column layout. Mobile and desktop version of Facebook page were selected as a platform to observe and monitor VI users' navigation activities in windows environment and to analyse their navigation techniques.

Fig. 2: Sample layout of Facebook desktop version (windows environment)

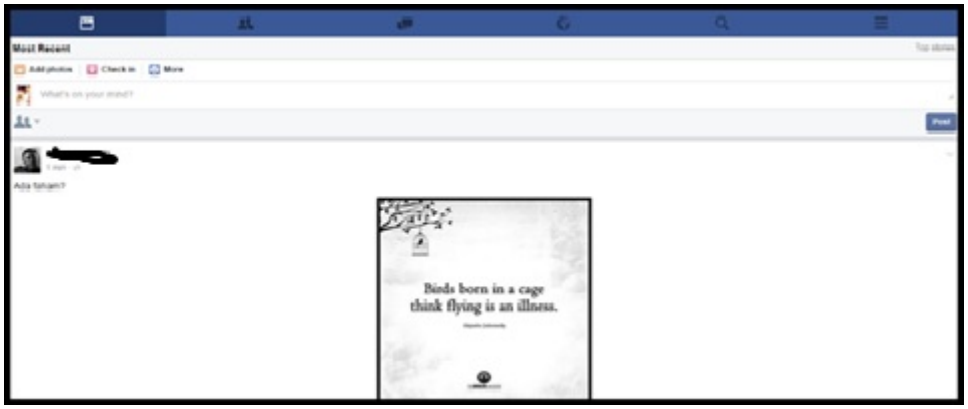


Fig. 3: Sample layout of Facebook mobile version (windows environment)

5.4 Procedure

Task observation is the recommended approach to collect the required data since this study focused on navigation activities that could reflect navigation behaviour of VI users where accurate data cannot be elicited through questioning approach [22]. Therefore, as discussed earlier, Cognitive Walkthrough (CW) is adapted to obtain information on participants' behaviour and the affects. VI users' focused on the communication related features inn Facebook [44]. Therefore, as shown in Table 3, five communication related tasks were assigned to the VI users and instruction of all five tasks related to both versions of Facebook were provided to the participants. At the beginning

of each task, participants were asked to verbally state the following: "Beginning Task". Subsequently, when they completed the task, participants were requested to verbally state the following: 'Task Complete". Instructions to perform the assigned tasks were intentionally skipped out to determine how well the web page guides the VI users in performing these tasks. The participants were advised to make some assumption on how to proceed using the information that have been given to them.

Table 3. List and descriptions of Tasks

Number of tasks	Task Descriptions
1	Find New or Existing friends on Facebook
2	Upload status on Facebook Timeline
3	Upload any message on friend's Facebook Timeline
4	Send a private message to friend on Facebook
5	Log out from Facebook

The observation was conducted in a naturalistic environment without providing any formal training in advance for the participants. Training is irrelevant for this study since people assessing web sites without any formal training [45].Tools such as camcorder, desktop computer and voice recorder were used for the observation. Participants' web navigation activities were captured using camcorder.

5.5 Observation

Detail explanations and instructions about the tasks were provided to the participants at the beginning of observation. They were encouraged to think aloud during their navigation. However, VI users feel more comfortable in sharing their experiences at the end of every task. Their attention was focus on audio generated by screen reader during navigation activities. This is very important for them to understand and interpret the layout as they work through the tasks. The observation was conducted in naturalistic environment and participants acted as their own control without any guidance from the observer. VI users' navigation activities in each task were recorded by using camcorder. Observer detailed out the techniques applied by participants during their completion of every task without any interference.

6.0 RESULTS AND ANALYSIS

The highest repetition of navigation techniques employed by the participants were recorded. The data of navigation techniques from the recorded observation on subjects' navigation process plotted in form of table as shown in Table 4 and Table 5. The participants were clustered under specific region based on the navigation techniques.

Table 4: Mapping of Users' Navigation Techniques By Five Tasks in Desktop Version Facebook Layout

No of Task	1			2			3			4			5			Grouping of Region
Participant	BW	S	G	BW	S	G	BW	S	G	BW	S	G	BW	S	G	
1	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	X
2	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	X
3		/			/		/			/			/			Y
4		/			/			/			/			/		Z
5			/			/			/			/			/	Z
6	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	X
7	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	X
8		/			/			/			/			/		Z
9		/			/			/			/			/		Z
10	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	X
11	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	X
12	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	X

Navigation technique: *BW: browsing; S: Searching techniques in screen reader; G: General searching techniques*
Grouping of Region: *X: Using three types of navigation techniques only; Y: Using two types of navigation techniques only;Z: Using One navigation technique only*

Table 5: Mapping of Users' Navigation Techniques By Five Tasks in Mobile Version Facebook Layout

No of Task	1			2			3			4			5			Grouping of Region
Participant	BW	S	G	BW	S	G	BW	S	G	BW	S	G	BW	S	G	
1		⁄			⁄			⁄			⁄			⁄		Z
2		⁄			⁄			⁄			⁄			⁄		Z
3		⁄			⁄			⁄			⁄			⁄		Z
4	⁄			⁄			⁄			⁄			⁄			Z
5		⁄			⁄			⁄			⁄			⁄		Z
6		⁄			⁄			⁄			⁄			⁄		Z
7		⁄			⁄			⁄			⁄			⁄		Z
8		⁄			⁄			⁄			⁄			⁄		Z
9		⁄			⁄			⁄			⁄			⁄		Z
10		⁄			⁄			⁄			⁄			⁄		Z
11		⁄			⁄			⁄			⁄			⁄		Z
12		⁄			⁄			⁄			⁄			⁄		Z

Navigation technique: *BW: browsing; S: Searching techniques in screen reader; G: General searching techniques*
Grouping of Region: *X: Combination of Three navigation techniques only; Y: Combination of Two navigation techniques only;Z: Combination of One navigation technique only*

6.1 Application of Navigation Techniques in Desktop and Mobile Version of Facebook layout

The collected data of the participants' navigation techniques (as shown in Table 4 and 5) were converted into spectrum (as shown in Figure 5 and 6). As shown in Table 6, web navigation techniques employed by participants particularly browsing, searching techniques in screen reader, and general searching using keywords were represented based on specific codes in Spectrum. In this study, participants were grouped in Region X if they employed a combination of three navigation techniques for their navigation activities. Meanwhile, participants were grouped in Region Y if they employed two types of navigation techniques whereas Region Z implied that participants employed only one navigation technique for their navigation activities. For example, if the participant employs two navigation techniques such as browsing and searching techniques using screen reader, they are categorised under Region Y.

Table 6: Data categorization

Region	Details of data
X	Three types of navigation techniques
Y	Two types navigation techniques
Z	One navigation technique

Based on the number of navigation techniques employed, the participants were clustered according to the category of region. Figure 5 presents the compilation data of navigation techniques for Facebook desktop version in Spectrum form. Based on the compilation data in the plotted spectrum, 7 out of 12 participants were categorized under Region

X where participants employed a combination of three navigation techniques to complete the assigned tasks. However, 4 out of 12 participants were classified in Region Z where they employed one navigation technique to complete the assigned tasks. Only one participant was classified in Region Y, which implies that the participant employed a combination of two navigation techniques to complete the assigned tasks. Overall, majority of these participants employed combination of multiple techniques to complete the assigned tasks for the desktop version of Facebook.

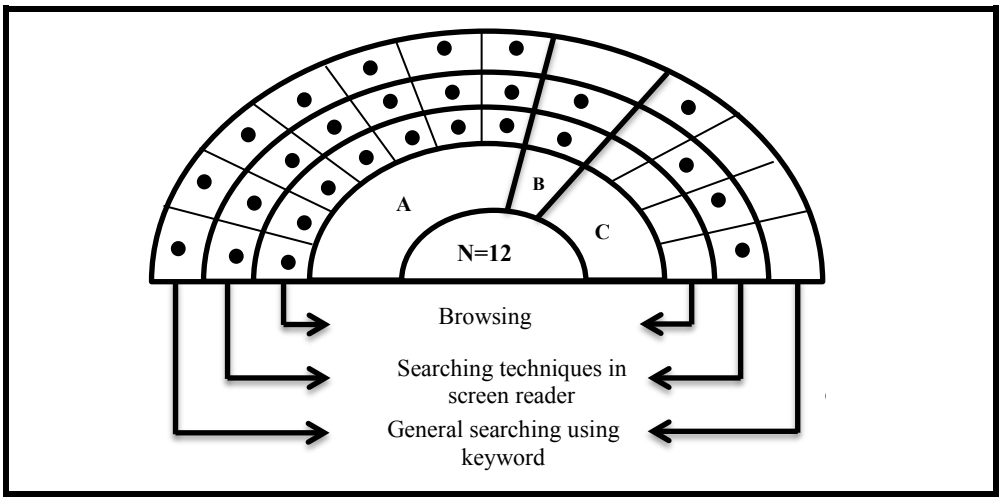


Fig.5: Navigation Techniques in Facebook Desktop Version

Figure 6 presented compilation of various types of navigation techniques used by participants in mobile version of Facebook. Based on the compilation data in the plotted Spectrum indicated that all participants were grouped in Region Z. They employed single navigation technique to complete the assigned tasks. None of these participants was grouped under Region X and Region Y for Facebook mobile version. Besides, majority of these participants employed searching techniques in screen reader to perform tasks for the mobile version of Facebook. The plotted Spectrum for the desktop version of Facebook appeared composite compared to the plotted Spectrum for the mobile version of Facebook. As previously mentioned, Facebook desktop version represents complex layout whereas Facebook mobile version represents non-complex layout. The plotted Spectrums proved that complexity of web layout is one of the influential factor towards the navigation techniques employed by participants.

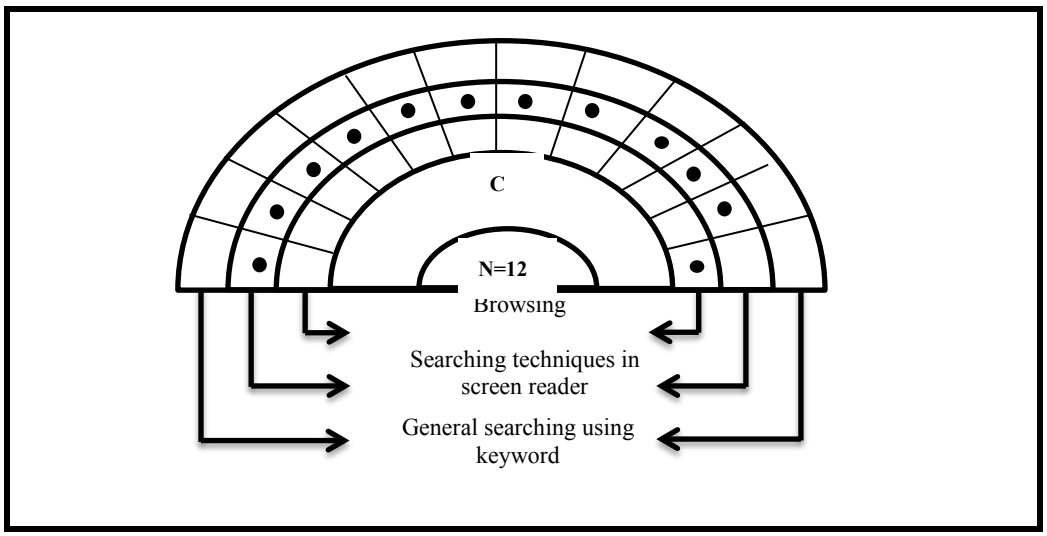
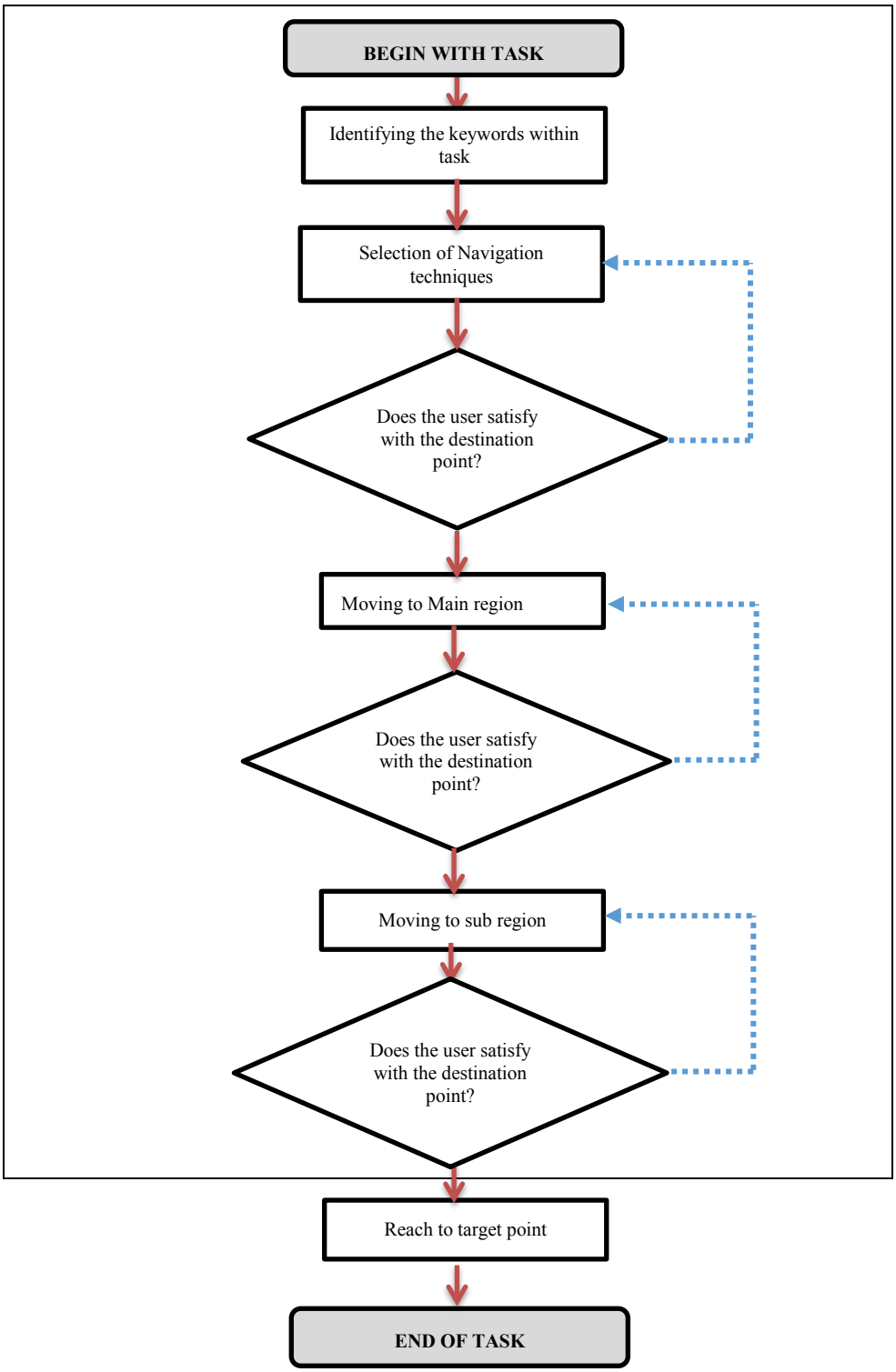


Fig.6: Navigation Techniques in Facebook Mobile Version

7.0 DISCUSSIONS OF FINDINGS BASED ON RESEARCH OBJECTIVES

7.1 To examine VI users' navigation techniques and the reasons of having interpretation issues in Facebook

The observation on VI users' navigation activities was executed according to three navigation techniques, which were browsing, searching techniques in screen reader, and general searching techniques. Based on the observation, it was revealed that participants utilized arrow and tab for general browsing to acquire the overview of web page. Searching techniques in screen reader was the most common navigation method among these participants. Accordingly, navigation using headings and subheadings techniques in screen reader allowed these participants to move from one division to another division or subdivisions effortlessly. Meanwhile, general searching techniques include searching using keyword and search box. Participants employed these techniques at the point where they had extreme difficulty in dealing with large amount of information presented in complex layout. More specifically, they tracked their target point by correlating the keywords and search results from one division to another division. Besides that, it was also revealed that participants identified their target point based on assumptions given from their previous experiences with other web pages. However, these attempts would not work in certain circumstances. Figure 7 shows the VI users' navigation activities in Facebook.



** *Represents Facebook mobile version*; *Represents Facebook desktop version*

Fig.7: Comparison of VI users' Navigation Activities in Facebook

VI users' navigation activities became more difficult once they loss of context with either current position or their target point in completing their task. The inaccuracy of their prediction and estimation led to incorrect destination point among the participants. Therefore, participants traced information to reach their target destination using multiple navigation techniques. This behaviour is referred as information scent, which is part of information foraging [46]. In fact, this is an essential in Human Computer Interaction (HCI). It was developed at the Palo Alto Research Centre by Card and other researchers using wild animal food hunting analogy [47]. This study discovered that the effect of information scent emerges after identifying related keywords based on the assigned tasks in order to reach the target point. The accuracy of these keywords creates a pathway for VI users to move from one region to another region. The extraction of keywords is based on self-prediction, which is influenced by previous experiences in other web sites [48]. Based on the observation in this study, when the participants' keywords did not match with their target point, they reversed their searching process back to the initial point by extracting new keywords before they proceeded the navigation process (as shown in Figure 7). This explains the contributing factor to why most participants employed multiple searching techniques for the desktop version of Facebook compared to the mobile version of Facebook in this study.

7.0 SUMMARY

Conclusively, this research presents the results of study that were designed to examine differences in navigation techniques and web interaction. In this study, participants were asked to perform assigned tasks via navigation in desktop and mobile version of Facebook layout. Spectrum as data representation method was used to examine the navigation differences in desktop and mobile version of Facebook layout. This study proven that the adaption of the navigation techniques influenced by the web page layout. According to the researcher's observation, there is strong effect of information scent during VI users' navigation activities where this considered as underlying reasons of the employment of various types of navigation techniques for complex and non-complex layouts. Essentially, information scent is part of information foraging [30], [49]–[55]. Nonetheless, there are many studies discussed about the importance and impact of information scent for navigation activities among VI users such as Takagi and Vigo [49] [52]. Contrary to the recent study by Vigo [56], this study evidenced that VI users' navigation techniques based on the complexity of layout, which is strongly influenced by information scent. This finding considered as substantial evidence on information scent, which was previously applied among sighted users only. Besides that, these findings will serve as a guideline for web designers on navigation and predictability. In addition, strong information scent behaviour among VI users will make for remarkable future research.

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