

EVALUATION OF MENU HIERARCHY DISPLAY TYPES IN SELF-CHECKOUT SYSTEM: EFFECTS ON HUMAN PERFORMANCE

N. Ahmad¹, R. Z. Radin Umar¹, I. Halim¹, M. S. S. Mohamed¹, M. R. Jamli¹, M. S. Baharudin² and M. Hamid²

¹Faculty of Manufacturing Engineering,
Universiti Teknikal Malaysia Melaka, Hang Tuah Jaya, 76100 Durian
Tunggal, Melaka, Malaysia.

²Department of Manufacturing & Materials Engineering,
International Islamic University Malaysia,
50728 Kuala Lumpur, Malaysia.

Corresponding Author's Email: ¹nadiaha@utem.edu.my

Article History: Received 13 August 2017; Revised 14 October 2017;
Accepted 13 December 2017

ABSTRACT: Over the past few years, the retail industry especially in the US and UK supermarkets, has been experiencing a shift towards the self-checkout technology. Unfortunately, the self-checkout system is still far from perfect. There are many technological problems and design flaws that often irritate many shoppers such as the difficulty to find the item in the look-up directory. Menu hierarchy is one of the menu selection systems that is commonly used for many applications. The objective of this paper is to investigate the two types of menu hierarchy displays in the retail self-checkout system –graphical and non-graphical– and their effects on the human performance. The comparison between the two display types were made using the t-test by evaluating the completion time of the menu selections, the number of eye fixation and human errors made. The scope of this study is limited to the menu selection for produce items that need to be weighed at checkout. The study finds that there is not enough statistical evidence to conclude that the menu hierarchy system with the graphical display will result in faster performance in the retail self-checkout system than the one without the graphical display.

KEYWORDS: *Menu Hierarchy; Self-Checkout; Retailers; Types of Display; Human Performance*

1.0 INTRODUCTION

Over the past few years, the retail industry worldwide especially in the US and UK supermarkets, has been experiencing a shift towards the self-checkout technology [1-2]. The use of this technology allows retailers to reassign their workers to other tasks that can directly or indirectly improve the customer experience such as restocking, bagging goods, and attending to customer requests. The self-checkout system also has the potential to increase the efficiency of the checkout process and cut the operating cost for the retailer as well as giving more control and privacy to shoppers [1]. However, adopting a self-checkout system requires a huge investment for the retailer. Thus, the system must be natural and user-friendly in order to increase customer acceptance, satisfaction and consequently generate high return of investment [3].

Studies have shown that the speed of the transaction as well as the attributes of the scanning machine as some of the most important factors for customer satisfaction in self-service system usage [4-5]. Unfortunately, the self-checkout system is still far from perfect [6-8]. There are many technological problems and design flaws that often irritate many self-checkout users. One of the common problems faced by the self-checkout users is the difficulty to find the items in the look-up directory especially the produce items which do not always come with the barcodes for scanning [6]. When this happens, the shopper must wait for an attendant on duty for assistance, which can prolong the checkout process. Therefore, there is a need for a user-friendly menu selection system to assist self-checkout users to find items quickly and on their own, and ultimately maintain their satisfaction.

A hierarchical menu is one of the menu selection systems that is commonly used for many applications such as the phone menu, automated teller machine (ATM) and retailer's cashier system. It is also used in the vehicle navigation interface menu [9]. It consists of a tree-like multi-level menu structure that ranks and lists choices according to the level of importance or cluster families [10]. Menu hierarchy also emphasizes the visual presentation of a well-designed menu structure that is intuitive and promotes self-learning [11]. An excellent visual presentation can reduce cognitive workload while boosting comprehension, memory and decision making [12]. The

effectiveness of the menu hierarchy design is therefore, determined by the time the user takes to accurately get the information needed. Inefficient design of menu hierarchy can result in the user getting lost, increase errors and complicate the menu selection process. Consequently, this will require the user to take more time to develop a mental model of the menu structure before reaching the final selection [13]. Masoodian and Lane [14] suggest that graphical visualization in information searching can be more effective than the textual based visualization. However, there is no prevalent study that involves menu hierarchy with graphical visualization for self-checkout system.

This preliminary study investigates two types of menu hierarchy displays in the retail self-checkout system –graphical and non-graphical– and their effects on the human performance. The comparison between the two display types were made by evaluating the completion time of the menu selections, the number of eye fixation and the human errors made. The scope of this study is limited to the menu selection for produce items that need to be weighed during the checkout process.

2.0 METHODOLOGY

The initial lists of the produce items were taken from the checkout system at two hypermarkets in Malaysia. The produce items were categorized as fruits, meats, seafood, vegetables and others for the main menu selection. Under each main menu category, the item was further divided into sub clusters until the final sub-menu list: the terminal option. The menu structure was designed with 4 levels of hierarchy: main menu, classification, alphabet, and terminal option. Figure 1 shows the structure of the menu hierarchy developed. Based on the structure developed, two types of menu selection interfaces were created using Microsoft PowerPoint. One of the menu selection interfaces contains symbolic graphical representation of the menu as shown in Figure 2. The other menu selection interface contains only textual representation of the menu without the graphical aid (see Figure 3).

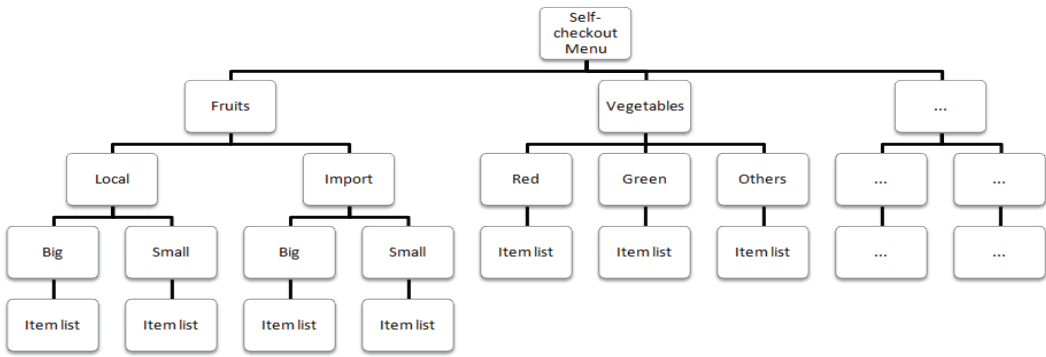


Figure 1: Menu hierarchy structure of produce products

To evaluate the menu selection systems, twenty college students of mixed genders were recruited as participants in this study. All participants had never used a retail self-checkout system. However, participants had directly experienced menu hierarchy selection systems such as the automated teller machine (ATM) or mobile phone application menu. Each participant was given the task to search a list of specified items from the menu system. The time taken to find the items for each participant was recorded. An eye tracking device with Ogama open-source software [15] was also used to track and record the participant's eye movement data in order to evaluate the participant attention to the menu screen. In addition, the software detects the gaze fixation through the maintenance of visual gaze on a single location. In this study, the total number of eye fixations were recorded for each participant to objectively evaluate the impact of graphical aid in the menu selection system.

The data was processed and analyzed with a statistical tool called Statistical Package for the Social Sciences (SPSS). The significant difference between the types of graphical and non-graphical display performances was evaluated using t-test in term of the completion time of the menu search, the number of eye fixations and the number of errors made during the menu search. The Levene's Test was also performed to evaluate the equality of variance assumption in the t-test.

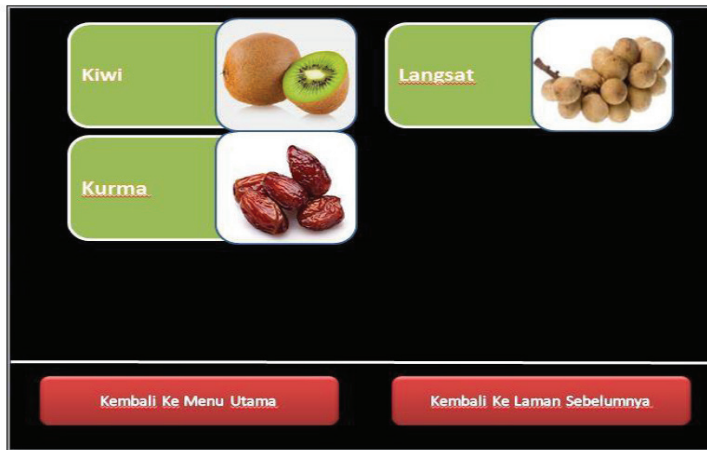


Figure 2: Menu with the graphical display at terminal level



Figure 3: Menu without the graphical display at terminal level

3.0 RESULTS AND DISCUSSION

The results show that the non-graphical display generally took longer time for task completion. Figure 4 illustrates the average total completion time to complete the task for both displays. In addition, it can also be seen that the graphical display led to shorter time of completion in all level categories except for the alphabet level in which the difference is not apparent. Figure 5 portrays the average completion time according to each level of the menu hierarchy. At the alphabet level as shown in Figure 6, both displays have no graphical representations, which cause the tendency of both displays to produce similar results.

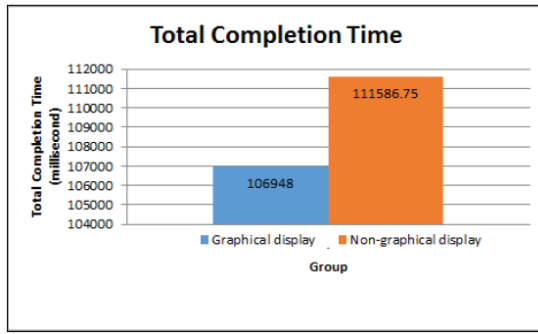


Figure 4: Average total completion time of each type of menu system

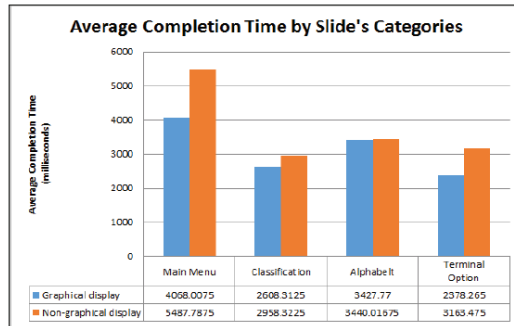


Figure 5: Average completion time of each level of menu hierarchy

In order to evaluate if there are significant differences between the results by the graphical and non-graphical displays, a statistical analysis was conducted using t-test for equality of means followed by Levene’s Test for equality of variance to evaluate the validity of the equal variance assumption. It was found that the difference in the average total completion time was not statistically significant at $\alpha=0.05$, as shown in Table 1. Similarly, the statistical results for comparisons based on the levels of the menu hierarchy, also show no significant differences between the graphical and non-graphical displays. Only the difference at the terminal option level of the menu hierarchy appeared to be marginally significant. In addition, the Levene’s Test showed that only the result of the classification level was significant hence, leading to invalid variance equality assumption. Adjustment to the t-test using Welch-Satterthwaite method showed that the difference was still insignificant with $t=1.282$, $df=8.354$ and $p\text{-value}=0.234$.

Furthermore, it was found that the participants navigating the graphical display produced more errors during the menu search compared to the participants navigating the non-graphical display. The number of eye fixations, however was always higher for participants operating the graphical display in all levels of the menu hierarchy. Conversely, statistical analysis using t-test, showed that there was no significant difference between the two display types, as shown in Table 2.

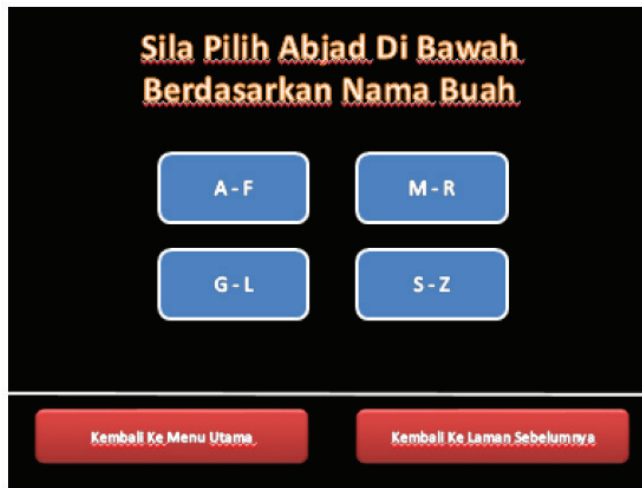


Figure 6: Menu display at Alphabet level which has no graphical cue in both types of display

Table 1: Results of statistical analysis on task completion time

Average Time	Levene's Test		t-test				
	F	Sig.	t	df	Sig.	Mean Difference	Std Error Difference
Total	.580	.459	-.418	14	.682	-4638.75	11086.84
Main Menu	.153	.702	-1.517	14	.151	-1419.78	936.83
Classification	8.133	.013	1.282	14	.221	489.45	366.11
Alphabet	2.372	.146	-.016	14	.987	-12.25	760.49
Terminal option	1.224	.287	-1.955	14	.071	-785.21	401.57

Table 2: Results of statistical analysis on total errors and number of eye fixation

Average Number	Levene's Test		t-test				
	F	Sig.	t	df	Sig.	Mean Difference	Std Error Difference
Total Error	6.943	.020	1.697	14	.112	3.75	2.21
Fix_Main Menu	4.428	.054	1.028	14	.321	15.00	14.59
Fix_Classification	.000	1.00	.126	14	.902	1.00	7.95
Fix_Alphabet	2.172	.163	1.731	14	.105	10.00	5.78
Fix_Terminal option	8.28	.012	1.069	14	.303	6.00	5.61

In summary, the experimental results showed a trend that the graphical display performs better than the non-graphical display. However, the statistical analysis from this study showed that there is no strong statistical evidence to conclude that the menu hierarchy system with graphical display leads to faster menu search in the context of the retail self-checkout system. This outcome might be the result of the higher number of errors made with the graphical display being compensated by the time saving that was expected to be observed from the use of the graphical aid. It is postulated that the larger number of errors in the graphical display might be due to the participant's tendency of making instant decisions prompted by the graphical images. Although the images might cue participants to make quick decisions, the instant decisions made may not necessarily be accurate, leading to errors.

Other possible reason that might influence the finding is the type of participants involved in the study. The participants recruited in this study were in the group age that were mostly accustomed to the menu system in technological devices such as mobile phones and touch screen devices. Therefore, they may be more familiar to navigating through the menu hierarchy system compared to the people in other age groups. It is therefore interesting to see the results if the participants involve the older generation who are less accustomed to the menu search in technological devices. In conclusion, further study with a larger sample size that includes various age groups is needed to obtain more conclusive results.

The experimental design may also need to be compared with the design method in which, the participants are given the physical items and asked to search through the menu system in order to mimic the

real scenario in the retail self-checkout system. Instead of having the name list of items as reference, the participants must search the menu based on the perception or familiarity with the names of the given items. In this case, visual representation of the items on the menu display may help the user to identify the target items faster especially when the items come from a product family with high varieties.

4.0 CONCLUSION

This study investigates if the types of the menu hierarchy systems have significant effect on the human performance in the retail self-checkout system. The menu look-up system with the graphical display and non-graphical display were evaluated and compared in terms of the average task completion time and the user attention towards the display screen. This preliminary study finds that there is a trend that the graphical display may improve users' performance in the retail self-checkout system. However, the statistical evidence to conclude that the menu hierarchy system with the graphical display will result in faster performance than the one without the graphical display cannot be established in this study. The higher number of errors made during the menu search with the graphical display might offset the time saving expected from the graphical display.

In conclusion, there may be other factors that may influence the performance in using the self-checkout system in retails. Further studies are needed to investigate the influence of other factors such as the various ways menu can be classified, the age of the user groups and the variety of the product searched. The benefit of a graphical display may increase if the menu search involves a product family that has high varieties such as apple fruits that are almost similar but are of different types or traits. The way the participants are given the instructions for menu search may also has an influence on the result which further requires more extensive study to determine the impact of the menu design on the self-checkout performance in retail application.

ACKNOWLEDGMENTS

The authors are grateful to the Malaysian government, the Universiti Teknikal Malaysia Melaka (UTeM) and International Islamic University Malaysia (IIUM) for the support to publish this manuscript. This study is partially funded by the UTeM short term grant (PJP/2015/FKP(2D/S01393)).

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