Adaptable and Adaptive E-Commerce Interfaces: An Empirical Investigation of User Acceptance

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***Abstract*—Electronic Commerce (E-Commerce) is becoming more competitive, particularly with increasing diversity of online consumers. However, the personalization of user interface can establish one-to-one customer relationships in E-Commerce, by two contrasting approaches: adaptable and adaptive. This study aims to evaluate three interaction approaches in E-Commerce: adaptable, semi-adaptive and fully adaptive. It aimed at measuring attitudes toward these interfaces in accordance with the following factors: Perceived Ease of Use (PEOU), Perceived Benefits (PB) and Behavioural Attitudes (BA). The three constructs were extracted from the Technology Acceptance Model (TAM). Pursuing the aims, an experimental E-Commerce platform was implemented with three different product catalogue conditions: adaptable, semi-adaptive and fully adaptive. An independent group of participants (n=60) were instructed to perform three tasks using each of the product catalogues. The tasks were designed with one complexity level in order to control the effect of task complexity on participant attitudes. Upon completion, the participants completed a questionnaire devised specifically for this study. The results showed that the semi-adaptive interface ranked first for all aspects of user acceptance. The adaptable interface ranked second for acceptability and preference and the fully adaptive interface ranked third.**

***Index Terms*—Adaptable, Adaptive, Interaction, Technology Acceptance, E-Commerce**

I. Introduction

With the rapid increase in the number of tasks that need to be completed, the adoption of adaptive or adaptable approaches could potentially influence a perceived acceptable level for system utilization [2, 3]. Furthermore, the information needing analysis is often large and the time allocated for accomplishing this may be very limited as the users may be unfamiliar with the interface. Users usually employ changing behavioural methods and styles even when conducting similar responsibilities [4]. Applications that provide extensive functionalities and features may fail to serve users with diverse needs [5], while systems offering a more restricted choice of functionality could possibly lose the user's motivation [6]. In addition, it is unlikely that the organization of the features, which ensure the functionality of the system, will be convenient to all users. It is regularly observed that for such problems, the adoption of adaptive, adaptable or a semi-adaptive user interfaces is crucial [7].

The aim of this study is to evaluate the adaptable, semi-adaptive and fully adaptive user interfaces in the context of E-Commerce. It is worth noting that the three E-Commerce approaches were extensively evaluated in terms of effectiveness and efficiency. These previous evaluations targeted improving the usability of E-Commerce interfaces. In this study, a great deal of emphasis was placed on the user's first impression, due to the role it plays in competitive environments of online business, particularly E-Commerce. It is anticipated that the use of adaptive and adaptable interface techniques will improve initial attitudes towards E-Commerce interactions. This potential was well recognized in the current literature to E-Commerce; however, it was not evaluated empirically. Therefore, this research attempts to fill this gap in the current knowledge.

This paper is organized into seven sections. The second section will identify the current knowledge on adaptable and adaptive interface techniques and previous studies, which have examined the role of adaptable and adaptive user interactions, will be presented and analyzed. In the third section, the experimental platform and its three interface techniques will be described. The design of the experimental study will be presented in section four and, in the fifth section, an analysis will be conducted on the obtained results. The sixth section will then discuss the results in relation to the research aims and objectives. Finally, conclusions will be provided in the seventh section.

II. Literature Review

This section describes the adaptable, adaptive and semi-adaptive approaches. In addition, related studies that compared the three approaches are presented. In the adaptive user interface, the interface dynamically initiates actions on behalf of the user by changing the content and presentation to ensure that it is suitable for users with different characteristics [9]. In the adaptable interface, the user initiates actions by adjusting the content and presentation until a decision about the proffered layout is implemented [9]. In the semi-adaptive approach, the system initiates the changes of the presentation, but the user is allowed to manipulate it until the final decision about the preferred layout is implemented [10].

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A. The Adaptable Approach

The adaptable approach provides users with the capability to organize an interface, information or service, by themselves, according to their usage criteria [11]. Generally, it aims to gratify the customer's requirements and preferences, especially those of a heterogeneous and changing nature [11]. This contributes towards the uniqueness and precession of the appearance and layout of an interface and eventually leads to greater customer loyalty and repeated purchases [12, 13]. Providing the user with the ability to customize the interface saves time and effort while it also promotes online business [14]. However, it is regularly observed that users do not fully utilize the customization elements provided, due to the difficulties associated with the actual customization activities [3]. Another argument suggests that users tend to customize under particular circumstances which relate directly to changes in their lives, such as changing jobs or moving house [14]. Although the shortage of time and lack of interest are considered among the barriers to the adaptable approach, the sharing of customization profiles between users is proposed as a means for tackling this issue [14].

Adaptability techniques vary in terms of when and how to change the content and presentation elements. It is argued that adaptability can be achieved by two key solutions: as-you-go and up-front [15]. The former denotes the process in which the user adjusts the interface to suit particular preferences during the actual task performance, while the latter requires that the customization of the interface is carried out prior to the start of the actual task. Based on these two solutions, user performance was evaluated empirically [15], the results revealed that the customization of the interface was more efficient when it was carried out prior to the user engagement in the actual task performance when compared with the performance of customization during the task. Interestingly, customization techniques differ according to the situation under which the user interacts with the system.

B. The Fully Adaptive Approach

The concept of the adaptive approach denotes the personalization of the content, structure and presentation of the system to tackle the diversity of users' background knowledge, abilities and skills and their changing preferences over time [5]. It aims to contribute toward the reduction of information overload as well as the promotion of customer satisfaction and loyalty by establishing personalized relationships [6]. In E-Commerce contexts, the adaptive approach is utilized to establish new relationships with customers and to improve the existing ones [2]. It is argued that price has a positive relationship with customer loyalty, whereas the use of adaptation in the user interface establishes trust and encourages customers to feel that they are at the centre of the seller's interests [6]. Amazon provides an example that offers over 23 types of adaptation features [16]; for example, Amazon provides customers with intelligent recommendations based on their historical purchases, it also analyzes the browsing record of visitors to adapt the user's interface. Although the use of adaptation is seen to be beneficial [17], the argument of this approach repeatedly raises issues which relate to privacy and security [18]. The privacy concern is the key downside when the adaptive approach is employed in the user interface, especially when private information about users is gathered without their permission and their actions are monitored without them being informed [6]. The adaptive approach can be categorized into two types: adaption of information content and adaptation of the Graphical User Interface (GUI) [15]. The adaptive content aims to display information representing volume and transactions of the web content, while also listing and displaying tailored content for each individual user. On the other hand, the adaptive GUI adapts its components to include the number and position of the items in menus and sub-menus [15]. In fact, the interface can be presented adaptively if the appropriate content is determined based on domain-specific knowledge prior to presentation [19]. In addition, a decision about the way content is presented to the user is required, such as the presentation layout and the modalities used [19].

The successful implementation of an adaptive interface relies on several analytical techniques that are used to forecast the future needs of the user, based on an internal representation of their characteristics and qualities created by the system [20]. For example, rule-based filtering, collaborative filtering and content-based filtering are utilized to create a user model. User Modeling (UM) is a process of gathering information about users in order to anticipate their requirements and to adapt the user interface accordingly [21]. It is seen to be a very important aspect of adaptive user interfaces because it tackles the diversity of user characteristics and their changing preferences over time [22]. The collection of information relates to the creation of UM which can utilize several methods [23], such as: conducting a survey, monitoring user navigations and actions, and using stereotypes. In brief, UM is utilized in order to build an internal representation of user characteristics and to ultimately understand the user's behaviors and needs.

C. The Semi-Adaptive Approach

The semi-adaptive approach was proposed as a means for integrating both the adaptable and adaptive components. Horvitz (1999) argued that little attention has been paid to the potential of this approach; in contrast Bunt et al. (2007) argued that purely adaptive interfaces no longer exist, as the new semi-adaptive interfaces provide customization features which allow the user to continually adapt the interface. In semi-adaptive interfaces, the user's profile, tasks and behaviors are determined by the system before it proposes the initial interaction mode that is considered appropriate for that user [15]. Consequently, it is assumed that the user is able to perform customization activities in order to facilitate efficient use of the system [15]. If the user is unable to customize the interface, hints and tutorials should be provided to help the user understand the customization process [15]. In this approach, the adaptation elements

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facilitate more efficient customization, while the customization activities provide the adaptation techniques with more accurate feedback about the user's preferences [15]. In addition, the adaptive approach offers the user the ability to control and change the proposed adaptation while providing feedback which can override the adaptation suggestions [24].

III. Related Studies

The three interface techniques were evaluated empirically by several researchers. An investigation was conducted by Tsandilas [25] into the effect of accuracy in deploying the adaptive approach on user performance; the results indicated that the accuracy of the adaptation suggestions affected the user's ability to locate items. Another study [26] into the influence of accurate and predictable adaptation on user satisfaction and performance found that the effect of accuracy was stronger than that of predictability when reviewing user performance and satisfaction. The user's involvement in customization activities was also evaluated to determine the effect of the adaptable and adaptive approaches on the user's ability to learn, complete a task and on satisfaction levels [3]. This study revealed that the interface customization features were not being fully utilized (i.e. users customize very little) due to the complexity involved and the time required to learn and perform the actual customization.

Comparisons between the adaptable and adaptive approaches were performed by many researchers. To illustrate, Findlater and McGrenere [9] conducted an investigation into the effect of using adaptable and adaptive interfaces on efficiency and user attitudes; they found that the adaptable approach was more efficient and preferred by users. They also found that use of the adaptable approach had a positive effect on user satisfaction, because the users felt that they had more control over the system when compared to the adaptive approach [9]. The study recommended that the value of the adaptable approach should be explicitly shown to the user through examples [9]. Another study [20] into user preference showed that 65% of the users perceived the adaptable approach as the most preferred approach in comparison to 15% of users who preferred the adaptive approach. Contradictory to these finding, a study by Jameson and Schwarzkopf [27] showed there to be no significant difference between the two approaches with regard to user performance; however, contradictory results were found when comparing the adaptable and adaptive approaches.

Several researchers also considered the combination of adaptable and adaptive elements of the user interface as this produces a semi-adaptive interface. For example, Stuerzlinger et el. [28] conducted a study into the integration of customization and personalization interface techniques with a sample of 13 participants. The study found that users usually struggle to utilize customization features, especially at the beginning. Another study [29] investigated the role of the adaptable and semi-adaptive interfaces to tackle visual complexity, they found that users preferred the semi-adaptive approach over the adaptable one. The study also identified a number of recommendations, provided by the semi-adaptive interface, which had a positive effect on overall task performance. In addition, a two-phase investigation by Bunt [24], into the factors influencing the effective combination of the adaptable and adaptive approaches, found the semi-adaptive approach to be more beneficial than the adaptable one with regards to user performance and satisfaction. Furthermore, by providing users with recommendations through the adaptive system, prior to the actual customization process taking place, this study revealed that these actions contribute to the reduction of customization time and effort as well as to the improvement of overall task performance.

Many studies have evaluated adaptable and adaptive interactions, in several contexts. In the context of E-Commerce, Rigas and Al-Omar [30] conducted an investigation into the role of adaptable, semi-adaptive and adaptive user interfaces to tackle visual complexity and to determine which approach was best in terms of controllability. The study revealed the semi-adaptive approach as being ranked first in terms of providing controllability, with the adaptable approach being ranked second. In the context of in-vehicle telematic systems, Lavie and Meyer [31] conducted an investigation into a number of proposed factors which were deemed to influence adaptive interactions. The study concluded that the adaptive approach was more beneficial in routine tasks, especially for elderly people, but it negatively affected the performance of non-routine tasks. In addition, the semi-adaptive approach was identified as beneficial for both routine and non-routine tasks, when it was carefully implemented. In brief, the adoption of both adaptable and adaptive approaches was found to be beneficial in several different contexts.

IV. Experimental Platform

To achieve the aims of this empirical investigation, an experimental E-Commerce platform was specifically implemented. The platform offered features and services that are usually provided by E-Commerce web-based systems. Furthermore, it presented information about laptops, which are in great demand and which are deemed a necessity for daily life. Data, containing product information and specifications, were gathered from different sources, such as the Sony and Dell websites; this information was entered into the database in preparation for the experiments. The data incorporated information from 22 (n=22) different laptop brands based on the essential specifications necessary for promoting the selling of the specified products. The specification of the products included screen size, budget, operating system, stylishness, battery life, weight, processor speed, company, screen resolution, hard drive space, RAM and the optical drive. In summary, this E-Commerce platform was implemented specially for this experimental study.

The experimental platform was implemented with three different techniques of user interface: adaptable, fully adaptive and semi-adaptive. The three interfaces

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TABLE I.
DIFFERENCES BETWEEN THE THREE INTERACTION APPROACHES IN TERMS OF CONTROL (A), ADAPTATION METHOD (B), INFORMATION ABOUT USERS (C), USER EXPERIENCE (D) AND HELP AND SUPPORT (E).

Factor	Approach		
	Adaptable	Fully adaptive	Semi-adaptive
a	The user was in control	The system was in control	Balanced between the user and the system
b	Relied on the user's provided information	Relied on analyzing navigational patterns and historical purchases	A combination of both
c	Not required	Required	Required
d	Required	Not required	Required
e	Should be provided	Not necessary	Should be provided

were similar in terms of presented information contents, tasked to be performed and overall layout. However, there were several differences between them in terms of control, adaptation method, information about users, user experience and help and support. Table I shows the differences between them in terms of control (a), adaptation method (b), information about users (c), User experience (d) and help and support (e).

Fig. 1 shows the three interface techniques. The user can switch between the three techniques using a dropdown menu designed specifically for this study. The E-Commerce interface implemented for this study included a product catalogue, product specification details and the dropdown menu for switching the interface and the task. The products were displayed on the product catalogue using four data lists in the first page, one at the top which displays the first product from the product catalogue with a large image. The remaining three data lists, below the first one, only display products with smaller images. The larger image was utilized to highlight the most recommended product from the catalogue. The selection of the highlighted product (with the larger image) was dependent on the interface technique utilized. In addition, the user could navigate through all of the pages by: using the next hyperlink, searching for and then selecting a particular product in accordance with their requirement. The following pages of the product catalogue consisted of three data lists, as no products were highlighted in these pages. In the product catalogue, the system displayed the products by listing the product features, such as screen size, budget, operating system and stylishness only and the details of the product could be viewed by clicking on the product image for detailed specification of the product.

Fig. 1 (a) shows the view of the adaptable interface where the customization features appear in the product catalogue. The adaptable interface was implemented to ensure that the predefined contents were fixed during the design phase. However, the user can change the content presentation according to their preferences. In this interface, the products appear in the absence of any considerations of the user's preferences. This drives the

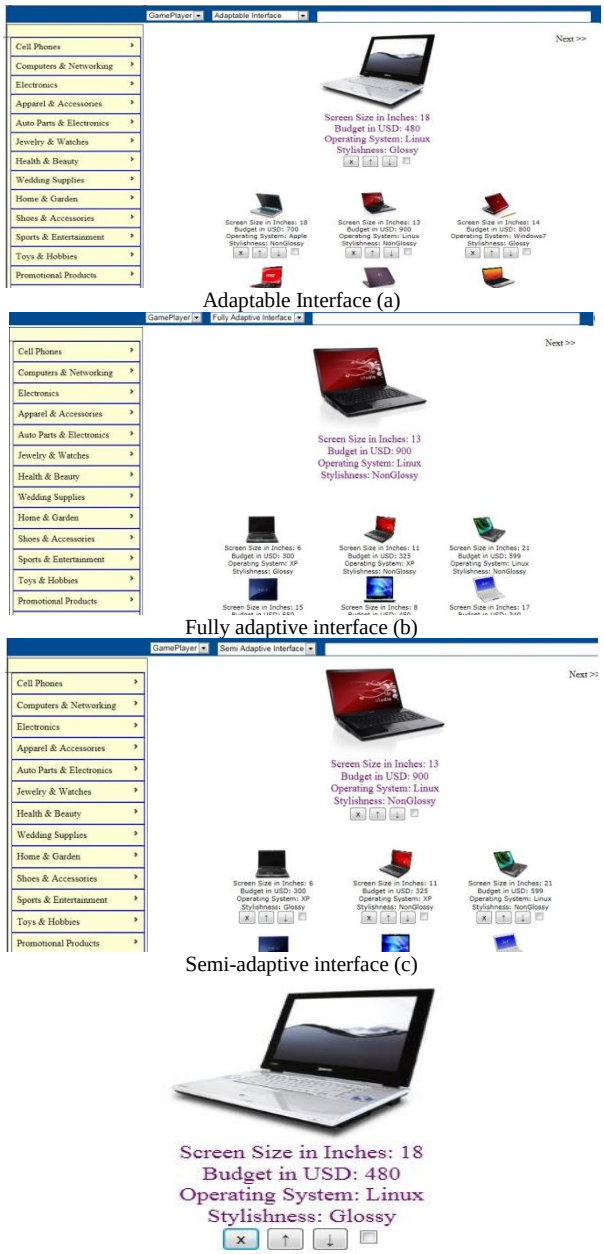

Figure 1. The adaptable interface (a), the fully adaptive interface (b), semi-adaptive Interface (c) and Single Product view with customization buttons (d)

user to spend time in customizing the product catalogue to facilitate the efficient searching for desired products. In fact, customization of the product catalogue has many options, such as changing the order of the list, moving less preferred products to the end of the list and changing the position of a product. The customization features were represented by four buttons, as shown in Fig. 1.

The fully adaptive interface considers the user's preferences by ordering the products based on best matching to least matching the preferences. Providing E-Commerce content in an adaptive manner relies on a variation of content presentations which are included within a single layout. The decision for identifying content to be presented to the user is implemented based

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on predefined stereotypes. Although the adaptive interface saves the user time and effort, it does have a number of drawbacks. Firstly, it fails to provide the user with the ability to change the appearance and order of the products, as they are not able to control the system. As displayed in Fig. 1 (b), the list of products was displayed in accordance with the best match of the user's preferences, this was based on three stereotypes: game player, professional or student. Each stereotype was associated with particular preferences which determined the order in which the products were display. It can be seen that the customization features were not provided. In fact, the user was required to navigate and search for products in the absence of explicit customization features in the displayed product catalogues. However, the system intelligently analyzes the user's navigational behaviour and then adapts the product catalogue display accordingly. For example, if the user visited more than three products from the same brand, the system will assume, based on probability, that the user likes that brand. Consequently, the system will move the products from that brand toward the top of the list; the same is true for other, recurring, specifications of the products.

The semi-adaptive interfaces were designed to allow tailoring of a system's interactive behaviour to consider both the individual needs of the human users and the altering of conditions within an application environment. It inherits features from both adaptable and adaptive environments. In Fig. 1 (c), it can be seen that the system appearance is similar to that of the adaptable interface. In addition, it initially presents the product catalogue contents according to the three scenarios used in the adaptive approach: game player, professional and student. Similar to the customizability of the adaptable interface, the user can change the product catalogue appearance, but the system herein stores the user's customization activities to feed the intelligent adaptation process. For example, when the user dismisses three products from the same brand, the system increases the probability that the user does not like that brand. Consequently, products from the same brand are moved down to a lower position in the list. The same is true for other characteristics of the product.

The adaptable and semi-adaptive interfaces utilized two customization techniques: coarse-grained (i.e. moving an item to the tail) and fine-grained (i.e. moving items to a specific location) [9]. The implementation of coarse-grained and fine-grained techniques in this system utilized four buttons. The four buttons were ordered from left to right. In the coarse-grained technique, the first button moved the item out of the current view and placed it at the tail of the list. The products which appeared before the dismissed product would then appear in the same manner in the data lists. The products which appeared after the user dismissed product were then moved up by one position which allowed the user to select the best product according to their preferences. Similarly, the fourth button allowed the user to check multiple products by moving them out the current view or by placing them at the tail of the list. The displaying of products above or below the dismissed products was similar to that for the first button. In the fine-grained technique, the second and the third buttons allowed the user to move the clicked product one step up or down respectively (i.e. swapping the position of the clicked product with the product above or below it). Unfortunately, this interface neglected the opportunity to utilize the user feedback acquired from the customization activities, because the system did not store or analyze these actions. In Figure 1(c), it can be seen that the four buttons, located beneath the brief product description, were associated with each product and allowed the customization of the product catalogue contents.

V. Experimental Study

The investigation herein evaluated user acceptance of three interface techniques: the adaptable, semi-adaptive and fully adaptive user interfaces, in the context of E-Commerce. Prior research examined the role of these three techniques in terms of testing usability of innovative E-Commerce approaches. In this investigation, the nature of competitive E-Commerce environments is considered; hence a great deal of emphasis has been placed on the user's first impression, due to its role in turning visitors into customers. It can be suggested, therefore, that the use of adaptive and adaptable interface techniques will improve initial attitudes towards E-Commerce interactions. This potential was recognized in the extant literature of E-Commerce, however, it was not evaluated empirically. Therefore, this research attempts to fill this gap in the current knowledge. An extensive laboratory-based experiment was designed to evaluate and measure the user's acceptance of adaptable, semi-adaptive and fully adaptive interface techniques in E-Commerce. A within-participant experimental design [32] was utilized where 60 participants (n=60) were instructed to interact with the three interfaces, they were then asked to rate each one according to three factors extracted from Technology Acceptance Model (TAM).

A. User Acceptance

In order to highlight the value-added by adopting the TAM, it was important to compare it with usability-based studies and other models in Information Systems (IS) literature. Usability testing aims to examine effectiveness, efficiency and user satisfaction of innovative user interfaces [33]. However, TAM-based studies utilizes cognitive variables for predicting IS acceptance and highlight cause-effect relationship between beliefs and intentions [34]. The TAM shares similar characteristics with most of the IS use theories, like Expectancy-Confirmation Theory (ECT) [35]. However, TAM-based studies place a great deal of emphases on initial attitudes, resulting from the first impression, which is argued to be critical for E-Commerce interfaces [36]. In contrast, ECT evaluates post-adoption attitudes, resulting from the mapping between the initial expectations and the perceived performance of the system [37]. More importantly, similar research suggested using the TAM constructs to measure initial users' attitudes towards E-

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Commerce interfaces [38] or enforcing usability testing with a TAM-based initial attitudes investigation [39]. In addition, the TAM has shown to be the most widely accepted model among IS researchers, due to the richness of its empirical supports [40].

This investigation utilized the TAM, to measure user acceptance of technology. The TAM was initially proposed by Davis [34] to measure two main variables: Perceived Ease of Use (PEOU) and Perceived Usefulness (PU). PEOU has been defined by Davis [34] (page:320) as: "the degree to which a person believes that using a particular system would be free of effort". PU is known as: "the degree to which a person believes that using a particular system would enhance his or her job performance" [34] (page:320). Within the TAM, PU is considered to be a major factor in determining system usage, while PEOU is a secondary factor. The TAM was extended several times to include different factors, such as the model proposed by Venkatesh [41] which included social norms. In addition, a study by Shih [42] extended the TAM to also measure user acceptance of online shopping. Another study conducted by Aldiri et al. [38] relied on an extended version of the TAM; they evaluated the initial trust in E-Commerce by measuring trust beliefs and intentions in relation to the two key factors of the TAM: PEOU and PU. In summary, the TAM has reliable instruments and is empirically sound.

In this study, the TAM was adopted to measure user acceptance of the three E-Commerce interface techniques. The PEOU construct was employed as one of the perceptual belief factors or belief attitudes. However, PU indicates usefulness from an organizational perspective within the scope of the original TAM. PU was replaced in the proposed model by Perceived Personal Benefits (PB) to represent PU from the individuals' perspective on how they perceive that they have actually benefited from the system. The Behavioural Attitudes (BA) construct was included to represent the user's intentions toward using the system. In this research model, the user's attitudes were measured by three main constructs: PEOU, PB and BA. Each construct was represented by five statements which were extracted from a relevant and related study; to illustrate, this included: PEOU [1], PB [8] and BA [1, 8]. Table II shows the questionnaire constructs and statements. These constructs were developed and tested for reliability and validity as shown in appendix A. The content and reliability of the research instrument was tested by a panel of experts and through the use of statistical procedures, respectively. In summary, this study relied on a measuring user attitudes using the three construct of: PEOU, PB and BA.

TABLE II.
QUESTIONNAIRE CONSTRUCTS AND STATEMENTS

Construct		Statement	Ref.
PEOU	PEOU1	This website was easy to use.	[1]
	PEOU2	It was difficult to become familiar in operating and using this website.	[1]
	PEOU3	This website was flexible to interact with.	[1]
	PEOU4	I felt that the website was clear and understandable.	[1]
	PEOU5	The use of this website would be free of effort.	[1]
PB	PB1	This website was useful for searching and buying laptops.	[8]
	PB2	This website was inconvenient and ineffective.	[8]
	PB3	I complete all the tasks more quickly using this website.	[8]
	PB4	I found that my productivity was increased using this website.	[8]
	PB5	This website increased my accuracy of completing tasks.	[8]
BA	BA1	I will revisit this website in the near future.	[1]
	BA2	I would provide this website with my personal details.	[1]
	BA3	I am likely to purchase from this website.	[8]
	BA4	I would not use my credit card to purchase from this website.	[8]
	BA5	I am likely to bookmark this page and recommend it to my friends.	[8]

B. Experimental Procedure

For preparation purposes, participants were provided with 10-minutes training sessions prior to commencing the actual experiment. Three sessions were utilized to introduce the three experimental conditions and to provide the users with the basic knowledge of the interface features and the way in which each condition was designed to display the content. In addition, the participants carried out training tasks in the absence of any support to ensure that they had fully grasped the features provided by the three experimental conditions. In summary, the participants were trained to use the three interaction modes prior to the actual experiment. Three common tasks were designed to control the experimental practice, to mirror the behaviors that are normally carried out when searching for products online.

Users were provided with scenarios in which they had to find products in accordance with the four attributes of the study. The difficulty of each task was controlled by standardizing the number of search factors and the number of products satisfying the search criteria. In Task 1, the participant was provided with a student scenario which required the individual to find products based on screen size, price, operating system and stylishness. In Task 2, it was assumed that the participant would interact with the system to look for products with specifications that were deemed to be required by professionals, including battery life, processor speed, brand and weight. In Task 3, the scenario proposed the searching of products required by a gaming person, with requirements of screen resolution, hard drive, RAM and optical drive.

In order to control the task learning effect, the order of the interface presentations were varied amongst the participants, as shown in Table III. The participants were randomly assigned to six groups which were varied with regard to the order in which the three experimental

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conditions were used to accomplish Task 1, Task 2 and Task 3. For illustration purposes, the first group of participants (1-10) will be used as an example. For this group, the adaptable interface was used to accomplish the first task, the semi-adaptive interface was used to accomplish the second task and the fully adaptive interface was used to accomplish the third task; therefore, this group was labeled the ASF group in order to indicate the order of conditions – adaptable, semi-adaptive and fully adaptive.

Prior to commencing the task, the participants were instructed to answer several pre-experimental questions, including: age, education level, frequency of internet use, average internet usage (hourly per week) and frequency of purchase over the internet (purchase per week). Upon completion of the pre-experimental phase, each participant then used an interface to accomplish Task 1 – they used the interfaces in accordance with the order shown in Table III. Subsequently, the user was instructed to complete a questionnaire devised to measure three factors: PEOU, PB and BA. The rating for each statement was quantified based on a seven-point Likert scale [43], ranging from agree strongly (7 in the scale) to disagree strongly (1 in the scale) with one neutral answer (4 in the scale). After rating the first interface, the user was then asked to interact with the second interface to complete Task 2 and then rate the same statements using the same scale. The third interface was also evaluated based on the completion of Task 3 and then the provision of feedback and ratings on the statements relating to the three constructs in the questionnaire. These statements were labeled as post-task questions. The post-task stage aimed to measure user attitudes towards the interfaces used to accomplish the specific tasks. Upon completion of the experimental tasks, all participants completed a set of post-experimental questions which asked for their preference for each experimental condition. To prepare this data for analysis, the user responses to the questionnaire statements were gathered and coded to generate summated values for each variable.

C. Sample

Sixty participants (n=60) were randomly recruited to partake in this experiment. Based on the argument that students are the best surrogate for online shoppers [44], students at the Imam Muhammad Ibn Saud Islamic University (IMSIU) were recruited as participants. With regard to the participant age, the sample data showed that 77% of the participants were between 20 and 24 years of age, 20% were between 18 and 20, and 3% were between 25 and 30 years of age. For the education factor, the data showed that 60% the participants were final year undergraduate students, 30% were undergraduate students and 5% were graduated students. In addition, the sample data showed that 75% of the participants were frequent internet users who accessed the internet more than five times a week, 18% accessed the internet between three and five times a week and 7% of the participants used the internet once or twice a week. Furthermore, it was shown that 58% of the participants spent on average more than 10 hours each week using the internet, 27% spent on average between six and 10 hours using the internet each week and 15% spent on average between one and five hours on the internet each week. The user's experiences of internet-based purchasing varied considerably with 33% rarely purchase items over the internet (once or twice every three months) and 32% of the sample had never purchased anything via the internet. In addition, 22% of the participants occasionally purchased items over the internet (once or twice a month), 8% made purchases over the internet once or twice weekly and 5% of participants were regular E-Commerce users (purchasing items over the internet more than five times a week).

TABLE III.
INTERFACE ROTATION SCHEMES.

Users	Group	Task 1 (Student Scenario)	Task 2 (Professionals Scenario)	Task 3 (Game People Scenario)
1-10	ASF	Adaptable	Semi-Adaptive	Fully Adaptive
11-20	AFS	Adaptable	Fully Adaptive	Semi-Adaptive
21-30	FAS	Fully Adaptive	Adaptable	Semi-Adaptive
31-40	FSA	Fully Adaptive	Semi-Adaptive	Adaptable
41-50	SAF	Semi-Adaptive	Adaptable	Fully Adaptive
51-60	SFA	Semi-Adaptive	Fully Adaptive	Adaptable

VI. RESULTS

The gathered data was analyzed using three types of statistics: descriptive and inferential statistics as well as reliability tests. Patterns in the data were revealed by descriptive statistics (i.e. mean values); the mean values were used to describe the variables as a measure of central tendency [45]. The mean value is calculated by identifying the sum of all the scores which is then divided by the number of scores. Additionally, conclusions about the population were drawn through the use of inferential statistics, such as paired t-test (i.e. related t-test) and repeated-measures ANOVA. In the scope of this within-participants experimental design, the paired t-test was used to test the difference in parametric variables between two conditions [46]. However, the repeated-measures ANOVA test examined the difference in parametric variables when the number of conditions exceeded two [47]. In this study, the paired t-test was utilized to test the statistical significance between two interfaces and the repeated-measures ANOVA examined the difference among the three interfaces. The reliability tests suggested that all constructs were found to be reliable for use as predictor variables. In addition, Cronbach's Alpha [48] (i.e. Cronbach's α) was utilized to represent a coefficient of consistency and to examine the reliability of the summated scales with 70% (α=0.7) representing a critical value. The Cronbach's Alpha values were found to be greater than 70% for each construct and represented: 0.87, 0.90 and 0.89 for PEOU, PB and BA respectively. In summary, descriptive and inferential statistics were utilized to analyze the data obtained from this experiment.

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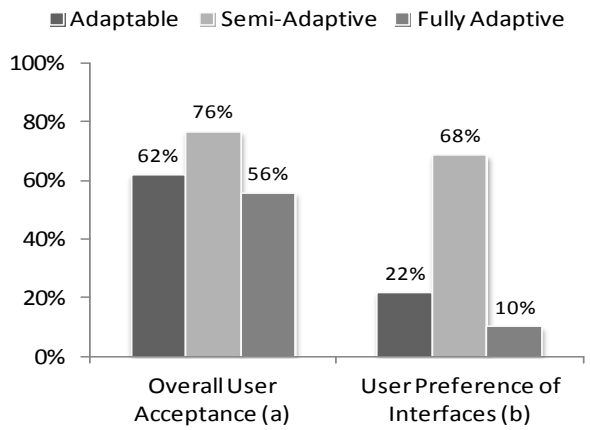

Figure 2. Mean values of overall user acceptance score (a) and user preference of interfaces (b).

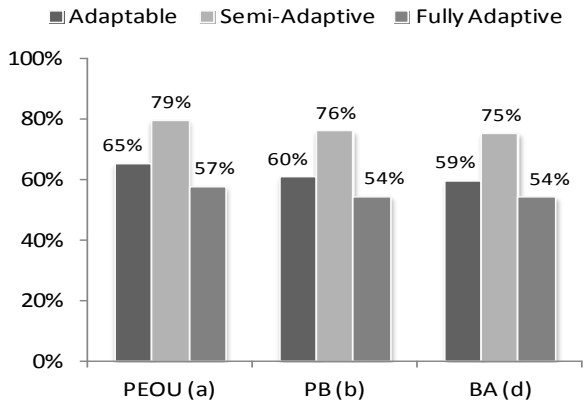

Figure 3. Mean Values of PEOU (a) PB (b) and BA (d).

Fig. 2 shows the mean values of overall user acceptance score (a) and user preference of interfaces (b). Overall, it can be seen that the semi-adaptive approach was ranked first based on acceptance and preference by users when compared with the adaptable and fully adaptive approaches. In addition, the fully adaptive approach was ranked third in terms of being the least accepted and preferred approach. The adaptable approach was therefore perceived to be the second most accepted and preferred interface to users after the semi-adaptive approach. In Fig. 2 (a), the mean value of overall user acceptance score represented the summated scale of the three factors of user acceptance. Its value for the semi-adaptive condition was found to be 24% and 38% higher than that for the adaptable and fully adaptive conditions respectively. In addition, the mean value of overall user acceptance for the adaptable condition was 11% higher than that for the fully adaptive condition. In Figure 2(b), the values of user preference of interfaces were summated from the pre-experimental questions in which the participant chose only one interface as a preferred condition. The analysis of user preferences revealed that 68% of the participants selected the semi-adaptive condition to be the most preferred condition, 22% selected the adaptable condition and 10% selected the fully adaptive approach. These results support the findings that the semi-adaptive approach was ranked to be the best interface, among the three conditions, by far. In fact, this value clearly identified a large variance among the three interfaces due to the nature of the question asked.

Fig. 3 shows the mean values of PEOU (a), PB (b) and BA (c). In Fig. 3 (a), the mean value of PEOU for the semi-adaptive condition was 22% and 38% higher than that for the adaptable and fully adaptive conditions respectively. The mean value of PEOU for the adaptable condition was 13% higher than that for the fully adaptive condition. As presented in Fig. 3 (b), the mean value of PB for the semi-adaptive condition was 25% and 40% higher than that for the adaptable and fully adaptive conditions respectively. The mean value of PB for the adaptable condition was 12% higher than that for the fully adaptive condition. In Fig. 3 (c), it can be seen that the mean value of BA toward using the semi-adaptive condition was 25% and 39% higher than that for the adaptable and fully adaptive conditions respectively; in addition, the mean value of BA toward using the adaptable condition was found to be 10% higher than that for the fully adaptive condition.

It is important to review the inferential statistics, including t-test and ANOVA. Table 2 reviews results of paired t-test and repeated-measures ANOVA tests with 95% significance levels. The critical value for the t-test was cv=2 and the critical value for the ANOVA test was cv=3.07.

VII. Discussion

In general, this investigation provided insights into initial users' attitudes towards adaptable and adaptive user interfaces. The findings of this study contributed to consumer behaviour literature, particularly E-Commerce research. Although, this experiment was carried out by 60 participants, it showed several indications of what an online consumer beliefs and how he/she intend to use adaptable and adaptive E-Commerce systems. Putting these interface techniques in practice is a key issue that mangers have to consider in order facilitating the success of E-Commerce presence and surviving aggressive competitions. Designers of E-Commerce interfaces should consider counterbalancing the adaptation control between the user and the system, as this has shown to have a remarkble positive effect on users' perceptual beliefs and behavioural intentions. It is even more important for E-Commerce providers to be aware of the development and the significance of the semi-adaptive approach, particularly to draw the consumers even closer by utilizing the first impression effect. Good interface design leverages considerable opportunities to businesses that keep in mind the diversity of its oline consumers.

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TABLE IV.
REVIEW OF INFERENTIAL STATISTICS USING PAIRED T-TEST AND REPEATED-MEASURES ANOVA.

Variable	Examined Conditions	Result	Sig.
User acceptance	Among the three conditions	F= 31 p<0.05	√
	The fully adaptive versus the adaptable approach	t_{59}=5.6 p<0.05	√
	The semi-adaptive versus the adaptable approach	t_{59}=2.2 p<0.05	√
	The semi-adaptive versus the fully adaptive approach	t_{59}=7.6 p<0.05	√
PEOU	Among the three conditions	F= 31.5 p<0.05	√
	The fully adaptive versus the adaptable approach	t_{59}=5.06 p<0.05	√
	The semi-adaptive versus the adaptable approach	t_{59}=2.5 p<0.05	√
	The semi-adaptive versus the fully adaptive approach	t_{59}=7.5 p<0.05	√
PB	Among the three conditions	F= 22.5 p<0.05	√
	The fully adaptive versus the adaptable approach	t_{59}=5.1 p<0.05	√
	The semi-adaptive versus the adaptable approach	t_{59}=1.86 p>0.05	No
	The semi-adaptive versus the fully adaptive approach	t_{59}=6.8 p<0.05	√
BA	Among the three conditions	F= 23.6 p<0.05	√
	The fully adaptive versus the adaptable approach	t_{59}=5.3 p<0.05	√
	The semi-adaptive versus the adaptable approach	t_{59}=2.2 p<0.05	√
	The semi-adaptive versus the fully adaptive approach	t_{59}=7.1 p<0.05	√

This research has revealed that the semi-adaptive user interface is more acceptable and preferred by users. It showed the impact of adopting semi-adaptive interface techniques in the context of E-Commerce environments. The acceptance of the semi-adaptive E-Commerce interfaces is sensed, since 76% had positive perceptual attitudes toward this approach. This is an indication for managers and designers of E-Commerce systems, since the acceptance can develop and lead to satisfaction and ultimately to customer loyalty with good adoption and implementation strategies. This argument is in agreement with other work in literature [30]. With 75% positive behavioural attitudes toward the semi-adaptive approach, it can be said that the investment in this approach potentially leads to improving sales and marketing. Managers of E-Commerce firms should focus on the usefulness and convenience of this approach and invest in building semi-adaptive E-Commerce interfaces, as it leverage increasing sales opportunities. The experiences gained from this experiment suggest that user acceptance of E-Commerce interfaces is influenced by the level of controllability provided to the user. In fact, it is becoming evident that distributing the control between the user and the system is more acceptable and preferred. The basic idea behind this is that the customization activities carried out by the user can be utilized to feed the intelligent adaptation process. This argument is in agreement with other work in literature [24].

During the experiment, a considerable number of participants didn't fully utilize the customization features offered by the adaptable interface. However, the customization activities witnessed a significant increase in performance when using the semi-adaptive interface. A number of participants felt their interaction with the adaptable interface was boring due to the length of time spent in customization. This, however, was improved while using the semi-adaptive interface due to the initial presentation that relied on a prediction of the user's requirements which provided the user with initial suggestions to minimize the customization activities needed. It is also worth noting that the design of each approach has several advantages. In the adaptive approach, the way in which the system presents a personalized view of each stereotype generally has a positive effect on the participants' attitudes towards the system. In the adaptable and semi-adaptive approaches, participants generally felt that the feature which allowed the moving of items from one place to another was an advantage. However, participants preferred to be engaged in fewer customization activities, due to the confusion resulting from repeated movement of items within the lists. This argument is in agreement with other work in literature [28].

Future research would be useful to investigate this area further, in particular an excellent opportunity to extend this research would be into the supplementing of semi-adaptive interfaces with other interaction metaphors, such as audio and expressive avatars. Furthermore, it is worth noting that the focus of this empirical investigation was placed on post-interaction user attitudes which resulted from the initial usage of the system, and the idea of measuring the attitudes of frequent users would merit further investigation.

VIII. CONCLUSIONS

This study has investigated user acceptance and preference of three E-Commerce interface techniques: adaptable, semi-adaptive and fully adaptive. An experimental platform was implemented specifically to serve the aims of this investigation. Several factors were controlled, such as the contents presented to the users, the E-Commerce interface layout, the tasks performed and the task learning effect. The platform was built with considerations to three predefined usage scenarios which assumed that the user was looking for a product (laptop) suitable for a student, professional and a game player. However, each interface technique dealt with the user's requirements and interactions differently. The aim of this study was to measure differences between user attitudes towards the three interface techniques with regard to their perception of ease of use, personal benefits and behavioural attitudes towards using the system. These constructs were derived from the TAM.

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Sixty participants were recruited to evaluate the three techniques in an experimental setting. The experiment utilized a within-participants experimental design in which each participant evaluated the three interfaces. The experiences gained from this experiment suggest that the semi-adaptive E-Commerce interface was more acceptable to users than the adaptable and fully adaptive interfaces. It became evident that integrating the adaptable and adaptive features into a single interface had a positive effect on user acceptance and preference. This therefore provides insight into the significance of, and the potential of, the semi-adaptive approach. Thus, it can be concluded that E-Commerce interface designers should embrace the development of semi-adaptive user interfaces.

APPENDIX A RELIABILITY AND VALIDITY OF THE INSTRUMENT

The research instrument was examined for reliability and validity using Cronbach's Alpha (α), the Average Variance Extracted (AVE), Composite Reliability (CR) and discriminate validity. It can be seen from Tables (V and VI) that the research instrument was found to be reliable and valid.

TABLE V.
PSYCHOMETRIC PROPERTIES OF THE CONSTRUCTS

Construct	Item	Loading	**α**	AVE	CR
PEOU	PEOU1	0.726	0.870	0.579	0.549
	PEOU2	0.800			
	PEOU3	0.741			
	PEOU4	0.731			
	PEOU5	0.803			
PB	PB1	0.736	0.900	0.644	0.594
	PB2	0.800			
	PB3	0.800			
	PB4	0.869			
	PB5	0.803			
BA	BA1	0.749	0.890	0.624	0.594
	BA2	0.827			
	BA3	0.823			
	BA4	0.723			
	BA5	0.823			

TABLE VI.
DISCRIMINATE VALIDITY OF THE CONSTRUCTS

Construct	PEOU	PB	BA
PEOU	**0.761**		
PB	0.741	**0.803**	
BA	0.724	0.771	**0.790**

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