Comparing Sequential and Simultaneous Menus for ecommerce Web Portals

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Abstract-The rapid development of Internet and its associated content delivery technologies and use of interactive and innovative web application portals has led to a situation where the Web can be accessed on a multitude of different platforms. These range from desktops, laptops and tablets to smart phones like Android, Blackberry and Apple. Web designers are always on the lookout for innovative interface options. This helps easing web navigation and user experience as well as offers better enhancements and performance. Web site and application design involves use of various types of menus like Top down, Simultaneous or Sequential as interactive alternative options for the users. The menu structure defines the extent of control which is provided to the user in performing a task. Success of web applications also depends a lot on the complexity or ease of information retrieval but also the manner in which information is presented during retrieval tasks. This research paper compares the use of Simultaneous and Sequential menus on e-Commerce web application portals. This involves a survey with users browsing web content using different system for computer-human interactions with regards to user experience and web portal performance.

Keywords-Sequential Menu;Simultaneous Menu; Web Design; User Interface;Computer Interaction

I. INTRODUCTION

Human interaction with the external environment transpires by exchange of information received and sent which is essentially input and output. Computer contact with humans involves receiving information which is output from the computer systems and the user's responseback using mouse and keyboard to provide input to the computer system. So user output becomes the computer input and vice versa. Web portals and user facing pages are designed with an understanding that web application users with specific tasks. These include browsing, entering data, searching information. The will want to use the web sites in a way that the interface is interactive with respect to their use. This involves use of Computer Human Interactions. Emphasis on manual tasks started with systematic studies on machine human performance for industries and factories since the early twentieth 1900s (Alan Dix, et al., 2004). While this recently gained a lot of attention, the use has been prevalent since the early 1980s. With the increasing use of web application portals and use of different systems and browsing devices, there is a need to deliver enhanced user experience and web performance. This includes designing simple, yet effective web site navigation and user interface interaction experience. The effectiveness in discovering information on the website depends not just on the complex information retrieval application database but also the manner in which the interface pages help make the information accessible. This involves the role of navigational menus. Web sites typically use interface designs like Drop Down, Event Trapping, Liner, Sequential or Simultaneous Menus.

In this research, the authors compared Sequential and Simultaneous menus for User experience browsing the web portals as well as the performance of web applications when using two menus. To accomplish this, web application portalsshould be designed to achieve the following critical goals:

- Ensure high levels of User experience, Ease of Use & Navigation , Presenting information
- Ensure these can be rated form Performance perspective and can be measured

Sequential or Hierarchical Menu has users selectingan option from each menu in serial stepwise succession.The selections must be made in a predetermined order. These are suitable for browsing based on context dependent menu choices, like selecting a Vacation options → Country → City → get list of tourist attractions or similar context menus as illustrated in Figure 1 below, citing an example from Microsoft Portal using Sequential menus which are essentially stepwise tasks. Hierarchical menus tend to have issues difficulties for some tasks. When search or comparisons require multiple selections, users are required to perform repeated choices involving with repeated backtracking within the levels of hierarchy instead of providing the full context. It might not be

possible to display each choice set in a single screen. When keyboard inputs are required, it becomes tedious to enter both option sets for 'C07' for first choosing 'C' menu and then '07' on the next window or webpage.

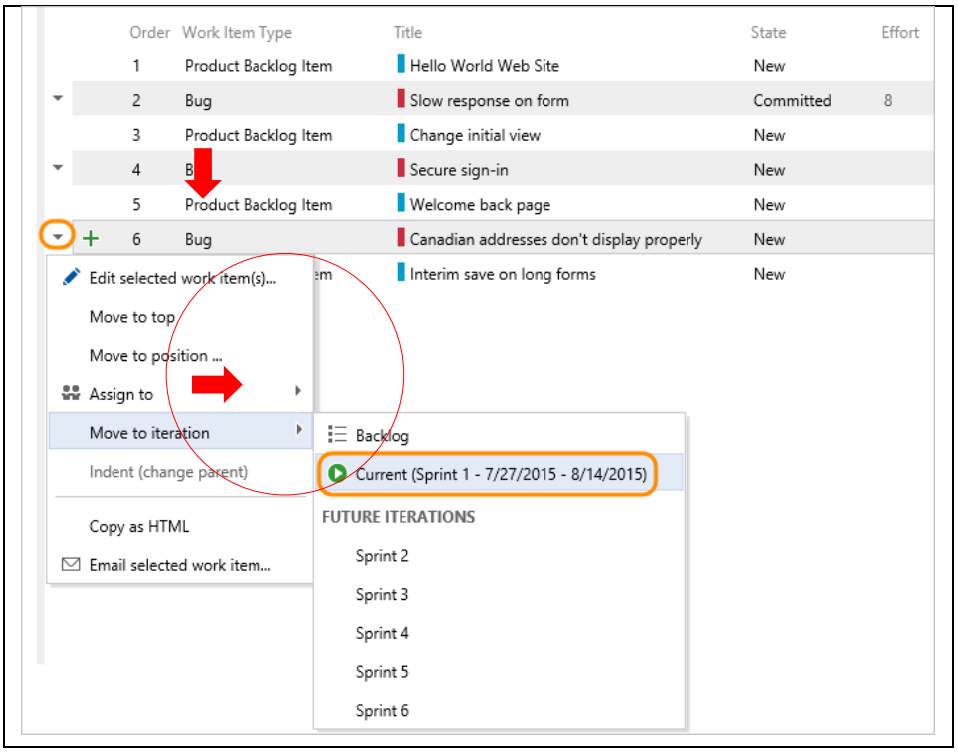

Figure 1: Example of Sequential Menus (Microsoft Bulk Modify Work Items, 2017)

Simultaneous Menus present multiple active menus at the same time and allow users to enter choices in any order. Here the menu options are available simultaneously. The user can select one of multiple responses in any order when filling out a search form. These menus are, in fact, pre-form fill-in method with the restriction that item options are selected rather typed. This is illustrated in the Figure 2 below citing an example of Amazon e-Commerce and US Department of Labour web portal using Simultaneous menus for the web portals.

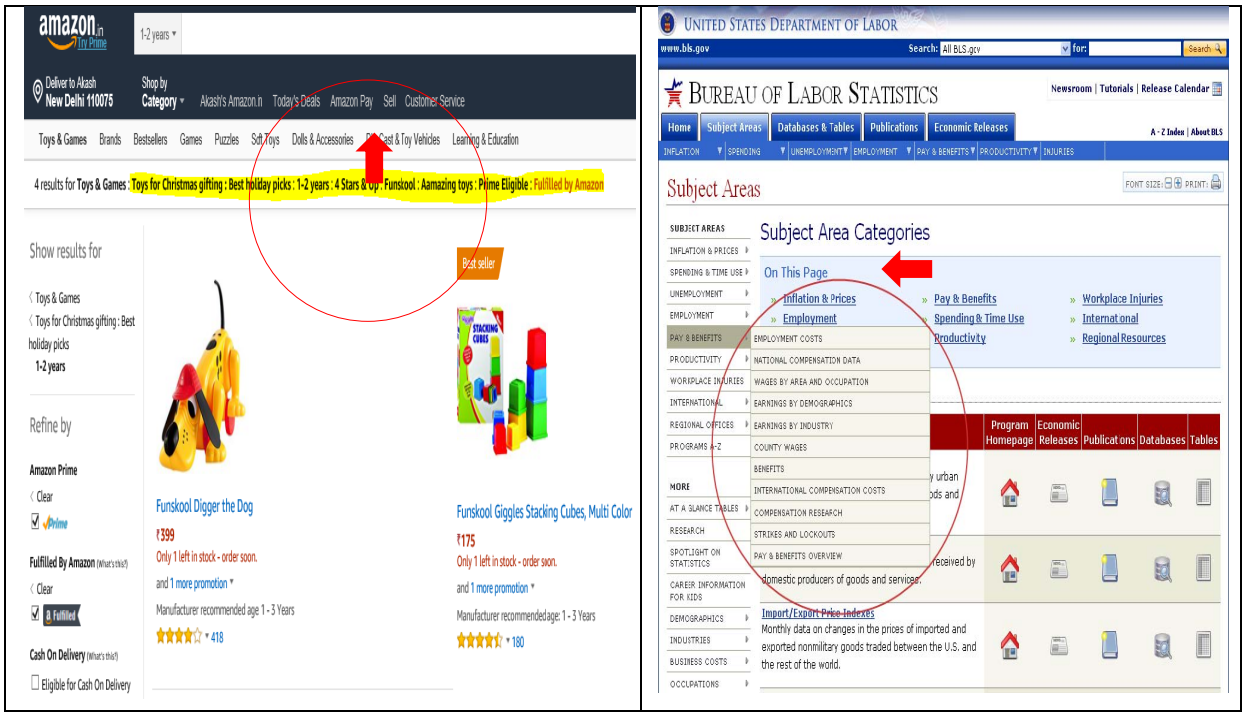

Figure 2: Example of Simultaneous Menus (Amazon Site, 2017 and US Dept. of Labour, 2017)

This research study is based on user interface design area and refers to theories applicable in this area such as good design principles, usability tests, etc. The main theory being referred in this study is on design principles in designing web pages to enhance the usefulness of their use by ordinary visitors.

II. LITERATURE REVIEW

Developers are on the lookout to design and create portalswhich are create simple and clear user interfaces, increase user fulfilment and personalization, ensure frictionless task completion and consistent visual aesthetics (Lavie, et al. 2014) The bottom line is to ensure the web application portal makes the user experience a happy one as well as increases the application performance from delivery standpoint. While various analytical and investigative research studies has been published till date which compare the trade-offs between the web application user experience and web portal performance based on use of different menus designs. This section reviews research papers based on Menu Design and User Experience perspectives and research papers are classified as per the perspectives.

A. Menu Design Perspective

Yamada et al. (2017) presented a tool to improve text reading on web sites. This was performed by converting entity names into links automatically. Then these are displayed as a widget which contains links to several relevant Web sites. Experiments displayed the proposed method outperformed existing state-of-the-art methods significantly.

Pratama et al. (2017), Mesbah, et al. (2012)discussed application development for a family tree portal android phones. The authors evaluated performance and design of mobile application satisfying the user expectations and experience.

Cristina et al. (2017) performed a research study with real time multi-level assessment. Firstly the aim was to investigate the user experience while performing a comprehension task on the web. This was done by use of real-time. Specific attention was given to cognitive load. Secondly the aim was to test the relationship between specific aspects of web design and users experience. The authors also presented and discussed the experimental design.

Most web application browsers are usually static in nature. Choudhary et al. (2017) proposed a novel method for auto extraction of contact details in a web application and presenting in a dynamic menu with voice interface options. This enhanced the user's accessibility via the browser extension. The system was implemented with tags present in HTML or manifested for each of the extracted options. This paper also presented implementation details of the system on a browser describing the implemented user interface.

Kumar et al. (2015) proposed a method to automatically extract and display a website specific menu as part of the browser menu for any website. By selecting the website specific menu option, it enables the user to launch the appropriate application for the type of menu option. The system was implemented using specific Meta tags, HTML tags or manifests for each option. Web developer was provided options to specify the entries by means of these tags. The implementation details of the system were presented for mobile devices and desktops and the research also described various user interfaces.

Lim et al. (2014) investigated the effects of menu design on users' emotion, search task performance and their mouse behaviors. The results were statistically significant. Menu design factors did actually affect user emotions. The users felt uncomfortable with bad combination of colors, smaller font size, text without code, abbreviated text, use of ambiguous term, random display and the need to scroll. However, this discomfort with the bad menu design does not necessarily affect their search job performance.

Drop-down menus are widely used in webpages to limit the format or content that the users input. It is convenient if the contents of drop-down list are fixed or has no dynamic menu label. YingyiduXiong (2012) proposed that a JSP custom tag should be is introduced so that the drop-down menu can extract data from database to generate options dynamically. The custom tag would have strong practice in practical applications.

Jeyalatha et al. (2011) designed and created an academic search web application accessed from database. This provided the user options to assist in organized search and download academic related web pages for various University users. The system was implemented in PHP and MySQL.

Cristina et al. (2011) examined the cross cultural differences on the interaction with the menu of web based application. This involved a comparative multilingual questionnaire determining the impact of user’s culture on design preference of the menu structure used in a vehicular environment. Results confirmed existence of cultural differences among users from Germany, USA and Japan.

Alton et al. (2009) conducted an empirical study on the web designs for restaurant menus. Results showed that too much color or many images, overloaded the senses. This made it almost impossible to pick up any information about the food to order. At the same time, colorless presentations felt bland and uninviting. The food menus designs which achieved balance, deployed unified decorative effects and a limited number of indicative strategies, consistent with principles discussed by Amare and Manning (2006, 2008).

Haruhiko Takeuchi (2009), Songthong et al. (2015) proposed a method for automatically evaluating web site menu structures. The evaluation system required content data and a menu structure with link names as input in a three stage process. This system was also applied to real data, such as Encarta's and Wikipedia's menus. The results confirmed the usefulness of the proposed system.

There is a need to identify and offer new methods and methodologies in order to build a good environment to develop web information systems and to offer to the users, menus which are perfectly adapted to their requirements. Kubryk et al. (2008) presented and compared methods to manage and build adaptive menus. These included ACO model of Dorigo, learning by antpsilas analogy with two smoothing methods. These were compared based on efficiency (answering time and computer load) and accuracy (customer expectations). The aim was to anticipate what a customer is the most open to do without altering his privacy.

Jem M (2002) compared sending compressed data to the client and performed interactive client data visualization on a desktop. The author presented the implication of using a static VRML environment with reduced geometry. These components together with data reduction methods significantly increased the data interaction between the client application and user, and allow tasks to be executed on the client.

B. User Experience Perspective

Abeysiriet al. (2017) proposed a methodology for identifying web application with regards to user satisfaction. The author proposed a structured questionnaire based on the five factors with a sample of 88 Web application users. Then the collected data was analyzed using a statistical tool and the results were validated using a primary data collection with 20 Web application users. The interview process and use of a common factor `satisfaction', helped reveal that usability and user satisfaction only were affected as against the other three variables.

Lenoidis et al. (2017) presented suite of tools offering monitoring, management, programming and testing of Smart IoT environments and Web artifacts (i.e., services, hardware modules, software components). The author introduced a REST-based communication middleware system to streamline synchronous and asynchronous remote services usage. The system also provided support to users who wish to create, explore, deploy, and optimize behavior scripts that combine and orchestrate the various technological facilities of Smart Environments. This was performed by use of universal and personalized exploration facilities to accelerate their discovery and a web-based code editor with context-sensitive support features. This enabled the designers to create innovative interactive experiences for intelligent spaces, but also empowers their inhabitants to tailor the intelligent facilities according to their preferences (Genaro, et al. 2014).

Robal et al. (2017), Pittsley&Memot (2011)addressed automatic evaluation of web user interfaces. The authors discussed ontology design for capturing knowledge of web usability domain for UI evaluation in particular. The author proposed that some of the Testing and validation of user experience done by humans could be executed automatically starting in early development phase.

Renz et al. (2017) raised the concern of locations having low bandwidth of e-learning for universities providing open online courses. The authors highlighted the need for an offline-enabled mode. The paper also explores technical approaches beamed to enhance the user experience in Web-based E-Learning, particular in Africa. These location with slow internet networkexperienced offline and disconnection issues. As a result, the learning process got disrupted, delayed and terminated in such regions.

Contrenas et al. (2017) presented a mobile application for searching places, people and events within a university campus. Leveraging semantic web and augmented reality, the authors developed the application with a high degree of query expressiveness and an enhanced user experience. To validate the work and check the enhanced functionality, a use case example demonstrated the complete searching process.

Lai et al. (2017) and Schmid et al. (2012)investigated the interface design of a web-based formative assessment system. This involved a questionnaire with feedback design in which college students participated. Usability questionnaires were used to collect qualitative and qualitative data. The results are provided for online educators, learning management system developers, and HCI practitioners for future design suggestions.

Hendarti et al. (2017) applied the use of literature study, questionnaire for lecturer and university students on odd semester 2013-14 for Jakarta University, Indonesia. The object of the research focused on the feature or variable of user friendly and menu to satisfaction variable on the web which supported teaching and learning process in university. The research aimed at determining user friendly features and menu which influenced learning process on the web. The authors used Likert scales to illustrate the results that concluded user friendly features influenced user satisfaction on learning process.

III. PROPOSED METHODOLOGY

The methodology used in this investigation study is based on measuring the ratings on web pages having different menus. The participants are 80 in number and belong toa foreign University and comprise of different ethnic and regional groups ranging from New Zealand, Australia, Philippines, India and China. Thea respondents are required to visit web application and submit the tasks provided to them in form of two studies. The web portals have content based on Information Technology courses based on Simultaneous and Sequential Menus. This portals are designed and developed using Adobe Dreamweaver software.Depending on the menus, user need to click number of times and complete the two study tasks. The time required by the participants for submitting each task is calculated on submission of each task. Then the users are required to provide their ratings based on User Experience, Ease of Use, Understanding, Navigation as well as the Amount of Information visible on the web pages as well as and the overall performance is rated (1: lowest to 10: highest).

TABLE 1: STUDY, TASK AND PAGE CONTENT DETAILS

Study	Task	Page Content
Study 1	Task 1	Network Theory – Terminology, Categories, Models, Topologies
	Task 2	Network Models – OSI and TCP/IP Models, IP Addressing, IPv6,
Study 2	Task 1	Network Management – Monitoring, Configuration, Performance Optimization
	Task 2	Information Security – System Tools, Authentication, IDS/IPS, IP Sec VPN

Both study tasks involve three types of questions – easy, medium and difficult. For both studies, the web pages are designed with Simultaneous and Sequential menus.

TABLE 2: TYPE OF TASKS AND PROCESS INVOLVED

Type of Task	Level	Task Process
Type 1 Question	Easy	Users need to select Yes or No for each question
Type 2 Question	Medium	Users are required to select one answer out of four predefined options.
Type 3 Question	Difficult	This task involves writing at least 60 words for each answer

For notational purpose, this sequence can be described as follows.

Study 1 and Study 2 → Tasks 1 & Task 2 → Web Content Level 1 – 2 – 3 → Questions

Using the Keystroke-Level Model (KLM) to calculate the time for competing the task and seeking the parameter score for the command sequences from the end users. For each of the tasks and studies, the authors calculated the time to submit the tasks by calculating the time taken by user to click submit Sutton, which implies completion of the task. KLM sub-divides physical motor operations as follows:

- T: time taken to complete the tasks
- S: Time started
- D: Submitted on completion
- U: User Satisfaction
- E: Ease of Use
- T: Ease of Understanding
- A: Amount of Information
- N: Ease of Navigation
- P: Performance rating

In order to calculate the time taken, $\sum T_{(i=1 \text{ to } 80)} = \sum (T_S - T_D)$.

To calculate the Parameter Scores, the following equations are adopted and illustrated in below sections.

- Score (User Satisfaction $_{(i=1 \text{ to } 80)}$) = $\sum$ ($Score_D$)
- Score (Ease of Use $_{(i=1 \text{ to } 80)}$) = $\sum$ ($Score_U$)
- Score (Ease of Understanding$_{(i=1 \text{ to } 80)}$)= $Score_T$)
- Score (Amount of Information$_{(i=1 \text{ to } 80)}$) = $Score_A$)
- Score (Ease of Navigation $_{(i=1 \text{ to } 80)}$) = $Score_N$)
- Score (Performance Rating $_{(i=1 \text{ to } 80)}$) = $Score_P$)

IV. RESULTS

To validate the study, descriptive statistics – mean, modes, standard deviation, standard errors along with and T-Test as inference statistic is used for evaluating the result data with 80 participants from different industries and background. Research results are illustrated below for two Studies each, this involved two tasks for 80 participants using Web Pages having Simultaneous and Sequential Menus for displaying the Study and Task contents.

Participant	Task Time	User Satisfaction	Ease of Use	Ease of Understanding	Amount of Information	Ease of Navigation	Performance Rating
User #1	1.23	8	9	5	7	9	7
User #2	1.28	9	8	7	7	7	6
User #3	1.41	6	7	5	8	9	9
User #4	1.74	9	6	5	6	9	6
User #5	1.68	8	7	6	8	6	9
User #6	1.63	7	6	8	9	7	6
User #7	1.51	6	5	6	8	8	9
User #8	1.42	6	9	7	8	6	7
User #9	1.56	6	9	6	6	7	8
User #10	1.67	8	10	5	7	9	7
User #11	1.84	9	5	5	8	7	8
User #12	1.37	8	9	8	9	9	9
User #13	1.55	7	7	6	8	6	9
User #14	1.32	9	8	7	9	8	7
User #15	1.73	6	7	8	9	7	8
User #16	1.70	9	8	5	9	9	7
User #17	1.32	7	5	7	7	8	8
User #18	1.59	7	7	6	9	9	7
User #19	1.78	5	7	6	6	6	8
User #20	1.17	7	8	6	9	8	6
User #21	1.57	8	9	7	6	6	8
User #22	1.21	7	9	8	6	8	7
User #23	1.85	6	8	7	7	8	7
User #24	1.79	8	7	8	6	6	8
User #25	1.85	9	6	8	8	6	8
User #26	1.15	9	8	8	8	8	8
User #27	1.94	9	8	5	9	7	6
User #28	1.20	7	9	7	8	9	9
User #29	1.58	7	8	5	7	8	9
User #30	1.35	8	6	5	8	7	9
User #31	1.79	7	8	7	8	7	6
User #32	1.44	7	6	7	9	7	8
User #33	1.51	9	8	7	9	6	9
User #34	1.47	7	9	5	9	8	6
User #35	1.57	8	9	8	9	6	9
User #36	1.61	9	9	5	6	7	8
User #37	1.62	6	5	7	8	8	8
User #38	1.93	8	9	8	8	8	9
User #39	1.49	7	7	6	6	6	9
User #40	1.91	8	5	7	7	9	7

Figure 3: Study 1, Task 1with Simultaneous Menus (1-40 Users)

Participant	Task Time	User Satisfaction	Ease of Use	Ease of Understanding	Amount of Information	Ease of Navigation	Performance Rating
User #41	1.37	8	7	5	7	8	7
User #42	1.21	9	8	8	8	7	7
User #43	1.10	7	9	8	6	7	6
User #44	1.62	9	8	6	9	8	7
User #45	1.63	7	6	8	7	9	8
User #46	1.51	6	5	7	6	7	6
User #47	1.73	8	9	7	7	7	8
User #48	1.66	8	6	7	8	6	7
User #49	1.41	9	7	5	9	8	8
User #50	1.57	6	8	5	7	8	6
User #51	1.71	7	5	5	7	7	8
User #52	1.21	9	9	6	7	7	8
User #53	1.52	8	5	5	9	9	9
User #54	1.78	5	5	5	7	6	8
User #55	1.15	7	8	5	7	9	6
User #56	1.39	8	7	6	8	9	6
User #57	1.10	6	6	6	9	6	7
User #58	1.41	6	7	5	7	8	7
User #59	1.61	7	7	7	7	8	7
User #60	1.68	7	8	7	8	6	9
User #61	1.57	6	9	5	8	9	7
User #62	1.25	9	5	8	6	6	6
User #63	1.16	7	7	5	7	8	6
User #64	1.28	6	8	8	8	9	7
User #65	1.52	9	9	8	9	9	8
User #66	1.43	7	6	5	8	7	8
User #67	1.91	8	8	8	9	8	6
User #68	1.48	6	7	5	8	9	8
User #69	1.22	6	5	5	6	8	8
User #70	1.52	6	9	6	6	7	9
User #71	1.29	7	8	5	7	8	8
User #72	1.57	5	5	7	8	7	9
User #73	1.44	7	9	8	7	9	9
User #74	1.19	8	7	5	8	7	8
User #75	1.76	7	9	5	6	9	7
User #76	1.32	8	8	8	6	9	8
User #77	1.70	7	8	6	7	9	9
User #78	1.61	8	6	6	9	6	7
User #79	1.44	7	7	8	8	8	9
User #80	1.80	9	9	7	8	7	8

Figure 4: Study 1, Task 1 with Simultaneous Menus (41-80 Users)

Participant	Takes Time	User Satisfaction	Ease of Use	Ease of Understanding	Amount of Information	Ease of Navigation	Performance Rating
User #1	1.94	6	8	6	9	8	8
User #2	1.89	6	7	7	7	7	9
User #3	2.18	8	9	8	8	7	9
User #4	2.15	9	8	8	9	6	9
User #5	1.79	9	6	6	8	8	9
User #6	2.25	8	6	8	7	8	9
User #7	1.86	8	9	9	7	6	6
User #8	2.36	9	9	7	7	9	9
User #9	2.15	6	9	6	6	8	6
User #10	2.07	9	9	7	9	8	6
User #11	2.42	7	7	7	8	7	7
User #12	2.18	6	9	8	7	9	6
User #13	2.18	8	7	6	8	7	7
User #14	1.58	8	9	6	7	9	6
User #15	2.18	8	8	7	9	7	6
User #16	2.23	6	8	9	8	8	6
User #17	1.48	9	7	7	9	6	8
User #18	2.09	9	9	9	8	8	6
User #19	2.03	6	8	9	7	8	6
User #20	2.15	7	8	6	9	7	9
User #21	2.33	9	9	7	6	7	7
User #22	2.46	7	6	9	8	9	8
User #23	1.94	7	8	8	8	9	9
User #24	1.61	9	6	9	9	7	9
User #25	1.54	8	8	7	6	9	6
User #26	2.09	8	9	9	7	7	6
User #27	2.21	6	9	9	7	7	6
User #28	2.18	8	8	7	8	8	8
User #29	2.25	6	6	6	9	7	6
User #30	1.64	7	9	9	8	8	8
User #31	1.45	8	9	7	8	6	6
User #32	1.93	6	8	6	8	9	9
User #33	1.73	6	9	7	7	7	6
User #34	2.31	6	8	7	8	6	6
User #35	2.07	7	6	7	8	9	6
User #36	1.47	7	6	7	9	9	9
User #37	2.03	9	9	6	8	7	7
User #38	1.34	9	6	7	7	7	6
User #39	1.53	9	8	8	9	9	6
User #40	2.01	8	9	6	9	6	9

Figure 5: Study 1, Task 2with Simultaneous Menus (1-40 Users)

Participant	Takes Time	User Satisfaction	Ease of Use	Ease of Understanding	Amount of Information	Ease of Navigation	Performance Rating
User #41	2.10	8	8	6	6	8	9
User #42	1.76	9	9	6	6	9	6
User #43	2.22	9	6	8	7	8	9
User #44	2.22	7	8	6	6	8	8
User #45	2.24	8	8	6	6	6	8
User #46	1.84	9	9	7	6	6	8
User #47	2.33	9	8	6	9	9	7
User #48	1.30	8	6	9	7	7	8
User #49	2.01	8	7	8	9	8	8
User #50	1.91	7	9	7	6	7	7
User #51	1.46	6	9	7	7	9	7
User #52	2.32	7	6	7	6	9	6
User #53	1.60	8	9	7	9	7	6
User #54	1.50	9	7	6	6	7	7
User #55	1.39	9	9	7	9	9	7
User #56	1.91	7	6	6	9	8	8
User #57	1.57	6	8	6	9	7	9
User #58	1.99	7	6	8	8	6	6
User #59	1.70	6	9	7	7	6	7
User #60	2.32	6	6	7	7	8	7
User #61	2.16	8	8	7	6	7	6
User #62	1.64	7	6	6	6	6	8
User #63	2.34	9	7	6	8	9	7
User #64	2.25	9	9	7	6	8	6
User #65	2.42	7	9	7	7	7	7
User #66	2.45	7	7	6	8	8	8
User #67	1.89	8	8	6	9	7	7
User #68	1.54	8	7	6	9	9	8
User #69	1.99	8	7	9	9	8	8
User #70	2.08	7	9	9	8	6	6
User #71	2.26	9	8	6	7	7	8
User #72	2.02	6	7	8	8	7	6
User #73	1.79	6	7	9	8	7	6
User #74	2.22	8	6	8	7	7	9
User #75	1.79	6	6	9	9	9	6
User #76	2.10	8	6	9	8	9	9
User #77	2.44	7	9	7	7	9	9
User #78	1.69	6	9	9	9	6	8
User #79	2.15	9	8	6	6	6	7
User #80	2.21	9	8	9	6	7	9

Figure 6: Study 1, Task2 Simultaneous Menus (41-80 Users)

Participant	Task Time	User Satisfaction	Ease of Use	Ease of Understanding	Amout of Information	Ease of Navigation	Performance Ratings
User #1	2.04	4	7	7	8	5	5
User #2	1.59	7	6	7	5	7	6
User #3	1.36	7	5	7	5	7	6
User #4	1.20	4	4	7	7	5	7
User #5	1.52	5	6	6	6	6	5
User #6	3.15	7	6	8	5	5	7
User #7	1.89	5	4	6	6	8	6
User #8	2.21	7	8	5	5	5	7
User #9	3.30	6	6	5	5	7	7
User #10	1.69	6	5	5	7	5	5
User #11	1.90	5	6	7	8	8	7
User #12	1.50	8	7	6	5	7	8
User #13	2.55	5	4	7	7	6	6
User #14	3.13	7	4	8	5	8	5
User #15	3.03	4	8	6	7	8	8
User #16	2.87	4	6	6	5	5	6
User #17	3.08	7	7	6	8	6	6
User #18	3.14	4	8	8	8	5	5
User #19	2.88	6	6	6	8	5	6
User #20	1.58	6	5	6	7	8	5
User #21	3.04	6	5	5	7	5	6
User #22	1.56	7	8	5	5	7	7
User #23	2.43	5	8	7	5	5	6
User #24	1.30	5	8	6	7	8	5
User #25	2.29	6	8	5	5	5	6
User #26	2.82	6	4	8	5	6	9
User #27	1.29	7	5	5	8	5	8
User #28	2.44	7	7	7	7	8	5
User #29	1.71	8	8	8	7	6	7
User #30	3.02	4	5	7	7	7	6
User #31	2.27	8	5	5	5	8	8
User #32	1.82	5	4	6	5	5	7
User #33	1.73	6	8	5	6	8	7
User #34	2.08	4	4	8	7	6	7
User #35	1.37	7	5	7	7	7	5
User #36	1.81	6	5	8	5	6	7
User #37	3.10	8	8	6	5	5	5
User #38	1.80	5	6	8	6	8	6
User #39	1.90	8	8	7	7	6	7
User #40	1.81	5	7	5	8	8	6

Figure 7: Study 2, Task 1 with Sequential Menus (1-40 Users)

Participant	Task Time	User Satisfaction	Ease of Use	Ease of Understanding	Amout of Information	Ease of Navigation	Performance Ratings
User #41	1.73	4	5	8	6	5	7
User #42	2.80	7	4	5	5	8	6
User #43	2.70	8	7	6	6	6	5
User #44	1.60	4	7	8	5	5	6
User #45	1.96	7	6	8	7	5	8
User #46	1.55	7	8	6	8	5	8
User #47	1.76	7	4	7	5	6	6
User #48	1.91	8	8	5	7	6	5
User #49	3.27	5	5	5	6	5	7
User #50	3.21	6	4	6	7	7	6
User #51	1.64	7	6	8	6	6	7
User #52	3.17	7	8	7	7	6	7
User #53	1.25	8	5	6	5	7	8
User #54	2.31	4	5	6	5	5	7
User #55	1.33	8	8	8	7	6	8
User #56	1.28	4	6	6	8	5	7
User #57	1.20	5	4	5	6	8	6
User #58	3.08	6	5	5	7	5	6
User #59	1.79	4	7	6	6	5	6
User #60	1.28	7	6	8	6	6	7
User #61	2.33	8	7	7	6	5	5
User #62	1.22	4	6	7	6	8	8
User #63	1.90	7	8	7	6	8	6
User #64	1.50	8	4	8	5	8	7
User #65	1.29	5	7	7	6	5	7
User #66	1.57	5	4	8	6	5	8
User #67	2.64	5	7	7	8	7	7
User #68	2.30	6	8	6	8	6	6
User #69	1.92	7	6	8	7	5	8
User #70	1.32	4	5	7	5	8	6
User #71	3.01	8	6	8	7	5	8
User #72	3.27	4	8	7	8	7	7
User #73	2.74	4	8	6	8	5	6
User #74	1.28	8	6	8	8	8	8
User #75	1.71	7	7	7	7	5	6
User #76	3.27	4	7	8	5	7	7
User #77	3.21	7	8	7	8	6	6
User #78	2.42	6	8	5	6	6	6
User #79	2.19	4	8	6	7	8	8
User #80	1.98	4	6	8	5	7	7

Figure 8: Study 2, Task 1 with Sequential Menus (41-80 Users)

Participant	Task Time	User Satisfaction	Ease of Work	Ease of Understanding	Amout of Information	Ease of Navigation	Performance Ratings
User #1	3.27	6	7	6	5	4	8
User #2	1.33	5	6	5	7	4	8
User #3	2.60	8	7	8	7	4	8
User #4	1.60	5	7	7	5	6	6
User #5	2.20	7	8	6	6	6	6
User #6	2.29	5	5	8	7	5	7
User #7	2.51	5	6	6	6	5	7
User #8	2.80	7	7	7	4	7	5
User #9	2.29	5	6	4	4	4	8
User #10	3.30	8	5	7	5	6	8
User #11	2.05	7	7	4	6	7	5
User #12	1.20	8	6	6	6	5	6
User #13	3.11	5	7	7	5	4	5
User #14	2.14	6	8	4	6	5	7
User #15	2.87	7	7	4	5	4	8
User #16	1.32	7	7	5	7	8	6
User #17	2.52	6	5	7	5	6	6
User #18	1.79	6	5	5	6	4	5
User #19	2.43	5	7	7	7	4	8
User #20	2.07	5	5	6	5	8	8
User #21	1.38	5	5	4	6	8	8
User #22	1.65	8	7	5	5	6	7
User #23	2.02	5	5	7	8	8	8
User #24	1.97	6	6	5	6	6	6
User #25	2.65	7	5	5	6	5	7
User #26	2.96	6	7	7	5	7	7
User #27	1.99	6	7	7	6	8	6
User #28	1.51	5	6	6	5	8	5
User #29	3.16	8	6	4	6	7	5
User #30	3.01	8	7	8	4	6	8
User #31	1.60	5	5	4	4	4	8
User #32	2.18	7	5	7	4	6	5
User #33	2.40	8	7	6	6	8	5
User #34	1.53	5	8	7	8	6	5
User #35	1.97	7	7	5	4	7	8
User #36	2.13	8	7	5	6	6	7
User #37	1.47	5	6	5	4	4	8
User #38	1.62	6	6	7	6	5	8
User #39	1.67	8	7	5	6	5	5
User #40	1.85	8	6	7	8	6	8

Figure 9: Study 2, Task 2 with Sequential Menus (1-40 Users)

Participant	Task Time	User Satisfaction	Ease of Work	Ease of Understanding	Amout of Information	Ease of Navigation	Performance Ratings
User #41	3.19	6	6	4	5	6	7
User #42	1.87	7	8	6	8	6	5
User #43	2.88	6	5	6	8	7	8
User #44	2.4-	7	7	5	7	5	7
User #45	1.91	7	5	7	8	7	5
User #46	2.55	7	5	4	7	8	6
User #47	1.47	8	6	6	5	8	5
User #48	2.1	5	5	7	4	6	8
User #49	3.22	8	6	5	5	6	7
User #50	1.61	8	5	4	4	5	5
User #51	2.89	5	7	4	8	8	8
User #52	2.8-	6	7	4	6	5	5
User #53	2.65	6	8	4	5	6	5
User #54	1.79	5	6	4	7	5	6
User #55	1.79	6	5	4	6	6	8
User #56	2.31	5	7	5	7	7	8
User #57	1.51	6	6	8	7	7	7
User #58	1.01	7	7	4	6	5	5
User #59	2.1-	6	6	6	8	7	6
User #60	3.05	5	5	4	4	5	8
User #61	1.2-	5	6	6	6	7	6
User #62	3.01	5	7	4	8	8	7
User #63	2.18	7	5	6	5	7	7
User #64	1.32	7	6	7	5	5	7
User #65	2.00	6	5	8	6	7	5
User #66	2.56	8	7	8	7	4	7
User #67	2.97	5	7	4	8	7	7
User #68	1.59	6	7	7	5	8	6
User #69	1.36	7	5	7	5	5	8
User #70	1.67	8	5	6	4	6	7
User #71	2.37	6	7	7	7	4	5
User #72	3.06	6	5	4	7	7	7
User #73	1.96	8	8	6	4	4	8
User #74	2.28	7	6	6	8	5	8
User #75	3.08	6	8	7	4	5	8
User #76	1.35	5	6	7	6	8	8
User #77	2.91	8	6	6	5	5	7
User #78	1.97	8	5	6	5	6	8
User #79	1.4-	7	6	5	7	7	6
User #80	2.5-	6	7	7	6	5	7

Figure 10: Study 2, Task 2 with Sequential Menus (41-80 Users)

V. RESULT ANALYSIS

This section involves using T TestDistribution for each parameter to compare the task variances with the variance.The author states that the Null Hypothesis (H0) is selected if there is ZERO difference in variances and alternate hypothesis (Ha) is selected if the difference in variance is greater than ZERO.

	Simultaneous Menu	*Sequential Menu*
Mean	7.3875	5.9375
Variance	1.303639241	2.059335443
Observations	80	80
Pearson Correlation	-0.108640857	
Hypothesized Mean Difference	0	
df	79	
t Stat	6.725129408	
P(T<=t) one-tail	1.24709E-09	
t Critical one-tail	1.664371409	
P(T<=t) two-tail	2.49419E-09	
t Critical two-tail	1.99045021	

Paired *t* test results

P value and statistical significance:
The two-tailed P value is less than 0.0001

Confidence interval:
The mean of Group One minus Group Two equals 1.45
95% confidence interval of this difference: From 1.02 to 1.88

Intermediate values used in calculations:
t = 6.7251
df = 79
standard error of difference = 0.216

Figure 11: T-Test for variance (User Experience)

	Simultaneous Menu	*Sequential Menu*
Mean	7.75	5.9375
Variance	1.35443038	2.059335443
Observations	80	80
Pearson Correlation	0.028422501	
Hypothesized Mean Difference	0	
df	79	
t Stat	8.898781907	
P(T<=t) one-tail	7.66765E-14	
t Critical one-tail	1.664371409	
P(T<=t) two-tail	1.53353E-13	
t Critical two-tail	1.99045021	

Paired *t* test results

P value and statistical significance:
The two-tailed P value equals 0.0611

Confidence interval:
The mean of Group One minus Group Two equals -0.39
95% confidence interval of this difference: From -0.79 to 0.02

Intermediate values used in calculations:
t = 1.8996
df = 79
standard error of difference = 0.204

Figure 12: T-Test for variance (Ease of Use)

	Simultaneous Menu	*Sequential Menu*
Mean	6.375	6.6
Variance	1.401898734	1.179746835
Observations	80	80
Pooled Variance	1.290822785	
Hypothesized Mean Difference	0	
df	158	
t Stat	-1.252504233	
P(T<=t) one-tail	0.106118446	
t Critical one-tail	1.654554875	
P(T<=t) two-tail	0.212236891	
t Critical two-tail	1.975092073	

Paired *t* test results

P value and statistical significance:
The two-tailed P value equals 0.2376

Confidence interval:
The mean of Group One minus Group Two equals -0.23
95% confidence interval of this difference: From -0.60 to 0.15

Intermediate values used in calculations:
t = 1.1900
df = 79
standard error of difference = 0.189

Figure 13: T-Test for variance (Ease of Understanding)

	Simultaneous Menu	*Sequential Menu*
Mean	7.6	6.35
Variance	1.103797468	1.243037975
Observations	80	80
Pooled Variance	1.173417722	
Hypothesized Mean Difference	0	
df	158	
t Stat	7.298165158	
P(T<=t) one-tail	6.68655E-12	
t Critical one-tail	1.654554875	
P(T<=t) two-tail	1.33731E-11	
t Critical two-tail	1.975092073	

Paired *t* test results

P value and statistical significance:
The two-tailed P value is less than 0.0001

Confidence interval:
The mean of Group One minus Group Two equals 1.25
95% confidence interval of this difference: From 0.89 to 1.61

Intermediate values used in calculations:
t = 6.9405
df = 79
standard error of difference = 0.180

Figure 14: T-Test for variance (Amount of Information)

	Simultaneous Menu	*Sequential Menu*
Mean	7.6	6.2625
Variance	1.179746835	1.436550633
Observations	80	80
Pooled Variance	1.308148734	
Hypothesized Mean Difference	0	
df	158	
t Stat	7.395971411	
P(T<=t) one-tail	3.87685E-12	
t Critical one-tail	1.654554875	
P(T<=t) two-tail	7.75371E-12	
t Critical two-tail	1.975092073	

Paired *t* test results

P value and statistical significance:

The two-tailed P value is less than 0.0001

Confidence interval:

The mean of Group One minus Group Two equals 1.34

95% confidence interval of this difference: From 0.96 to 1.72

Intermediate values used in calculations:

t = 6.9825

df = 79

standard error of difference = 0.192

Figure 15: T-Test for variance (Ease of Navigation)

	Simultaneous Menu	*Sequential Menu*
Mean	7.6125	6.5375
Variance	1.101107595	1.011234177
Observations	80	80
Pooled Variance	1.056170886	
Hypothesized Mean Difference	0	
df	158	
t Stat	6.615632378	
P(T<=t) one-tail	2.71807E-10	
t Critical one-tail	1.654554875	
P(T<=t) two-tail	5.43614E-10	
t Critical two-tail	1.975092073	

Paired *t* test results

P value and statistical significance:

The two-tailed P value is less than 0.0001

Confidence interval:

The mean of Group One minus Group Two equals 1.08

95% confidence interval of this difference: From 0.75 to 1.40

Intermediate values used in calculations:

t = 6.6421

df = 79

standard error of difference = 0.162

Figure 16: T-Test for variance (Performance Ratings)

From the above analysis, the authors rejected the null hypothesis as for each of the parameters (User Experience, Ease of Use, Ease of Understanding, Amount of Information, Ease of Navigation and Performance Ratings). For each of these parameters, the pair of samples selected have unequal variances and the difference is always greater than zero.

Function / Menu	Task Time	User Satisfaction	Ease of Use	Ease of Understanding	Amount of Information	Ease of Navigation	Performance Ra
Simultaneous Study 1	*1.51*	*7.37*	*7.34*	*6.43*	*7.6*	*7.57*	*7.62*
Simultaneous Study 2	*1.96*	*7.59*	*7.71*	*7.25*	*7.62*	*7.56*	*7.25*
Sequential Study 1	*2.14*	*5.94*	*6.2*	*6.6*	*6.35*	*6.26*	*6.54*
Sequential Study 2	*2.19*	*6.39*	*6.21*	*5.75*	*5.88*	*5.99*	*6.71*

Figure 17: Average of each parameter for both Study Tasks

On further analysis, the authors calculated the average for each critical parameter for both the Studies and each of the two tasks. Results from Simultaneous menus displays Study 1, pointing to the same inference that use of Simultaneous Menus is far more effective as compared to use of Sequential Menus. The graph highlights the analysis that Study 2 has higher average for most of the tasks, which points to the deduction that the Tasks for Study 2 which was performed using Sequential Menus has far better user acceptance as compared to the Tasks for Study 1 which was performed using Simultaneous Menus.

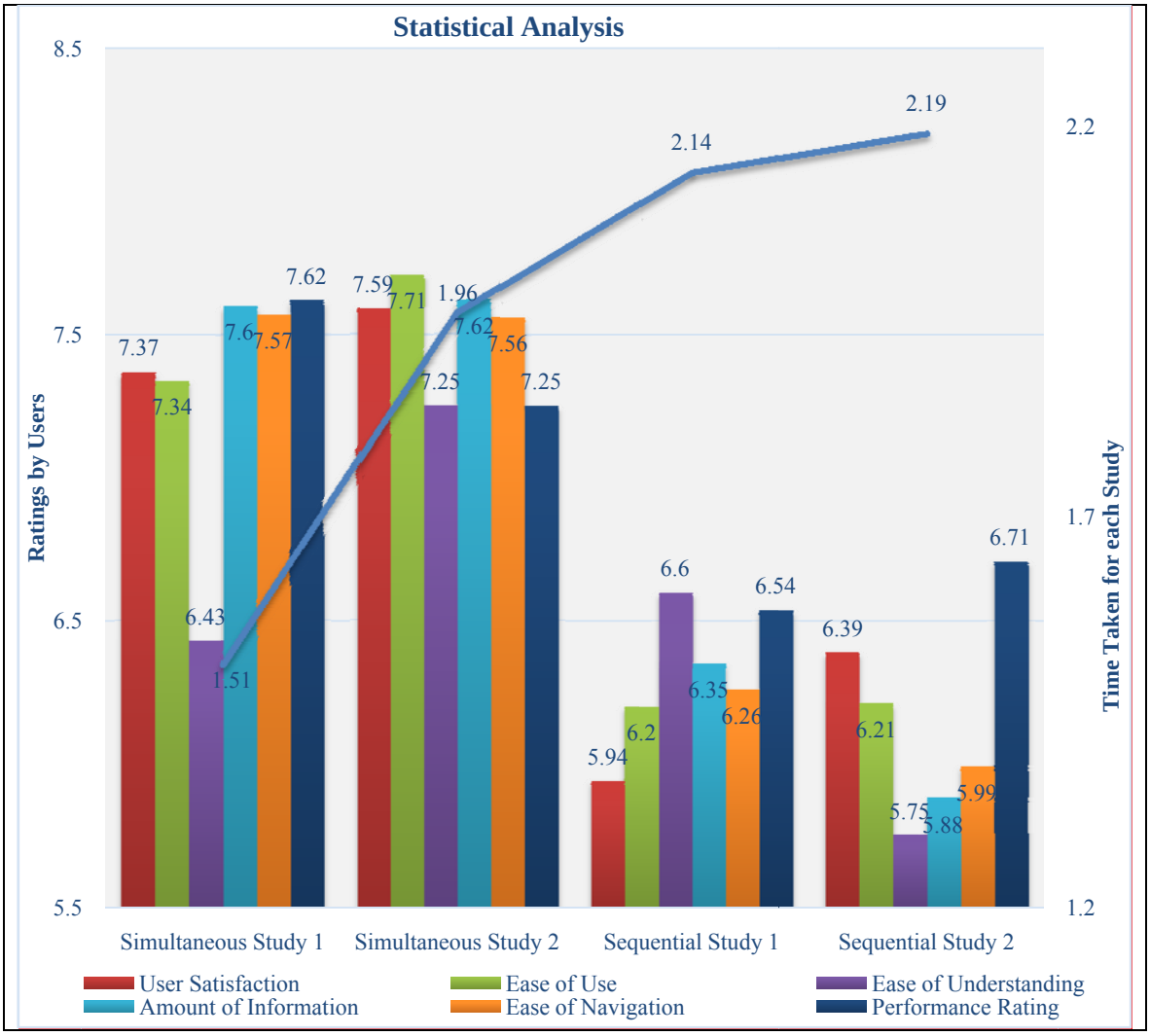

Figure 18: Critical Analysis of each Study and Tasks for various parameters

CONCLUSION

From the research survey performed and analysis of the parameters values, the authors conclude that use of simultaneous menus leads to improvement in critical parameters for user ratings. For this research total time taken for tasks submissions is auto calculated by the application post task submission. User Satisfaction, Ease of Use, Ease of Understanding, Amount of information displayed on the pages and Ease of Navigation are the critical parameters selected as the major factors for the survey. The User Ratings present a significant trend for use of Simultaneous and Sequential menus. After applying F-Test, statistics analysis of variance with F-critical one-tail correlation is performed. The final inference is that as per the results from data analysis there is a clear preference for Sequential Menus by users and an action item for developers when designing new application portals. It is further determined from the average scores of the two parameters that users accessing and working on web sites prefer Sequential Menus in form of web content.

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