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Analysis of User Experience Quality on Responsive Web Design from its Informative Perspective

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Abstract

This study aims to assess the user experience quality of responsive web design on mobile devices. Data were collected from 156 students at Universitas Indonesia, who were asked to evaluate user experience of web design on one of the following scenarios: responsive web design in both desktop and mobile device environment and nonresponsive web design in mobile device environment. The user experience quality was measured by looking at the number of clicks and scrolls as well as information quality that has been experienced by user. The results of the ANOVA test proved that responsive web design was able to maintain the user experience quality of website on home functionality, content readability, and enjoyment using website but not on the information architecture. In addition, responsive web design was also proven to reduce the amount of scrolling when reading content. However, responsive web design required more scroll and click than nonresponsive one when exploring its information architecture.

Keywords: *responsive web design, user experience quality, mobile device, informative perspective*

1. Introduction

Different browser's resolution size between different devices, especially mobile devices, can lead to a broken design problem. This is because a website may be accessed through a browser which size is below an expected minimum width [1]. This condition may cause hidden critical links, hidden components, as well some hidden important information that should have been presented to users without needing them to do horizontal scrolling thus decreasing the deliverable effect of certain values from website. Moreover, it can decrease website experience for website users.

Many companies created a different version of mobile websites to make website's user interface (UI) complies on different mobile browser's resolution size. Unfortunately, creating a new mobile website for every new-coming browser's resolution size is not a feasible thing to do [2]. It can decrease the productivity and demand more budgets from the company. Actually, what user really needs for mobile website is a single website which has UI that is not only PC-compliant but also flexible to many tablets and mobile phones without any configuration [2]. Even though being accessed from different browser's resolution size, the website also should be able to maintain the information and values inside through flexible UI for users [3].

Since its appearance in 2011, responsive design has offered flexibility to adapt UI of a single website to handle different resolution range so that user on different devices can experience the same expected website design [1]. Unfortunately, there hasn't been any research yet to prove whether it successfully maintains user experience quality on many devices although there are many technical articles about it on search engine results.

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2. Literature Review and Hypotheses Development

According to Jeffrey Zeldman, responsive design is a technique that designers use to deliver elegant visual experience regardless any browser size used and any constraints lied on accessing device [4]. A design is considered to be responsive if it uses these three points: a flexible grid, flexible images and media, and media queries [1]. By using media queries, website designers can define certain resolution ranges as conditions to use certain CSS definitions called fixed breakpoints [5]. That way, the designer can match which CSS definition will be applied to a given resolution that will create better visual experience to the website users.

On June 2012, Google's Pierre Far recommended responsive web design to companies that were going to build mobile website so that a single website can adapt on many browser's resolution [6]. It can help website developers to maintain only a single website, thus reducing time and complexity in maintaining multi websites [6]. Even though the definition and the steps to build responsive websites are easily found in search engines, there has not been any research yet whether the use of responsive web design is able to maintain website quality on any devices or not. Therefore, in this research, the quality of responsive web design was tested from success factor in achieving responsive web design's purpose and the benefit of its use.

According to Webtise, responsive web design is used with purpose/goal to ensure the website information to be delivered well without any loss of information regardless of any mobile devices it is opened from [7]. According to Cerejo [8], information quality of a website can be observed through 3 of 12 mobile user experience aspects, namely: functionality, information architecture, and content. A website's functionality should be informed from its homepage; therefore we observed home functionality later on this research regarding to the functionality aspect [9].

According to Frank Farris, responsive design on mobile device creates a website that needs less user interactions (scroll and click) than nonresponsive website does on mobile device to accomplish the same goal [10]. The benefit of responsive web design is said so because a website which can adapt its layout to browser's size should be able to adapt font's, pictures', and other component's size so that user can read the whole content without doing any horizontal scrolling to see hidden parts of website. Total click caused by mistakes should be decreased because responsive website is actually designed to create comfortable UI and handle limited size of mobile browser.

By considering the purpose and benefit of the responsive web design, we posit the following hypotheses:

H1: There is a significant difference of home functionality quality between different designs on different devices.
H2: There is a significant difference of information architecture (navigability) quality between different designs on different devices.
H3: There is a significant difference of content readability quality between different designs on different devices.
H4: There is a significant difference of enjoyment of using website between different designs on different devices.
H5: There is a significant difference of total scrolls used while exploring home functionality between different designs on different devices.
H6: There is a significant difference of total scrolls used while exploring information architecture (navigability) between different designs on different devices.

H7: There is a significant difference of total scrolls used while exploring content readability between different designs on different devices.
H8: There is a significant difference of total clicks used while exploring information architecture (navigability) between different designs on different devices.

3. Research Method

3.1. Respondents

The experiments were conducted to 156 students of Universitas Indonesia that met certain criteria. In order to avoid bias of user skills in using mobile device, we limited the respondents to those who are familiar with web browser in mobile device. Based on Khalaf [11], Americans usually browse for total 70 minutes per day in 2012, thus we only selected respondents who use web browser in their mobile device for minimum 60 minutes a day. This selection of respondents is part of our mechanism to guarantee the validity of our research.

3.2. Experiment Procedures

We asked respondents to do some tasks as part of usability testing and post-experiment survey. The following describes how we set our experiments:

- Each respondent was assigned randomly to one of the three designed environments and was given the same instructions.
- Once the homepage of the environment's website was shown, respondents were instructed to look and read whole information on it. Then, we recorded total scrolls used.
- Next, respondents were instructed to search an article somewhere inside the website titled "Kenali Anemia Aplastik". We did not provide search menu in the environment so that respondents had to search through given navigation menu or links as a part of exploring information architecture (navigability). Once the respondents opened a full page of the article, total scrolls and total clicks used were recorded. Total clicks were recorded only in this task because while searching article, respondents were supposed to click and move from one page to another one.
- As the last part of usability testing, respondents were instructed to read the opened article from the first to last sentence. After respondent finished reading, total scrolls used were recorded.
- After usability testing had finished, respondents had to complete the post-experiment survey regarding their experiences when using the designed environment we prepared. The respondents were asked to give ratings on the design they were working in for the following aspects: home functionality, information architecture (navigability), content readability, and enjoyment using website. We have developed 13-item questionnaires on 5-points Likert scale (from 'strongly disagree' to 'strongly agree') to measure these aspects. The complete questionnaire can be found in the Appendix.

3.3. Experiment Objects

Layout design, colors, and interactions of environments were made similar to a news site TIME as it is one of several recommended responsive websites in 2013 [12, 13]. Contents of the websites were taken from two Indonesian news sites.

In responsive web design, web designers mostly create three different layout designs, which are usually made for three different common devices: smartphones, tablets, and desktop monitor, creating three common breakpoints [14]. Smartphones and tablets are devices that people use

when they are mobile. Thus, we considered these two as the same type of devices: mobile devices.

We chose to use desktop and one mobile device platform to test the usability of responsive design. The resolution we used for mobile device and desktop were 320x480 pixels and 1280x760 pixels respectively. The responsive website was designed in 3 common breakpoints with each kinds of UI: above 767 pixels, between 481 pixels and 767 pixels, and under 481 pixels [14]. On the other hand, nonresponsive website was designed on a single UI for 1024 pixels layout. Either responsive or nonresponsive website will display an identical UI if it is opened through 1280x760 pixels (desktop). Thus, we excluded the option to access nonresponsive website on desktop from environment lists. The followings are three environments used as experiment objects as shown in Figure 1:

- Environment 1: responsive website accessed on mobile device.
- Environment 2: nonresponsive website accessed on mobile device.
- Environment 3: responsive website accessed on desktop.

Figure 1. Experiment Objects

4. Results and Analyses

The respondent demographics showed that 14%, 39%, and 47% of them use their mobile device for browsing for 60-90 minutes, 90-120 minutes, and above 120 minutes a day respectively. Having these values, we guarantee that our respondents have comparable skills in using browser in mobile device.

4.1. Reliability, Validity and Normality Test

Our instruments were validated by using reliability and validity test. An item is considered valid if corrected item-total correlation score is greater than r-table score. R-table score in this research was 0.157 with a significant level of 0.05, value of df was 154, and value of t was 1.975. Corrected item-total correlation scores from first to last questionnaire item were 0.549, 0.631, 0.547, 0.567, 0.629, 0.520, 0.447, 0.560, 0.570, 0.590, 0.581, 0.442 and 0.568 which mean that all items were valid.

In order to measure the reliability of each variable, we used Cronbach's Alpha value. A variable is said to be reliable when its Cronbach Alpha value is equal to or greater than 0.70 [15]. Cronbach's Alpha for home functionality, information architecture (navigability), content readability and enjoyment of using website were 0.706, 0.756, 0.776 and 0.776 respectively. Thus all variables were reliable.

We also did normality test before conducting hypotheses test. The normality of data can be seen by using skewness and kurtosis for each variable. The data is considered to be normal if abs (skewness) ≤ 1, and abs (kurtosis) ≤ 1 [15]. If the data is not normal, we can remove all outliers. Data is considered as an outlier if its Z-score is not in the range of -3.0 to 3.0 [16]. If outlier removal does not improve the normality, we can transform the data. In this research, we used log transformation as it can be used to improve data that have positive skew [17]. Based on

the normality test, there were two outliers in information architecture (navigability) data so that these two were excluded from hypotheses test, whereas data for home functionality, content readability, and enjoyment of using website were considered to be normal. All data of total scrolls used in exploration of home functionality, information architecture (navigability), content readability, and of total click used in exploration of information architecture (navigability) were transformed by using log transformation. Detail of normality test results can be seen in Table 1.

Table 1. Result of Normality Test

Variable	Skewness	Kurtosis
Home functionality	-0.511	1.644
Information architecture (navigability)	-0.201	-0.105
Readability content	-0.348	0.465
Enjoyment of using website	-0.271	0.060
Scroll of home functionality	-0.326	-0.862
Scroll of information architecture	-0.392	-0.898
Scroll of readability content	0.384	-0.819
Click of information architecture	0.964	0.081

4.2. Hypotheses Test Results

For the purpose of analysis, the mean difference between each environment on the analysis was observed. The means for home functionality, information architecture (navigability), content readability, and enjoyment of using website were calculated by finding the total score average of the items constructing each variable. The means for total scrolls and total clicks were calculated by finding the average data that have been recorded during usability testing. Table 2 summarized the means of our measurement metrics for each environment.

One way ANOVA was used to observe the significance of mean difference between three environments. Then, post hoc test was conducted to see which pair of environments that has the significant difference by using Bonferroni or Games-Howell. Bonferroni was used when the homogeneity of variances showed equal variance between all environments (used on 1st to 7th hypotheses) while Games-Howell was used in the other condition (used on 8th hypothesis).

On home functionality quality, the F score was 2.270 and the significant result of Anova was 0.107 which is greater than 0.05. The 1st hypothesis was not supported. There was no significant difference of home functionality quality between different designs on different devices.

On information architecture (navigability) quality, the F score was 5.711 and the significant result of Anova was 0.004 which is less than 0.05. The 2nd hypothesis was supported. There was a significant difference of information architecture (navigability) quality between different designs on different devices. Based on Bonferroni test, the significant difference lied between environment 1 and environment 3.

Table 2. Summarize of Mean in Each Environment

Variable	Env. 1	Env. 2	Env. 3
Home functionality	4.05	4.16	4.27
Information architecture (navigability)	3.80	3.93	4.15
Readability content	3.86	3.75	3.89
Enjoyment of using website	3.66	3.38	3.36
Scroll of home functionality	12.92	16.65	3.68
Scroll of information architecture	22.50	16.65	2.77
Scroll of content readability	9.96	38.18	4.49
Click of information architecture	6.87	3.10	2.17

On readability content quality, the F score was 0.562 and the significant result of Anova was 0.571 which is greater than 0.05. The 3rd hypothesis was not supported. There was no significant difference of readability content quality between different designs on different devices.

On enjoyment of using website, the F score was 2.059 and the significant result of Anova was 0.132 which is greater than 0.05. The 4th hypothesis was not supported. There was no significant difference of enjoyment of using website between different designs on different devices.

On total scroll used while exploring home functionality, the F score was 128.645 and the significant result of Anova was 0.000 which is less than 0.05. The 5th hypothesis was supported. There was a significant difference of total scrolls used while exploring home functionality. Based on Bonferroni test, the significant difference lied between environment 1 and environment 3, and between environment 2 and environment 3.

On total scroll used while exploring information architecture, the F score was 176.211 and the significant result of Anova was 0.000 which is less than 0.05. The 6th hypothesis was supported. There was a significant difference of total scrolls used while exploring information architecture. Based on Bonferroni test, the significant difference lied between environment 1 and environment 3, between environment 1 and environment 2, and between environment 2 and environment 3.

On total scroll used while exploring readability content, the F score was 156.317 and the significant result of Anova was 0.000 which is less than 0.05. The 7th hypothesis was supported. There is a significant difference of total scrolls used while exploring readability content. Based on Bonferroni test, the significant difference lied between environment 1 and environment 3, between environment 1 and environment 2, and between environment 2 and environment 3.

On total click used while exploring information architecture, the F score was 82.468 and the significant result of Anova was 0.000 which is less than 0.05. The 8th hypothesis was supported. There was a significant difference of total click used while exploring information architecture. Based on Games-Howell test, the significant difference lied between environment 1 and environment 3, between environment 1 and environment 2, and between environment 2 and environment 3.

5. Discussions

Home functionality quality was proved to be maintained well between different designs on different devices. The difference between home layouts did not affect user's ability to understand information about the website's overview. This might be caused by the same structure used between the two designs: placing the most important information at the top part of the layout and placing the less important ones below. We suggested that website designers can continue this way of designing homepage of responsive mobile website. User could understand the home well because usually user just needs to scan and skim the homepage to get the overview regardless the website design. The hidden part of nonresponsive website which needs the use of horizontal scroll on mobile device did not affect user much.

Information architecture (navigability) quality was not proved to be maintained well between responsive website on mobile device and responsive website on desktop. Information architecture for responsive website on desktop was considered to be better than on mobile device (see Table 2). This might be happened because exploring the navigation menu on mobile device required more time and efforts from user than on desktop. The only way to navigate to the desired page on mobile device was by clicking one of the options in drop down menu given. Some parts of navigation were certainly hidden in the mobile device while all parts of navigation were shown on desktop thus user

was easier to find and click the right option. Website designers need to consider this issue while designing responsive mobile website's navigation.

Readability content quality was proved to be maintained well between different designs on different devices. The difference between content layouts did not influence user's ability to read content because letters and words could still be seen clearly. However, website designers need to be careful when designing content layout because the more a user needs to change his viewport with horizontal scroll in order to read the whole paragraph, the more time is needed for the user to understand it. It seems that it's better to always make the whole content readable without attempting any horizontal scrolling, as responsive website does, to increase user understanding. Unfortunately, that issue is beyond the scope of this research.

This research also proved that the quality of enjoyment of using website between different designs on different devices was relatively the same. Website designers can continue to arrange components of responsive website from the most important parts on the top of layout followed by the less important ones bellow while designing layout for "less area" devices.

On total scrolls and clicks used while exploring website, there was an obvious significant difference between desktop and mobile device environment. It was because the desktop has more area than mobile device so that user did less scroll and click on it. Therefore, following discussion was focused on the significant difference of total scrolls and clicks between responsive and nonresponsive website on mobile device.

Our experiment results proved that nonresponsive website required user to scroll and click around 26% and 55% less (considered being better) than responsive website while exploring information architecture (see Table 2 for details). This showed that user needed more effort and more actions in responsive design to find the right navigation way that can lead them to the desired page. However, this did not affect the enjoyment of using website of responsive website. The greater number of actions done to find a desired page did not turn to a burden that can decrease user enjoyment. In terms of the total scroll required while exploring content readability, it was proved that the responsive website required 74% less scroll than the nonresponsive one (see Table 2 for details) because user had to do more horizontal scroll in nonresponsive design to read the whole parts of content.

6. Conclusions and Future Work

Our research results concluded three findings. First, we concluded that responsive web design was able to maintain information quality on home functionality, readability content, and enjoyment of using website but not on information architecture between different mobile browser's sizes. Second, responsive web design was able to reduce total scrolls required compare to nonresponsive web design when reading content. In our case, responsive web design was able to reduce total scrolls required up to 74% than nonresponsive web design did. At last, nonresponsive web design showed better than responsive web design in terms of total scrolls and clicks while exploring information architecture. In our case, the nonresponsive web design was able to reduce 26% and 55% total scrolls and clicks than the responsive one. Even so, it did not make significant difference of the enjoyment of using website between those designs.

There are two suggestions for the future work of this research. The first is to involve tablet devices, such as iPad, in the research environment because web designers nowadays seem to have to prepare at least three separate UI modes for their website: desktop mode,

mobile phone mode, and tablet mode. The last is to try out different kinds of navigation menu other than dropdown list, which hides the most of navigation menu options, to the likes of icons or a plain list. The latter can be used to explore the probability of whether or not information architecture quality can be kept well regardless the navigation menu used on a responsive web design.

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Appendix. Questionnaire

Variable	Questionnaire Item
Home functionality	The homepage gives me overview about website's purpose
	The navigation menu on homepage gives me overview about website's content
	The homepage gives me overview about things I can do on the website (i.e. reading news article)
Information architecture (navigability)	The navigation is easy (doesn't need much time of thinking) to use
	The navigation is simple (doesn't need long navigating time) to use
	The navigation is straight forward (always directing me to the right page) to use
	Regardless total click used, the navigation is fun to use
Readability content	The website's wording is clear and easy to be understood
	The website's wording is clear and easy to be read
	The website has enough white space (or margins) to make it readable.
	Every page contains the appropriate amount of components to fit into a page so that they don't distract me from reading the content.
Enjoyment of using website	The website is interesting (based on layout aesthetic)
	The website is enjoyable

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