# ENHANCING THE PERFORMANCE OF UNIVERSITY'S WEBSITE FOR MOBILE DEVICES BASED ON RESPONSIVE WEB DESIGN APPROACH

**TEH SHAN SHAN**



**FACULTY OF COMPUTING AND INFORMATICS**
**UNIVERSITY MALAYSIA SABAH**
**2017**

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**A THESIS SUBMITTED IN FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE**

**FACULTY OF COMPUTING AND INFORMATICS**
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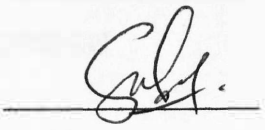
I hereby declare that the material in this thesis is my own except for quotations, excerpts, equations, summaries and references, which have been duly acknowledged.

10 May 2017



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# CERTIFICATION

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TEH SHAN SHAN
10 May 2017

# ABSTRACT

Responsive web design is a concept that provides an efficient way to deliver a holistic one web user experience across all the devices. As the year 2013 was declared as responsive web design year, therefore a survey is being conducted to find out the awareness of responsive web design concept among Malaysian public universities. With the evolution of the computer technologies, web page designs are getting richer with the scripts, stylesheets, and images on the web page. These current technologies increase the size of web pages and indirectly increase the load time. With a slow speed of web page loading speed of any website, users will leave these websites and redirect their searches to other competitors' websites. This will not only reduce users' satisfactions, but it also shows negative impressions towards these websites. Therefore, the aim of this research is to investigate several performance techniques in order to enhance the performance of the university's responsive website for mobile devices based on Amazon Web Services. A prototype is developed by using a Bootstrap framework and several principle methods of responsive web design such as viewport, media query, flexible grid and flexible image will also be applied. The prototype is hosted at Amazon Simple Storage Service and tested by using Viewport Resizer tool and actual devices. In order to improve the load time, different performance techniques are implemented into the prototype. The performance techniques include compress images, remove unused CSS (Cascading Style Sheets), combined files, minification, Gzip (a popular compressing application), cache and content delivery network. The experiments are tested by using Google PageSpeed Insights and WebPageTest tools. Based on the results obtained, using Google PageSpeed Insights tool, the measured speed score has increased on both mobile and desktop devices. Besides that, the WebPageTest tool also shows that the load time and HTTP (HyperText Transfer Protocol) requests can be reduced. In a nutshell, the performance techniques can be used to improve the performance of the university's responsive website and as a result the websites provide a better user experience for mobile users.

**Keywords**: Optimization, Performance Techniques, Responsive Web Design, University's Website, Mobile Devices, Amazon Web Services

# *ABSTRAK*

## *MENINGKATKAN PRESTASI LAMAN WEB UNIVERSITI UNTUK KELENGKAPAN MUDAH ALIH BERDASARKAN RESPONSIF WEB DESIGN*

*Responsif web design adalah satu konsep yang menyediakan cara yang berkesan untuk menyampaikan kandungan web yang holistik bagi semua peranti. Pada tahun 2013, konsep ini diisytiharkan sebagai tahun responsif web design, maka kajian kesedaran bagi konsep responsif web design dalam kalangan universiti awam Malaysia telah dijalankan. Dengan perkembangan teknologi komputer, reka bentuk laman web semakin kaya dengan skrip, style sheet, dan imej di laman web. Teknologi semasa ini meningkatkan saiz laman web dan secara tidak langsung meningkatkan masa loading. Dengan kelajuan yang perlahan, pengguna akan meninggalkan laman web ini dan mencari ke laman web pesaing lain. Ini bukan sahaja akan mengurangkan kepuasan pengguna, ia juga menunjukkan tanggapan negatif terhadap laman web ini. Oleh itu, tujuan kajian ini adalah untuk mencadangkan cara-cara untuk mengoptimumkan responsif web design bagi meningkatkan prestasi laman web universiti itu dengan kelengkapan mudah alih berdasarkan Amazon Web Services. Prototaip ini dibangunkan dengan menggunakan rangka kerja Bootstrap dan beberapa kaedah prinsip responsif web design seperti viewport, media query, grid fleksibel dan imej fleksibel juga akan digunakan. Prototaip dihoskan di Amazon Simple Storage Service, dan diuji dengan menggunakan peralatan Viewport Resizer dan peranti sebenar. Dalam usaha untuk menambahbaik masa loading, pelbagai teknologi prestasi telah dilaksanakan dalam prototaip. Teknologi prestasi termasuk memampatkan imej, keluarkan CSS yang tidak digunakan, menggabungkan fail, minification, Gzip, caching dan rangkaian penyampaian kandungan. Kajian telah dijalankan dengan menggunakan peralatan Google PageSpeed Insights dan WebPageTest. Berdasarkan keputusan yang diperolehi, Google PageSpeed Insights menunjukkan bahawa skor kelajuan telah meningkat pada kedua-dua kelengkapan mudah alih dan desktop. Di samping itu, WebPageTest juga menunjukkan bahawa masa muat dan HTTP permintaan telah berkurangan. Secara ringkas, teknologi prestasi boleh digunakan untuk meningkatkan prestasi laman web responsif universiti itu dan menyediakan pengalaman yang lebih baik untuk pengguna kelengkapan mudah alih.*

*Kata kunci: Pengoptimuman, teknologi prestasi, responsif web design, laman web universiti, kelengkapan mudah alih, Amazon Web Services*

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| | | |
|---|---|---|
| **Amazon S3** | - | Amazon Simple Storage Service |
| **AWS** | - | Amazon Web Services |
| **CSS** | - | Cascading Style Sheets |
| **CDN** | - | Content Delivery Network |
| **EC2** | - | Elastic Compute Cloud |
| **HiSRC** | - | High Source |
| **Gzip** | - | A data compression algorithm |
| **HTML** | - | HyperText Markup Language |
| **HTTP** | - | HyperText Transfer Protocol |
| **IDC** | - | International Data Corporation |
| **IT** | - | Information Technology |
| **RWD** | - | Responsive Web Design |
| **SVG** | - | Scalable Vector Graphic |
| **URL** | - | Uniform Resource Locator |

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# CHAPTER 1

# INTRODUCTION

## 1.1 Background of the Study

In this rapid development of the Information Technology (IT) industry, a website plays a significant role. A good website will encourage web surfers to stay at the website as long as possible and ultimately will come back to visit to the same site again and again (Tarasewich, 2002). In order to attract more users to specific website, it is important to ensure that the website is responsive and optimized (Modé, 2014). By implementing a Responsive Web Design (RWD) approach, it will be able to improve the user experience.

RWD is a term coined by Ethan Marcotte in May, 2010 in an article "A list Apart" (Marcotte, 2011). RWD is an approach that suggests design and development should be responding to the users' behavior and environment based on screen size, platform, and orientation (Knight, 2011). However, the most common problem in responsive websites is slow performance because it uses the same code for all devices which includes the code of desktop, tablet and smartphone, thereby making the page load becomes extremely slow (Kim, 2013).

A good website should not only provide an efficient user friendly environment, but the performances have to meet the users' requirements especially the load time of the web page. 73% of the mobile internet users have encountered websites that were too slow to load (Work, 2011). Guy Podjarny (Podjarny, 2012) ran a performance test on 347 responsive websites, and found out that the weight and load time of the websites hardly changed as 86% of the websites were "weighed" roughly the same when loaded in the smallest screen and largest screen. This shows that the website does not improve the performance of the website when loaded in the smallest screen (Kim, 2013). Thus, this issue may cause users to have bad

impressions towards the website as 47% of consumers expect a web page to load in two seconds or less (Work, 2011).

Speeding up the page load process is a crucial part in order to provide a responsive user experience and it correlates to how long the users will be willing to stay on a website and the degree of satisfactions when they interact with the website (Jun and Song, 2013). Moreover, page load also directly affects the website search engine (Gardner, 2011) as Google has recognized the importance of the web page speed is a new signal in search ranking algorithms (FeedBurner, 2010). A research about correlating between page load time and user experience has shown that most of the users are willing to wait for six to ten seconds for a site to be fully loaded before they abandon the page (Work, 2011). Surprisingly, a one second page delay could potentially cost a site $2.5 million in lost sales every year if an e-commerce site is making $100, 000 per day (Work, 2011). Therefore, improving the performance of a website using RWD is highly recommended in order to save the lost costs.

The goal of this research is to investigate several methods used for improving the performance of the university's responsive website in term of load time. A Bootstrap framework and several principle methods of RWD such as viewport, media query, flexible grid, and flexible image are used to create a prototype in this research. The prototype is hosted at Amazon Simple Storage Service (Amazon S3) and the responsiveness of the prototype is tested and assessed by using Viewport Resizer tool and actual devices. After assessing and testing the developed prototype, several performance techniques are implemented and embedded into the prototype. These performance techniques include compress images, remove unused Cascading Style Sheets (CSS), combined file, minification, Gzip, cache and Content Delivery Network (CDN). Several testing tools that include Google PageSpeed Insights and WebPageTest tools are used to test the performance of the prototype and the results are recorded.

In short, it is very important to ensure that the web experience for mobile users is as good as a desktop computer (Modé, 2014). The long loading time of the web page on mobile devices is the main problem for many responsive websites because

it needs to download extra CSS, and pictures or to hide and shrink some of the elements (Samoylova, 2014). Thus, developers should be concerned with the web performances during the design, implementation and deployment (Wisniewski, 2013).

## 1.2 Statement of Problems

The statements of problems in this research are stated and discussed as below:

i. **What strategies are Malaysian public universities utilizing to serve web contents to mobile users?**

Due to the increased accessibility to the Internet, mobile devices are widely used compared to a desktop computer. Therefore, a compatible website is required to serve mobile users better. It is imperative for every university's website to be able to display information accurately and effectively in any screen sizes or resolutions due to half of the students claimed that they accessed institution's websites by using mobile devices (Williams, 2013). Therefore, among the strategies, RWD concept is chosen to serve web contents to users due to it able to provide a flexibility website contents to be fitted on any screen sizes and resolutions because it provides "One Website, Many Devices" concept for the users (Taylor, 2013). However, a question remains to be answered is Malaysian public universities have realized the importance of the RWD approach towards the university's website.

ii **How can Malaysian public universities optimize the RWD for mobile devices to enhance web presence?**

RWD is an efficient way to deliver a holistic one web user experience across all devices. It is a concept to make the website to be viewed on all major type of devices with only one single URL. However, the most common problem in responsive websites is slow performance because it uses the same code for all devices which includes the code of desktop, tablet, and smartphone, thereby making the page load becomes extremely slow (Kim, 2013). A good website should not only provide an efficient user friendly environment, but the performances have to meet the users' requirements especially the loading time

of the web page as 73% of the mobile internet users have encountered websites that were too slow to load (Work, 2011). Speeding up the page load process is a crucial part to provide a responsive user experience which correlates to how long the users will be willing to stay on a website and the degree of satisfactions when they interact with the website (Jun and Song, 2013). Moreover, page load also directly affects the website search engine (Gardner, 2011) as Google has recognized the importance of the web page speed is a new signal in search ranking algorithms (FeedBurner, 2010). A research about correlating between page load time and user experience has shown that most of the users are willing to wait for six to ten seconds for a site to be fully loaded before they abandon the page (Work, 2011). Due to most of the responsive websites are taking a longer load time before mobile users can view the entire web page, thus different techniques are being investigated to improve the load time of university's website for mobile devices based on RWD approach is crucial which requires further addressing.

iii. **Which performance technique is the most effective in enhancing the load time of university's website for mobile devices based on RWD approach?**

Optimizing for speed on mobile has its challenges which including the need to encounter for reduced bandwidth and increased latency on mobile networks and reduced processing power on mobile devices. Moreover, with more than half of all new Internet connections coming from mobile devices, ensuring great performance for mobile users has become critical (Gardner, 2011). There are a lot of performances techniques are being investigated to improve the load time of responsive website. However, which performance technique is the most useful and effective in improving the load time of responsive website still need to be identified. Therefore, research is being conducted to determine the most useful and effective techniques that can be implemented into responsive website to improve the load time of university's website for mobile devices.

## 1.3 Statement of Objectives

This research aims to enhance the performance of university's website based on RWD

approach. The three main statements of objectives of this research are as below:

i. **To identify the trend of RWD in Malaysian public universities.**

As the evolution of devices, everyone can easily gain access to the web contents by using mobile devices at anytime and anywhere. A good impression will be given to users if a website meets the users' satisfactions. Similar to university's website, if a website provides a user friendly platform, most probably students will be willing to stay on that site and go through all the information of the website. As the RWD is on the trend and 52% of students claimed that they accessed the website by using mobile devices (Levitz, 2012), thus a research on the trend(s) of RWD in Malaysian public universities has to be identified to find out the awareness of RWD among Malaysian public universities. It is important for university's websites to be more user-friendly to attract more students (i.e. local and international students) to apply and increase the number of undergraduates or postgraduates students in Malaysia.

ii. **To enhance the performance of university's website for mobile devices based on RWD approach**

A RWD approach is able to make a website becomes more user friendly with only a single URL. However, the loads of code have affected the performance of the website. The slow performance of the website will cause the user to leave the website. Thus, enhancement of university's website based on RWD approach has to be defined in order to improve the load time of the web page. With a better load time on the web page, users may choose to stay at the site as long as possible and visit the site again. It is very important to ensure that the web experience for mobile users is as good as a desktop computer (Modé, 2014). Therefore, different techniques are being investigated in order to improve the load time of university's website for mobile devices based on RWD approach.

iii. **To determine the most useful and effective performance technique in enhancing the load time of university's website for mobile devices based on RWD approach.**

Website performance is one of the major factors that make users decide to stay

at the site. There are many ways to improve the performance of the website, and web developers have to decide on which performance technique is the most useful and effective in improving the performance of the website. Therefore, with a lot of performance techniques that are being investigated to improve the load time of the responsive website, research is conducted to determine the most useful and effective performance technique that can be implemented into the responsive website. As a result, web developers can improve the load time of university's website for mobile devices based on RWD approach with implementing the most useful and effective performance technique.

## 1.4 Methodology

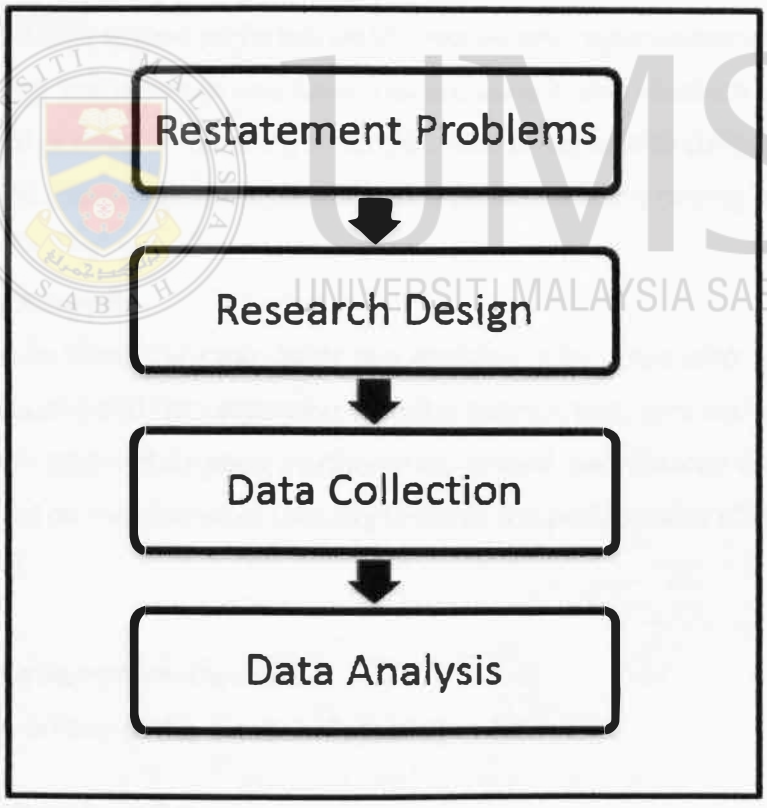


**Figure 1.1: Methodology**

### 1.4.1 Restatement Problems

In this phase, problems in this research are restated. The statement of problems

included what strategies Malaysian universities are utilizing to serve web contents to mobile users, and how Malaysian public universities can optimize the RWD for mobile devices to enhance web presence by using the most useful and effective performance techniques.

### 1.4.2 Research Design

Research design is identified in this phase. Moreover, the gaps of this research are analyzed based on the current issues. The gaps that are discussed here include the importance of the RWD approach towards the university's website and the most useful and effective methods used to improve the performance of university's website for mobile devices based on RWD approach.

### 1.4.3 Data Collection

For data collection phase, the procedures are discussed on how the case study is conducted and how several performance techniques are implemented into prototype. Other than that, the methods and tools that are used in this research are discussed which included domain of research, strategies used to serve web contents for mobile users, frontend framework, CDN, performance techniques and testing tools.



### 1.4.4 Data Analysis

Collected results from the case study are analyzed into responsive website, semi responsive website and not responsive website. Besides that, it is also classified into mobile website and mobile apps. Furthermore, several performance techniques are analyzed based on the degree of usability towards the performance of the website in term of speed.

## 1.5 Thesis Structure Outline

The structure outline of the thesis is discussed as below:

### Chapter 2 Literature Review

Chapter 2 covers reviewing of books, journals, articles, reports, and published papers. The main objectives of conducting literature review are to point to the strengths, weaknesses, omissions, or bias in previous works and to identify key issues