

Cho, Juyun; Kim, Jongheon

Article

An analysis on the mobile readiness of American Fortune top 500 companies' websites

The International Journal of Management Science and Information Technology (IJMSIT)

Provided in Cooperation with:

North American Institute of Science and Information Technology (NAISIT), Toronto

Suggested Citation: Cho, Juyun; Kim, Jongheon (2017) : An analysis on the mobile readiness of American Fortune top 500 companies' websites, The International Journal of Management Science and Information Technology (IJMSIT), ISSN 1923-0273, NAISIT Publishers, Toronto, Iss. 26, pp. 1-20

This Version is available at:

<https://hdl.handle.net/10419/219398>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.

An official publication of The North American
Institute of Science and Information Technology

ISSN:1923-0265

INTERNATIONAL JOURNAL OF

Management Science and Information Technology



NAISIT
PUBLISHERS **III**

www.naisit.org

The International Journal of Management Science and Information Technology (IJMSIT)

NAISIT Publishers

Editor in Chief

J. J. Ferreira, University of Beira Interior, Portugal, Email: jjmf@ubi.pt

Associate Editors

Editor-in-Chief: João J. M. Ferreira, University of Beira interior, Portugal

Main Editors:

Fernando A. F. Ferreira, University Institute of Lisbon, Portugal and University of Memphis, USA

José M. Merigó Lindahl, University of Barcelona, Spain

Vanessa Ratten, La Trobe University, Melbourne, Australia

Assistant Editors:

Cristina Fernandes, Polythecnic Institute of Castelo Branco, Portugal

Jess Co, University of Southern Queensland, Australia

Marjan S. Jalali, University Institute of Lisbon, Portugal

Editorial Advisory Board:

Adebimpe Lincoln, Cardiff School of Management, UK

Aharon Tziner, Netanya Academic College, Israel

Alan D. Smith, Robert Morris University, Pennsylvania, USA

Ana Maria G. Lafuente, University of Barcelona, Spain

Anastasia Mariussen, Oslo School of Management, Norway

Christian Serarols i Tarrés, Universitat Autònoma de Barcelona, Spain

Cindy Millman, Business School -Birmingham City university, UK

Cristina R. Popescu Gh, University of Bucharest, Romania

Dessy Irawati, Newcastle University Business School, UK

Domingo Ribeiro, University of Valencia, Spain

Elias G. Carayannis, Schools of Business, USA

Emanuel Oliveira, Michigan Technological University, USA

Francisco Liñán, University of Seville, Spain

Harry Matlay, Birmingham City University, UK

Helen Lawton Smith, Birkbeck, University of London, UK

Irina Purcarea, Adjunct Faculty, ESC Rennes School of Business, France

Jason Choi, The Hong Kong Polytechnic University, HK

João Ricardo Faria, University of Texas at El Paso, USA

Jose Vila, University of Valencia, Spain

Kiril Todorov, University of National and World Economy, Bulgaria

Louis Jacques Filion, HEC Montréal, Canada

Luca Landoli, University of Naples Federico II, Italy

Luiz Ojima Sakuda, Centro Universitário, Brazil

Mário L. Raposo, University of Beira Interior, Portugal

Marta Peris-Ortiz, Universitat Politècnica de València, Spain

Michele Akoorie, The University of Waikato, New Zealand

Pierre-André Julien, Université du Québec à Trois-Rivières, Canada

Radwan Karabsheh, The Hashemite University, Jordan

Ricardo Chiva, Universitat Jaume I, Spain

Richard Mhlanga, National University of Science and Technology, Zimbabwe

Rodrigo Bandeira-de-Mello, Fundação Getulio Vargas – Brazil
Roel Rutten, Tilberg University - The Netherlands
Rosa Cruz, Instituto Superior de Ciências Económicas e Empresariais, Cabo Verde
Roy Thurik, Erasmus University Rotterdam, The Netherlands
Sudhir K. Jain, Indian Institute of Technology Delhi, India
Susana G. Azevedo, University of Beira Interior, Portugal
Svend Hollensen, Copenhagen Business University, Denmark
Walter Frisch, University of Vienna, Austria
Zinta S. Byrne, Colorado State University, USA

Editorial Review Board

Adem Ögüt, Selçuk University Turkey, Turkey
Alexander B. Sideridis, Agricultural University of Athens, Greece
Alexei Sharpanskykh, VU University Amsterdam, The Netherlands
Ali Kara, Pennsylvania State University -York, York, USA
Angilberto Freitas, University of Grande Rio, Brazil
Arminda do Paço, University of Beira Interior, Portugal
Arto Ojala, University of Jyväskylä, Finland
Carla Marques, University of Tras-os-Montes e Alto Douro, Portugal
Carla Pereira, University of Beira Interior, Portugal
Cem Tanova, Çukurova University, Turkey
Cristiano Tolfo, Universidade Federal de Santa Catarina, Brazil
Cristina S. Estevão, Polytechnic Institute of Castelo Branco, Portugal
Dario Miocevic, University of Split, Croatia
Davood Askarany, The University of Auckland Business School, New Zealand
Debra Revere, University of Washington, USA
Denise Kolesar Gormley, University of Cincinnati, Ohio, USA
Dickson K.W. Chiu, Hong Kong University of Science and Technology, Hong Kong
Domènec Melé, University of Navarra, Spain
Dina Miragaia, University of Beira Interior, Portugal
Emerson Mainardes, FUCEPE Business School, Brazil
Eric E. Otenyo, Northern Arizona University, USA
George W. Watson, Southern Illinois University, USA
Gilnei Luiz de Moura, Universidade Federal de Santa Maria, Brazil
Jian An Zhong, Department of Psychology, Zhejiang University, China
Joana Carneiro Pinto, Faculty of Human Sciences, Portuguese Catholic University, Lisbon, Portugal
Joaquín Alegre, University of Valencia, Spain
Joel Thierry Rakotobe, Anisfield School of Business, New Jersey, USA
Jonathan Matusitz, University of Central Florida, Sanford, FL , USA
Kailash B. L. Srivastava, Indian Institute of Technology Kharagpur, India
Karin Sanders, University of Twente, The Netherlands
Klaus G. Troitzsch, University of Koblenz-Landau, Germany
Kuiran Shi, Nanjing University of Technology, Nanjing, China
Liliana da Costa Faria, ISLA, Portugal
Luiz Fernando Capretz, University of Western Ontario, Canada
Lynn Godkin, College of Business, USA

Maggie Chunhui Liu, University of Winnipeg, Canada
Marcel Ausloos, University of Liège, Belgium
Marge Benham-Hutchins, Texas Woman's University, Denton, Texas, USA
María Nieves Pérez-Aróstegui, University of Granada, Spain
Maria Rosita Cagnina, University of Udine, Italy
Mayumi Tabata, National Dong Hwa University, Taiwan
Micaela Pinho, Portucalense University and Lusíada University, Portugal
Paolo Renna, University of Basilicata, Italy
Paula Odete Fernandes, Polytechnic Institute of Bragança, Portugal
Paulo Rupino Cunha, University of Coimbra, Portugal
Peter Loos, Saarland University, Germany
Pilar Piñero García, F. de Economía e Administración de Empresas de Vigo, Spain
Popescu N. Gheorghe, Bucharest University of Economic Studies, Bucharest, Romania
Popescu Veronica Adriana, The Commercial Academy of Satu-Mare and The Bucharest University of Economic Studies, Bucharest, Romania
Ramanjeet Singh, Institute of Management and Technology, India
Ricardo Morais, Catholic University of Portugal
Ruben Fernández Ortiz, University of Rioja, Spain
Ruppa K. Thulasiram, University of Manitoba, Canada
Soo Kim, Montclair State University, Montclair, NJ, USA
Wen-Bin Chiou, National Sun Yat-Sem University, Taiwan
Willaim Lawless, Paine College, Augusta, GA, USA
Winston T.H. Koh, Singapore Management University, Singapore

The International Journal of Management Science and Information Technology (IJMSIT)

NAISIT Publishers

Issue 26 (Oct-Dec 2017)

Table of Contents

- 1 **AN ANALYSIS ON THE MOBILE READINESS OF AMERICAN FORTUNE TOP 500 COMPANIES' WEBSITES**
JUYUN CHO , Colorado State University, USA
JONGHEON KIM, Auburn University – Montgomery, USA
- 21 **CRITICAL SUCCESS FACTORS FOR KNOWLEDGE REPOSITORY IMPLEMENTATION: CONTENT, TECHNOLOGY AND PROMOTION**
NORFATIN FARHANAH ZAMANI , Universiti Teknologi MARA , Malaysia
TENGGU ADIL TENGGU IZHAR, Universiti Teknologi MARA, Malaysia
- 44 **A STUDY ON LIBRARY SPACE AND USERS SATISFACTION OF ACADEMIC LIBRARY USERS NEED**
NUR AINA ALIAA AHMAD LATFI , Universiti Teknologi MARA, Malaysia
TENGGU ADIL TENGGU IZHAR, Universiti Teknologi MARA, Malaysia
- 63 **RECENT DEVELOPMENT ON KEY DETERMINANTS OF EMPLOYEES' INNOVATIVE WORK BEHAVIOR IN KNOWLEDGE INTENSIVE FIRMS**
NUR FARHANA ZAIDI, Universiti Teknologi MARA , Malaysia
NUR AFIFAH YAKUB , Universiti Teknologi MARA , Malaysia
TENGGU ADIL TENGGU IZHAR, Universiti Teknologi MARA , Malaysia

This is one paper of
The International Journal of Management Science and
Information Technology (IJMSIT)
Issue 26 (Oct-Dec 2017)

An Analysis on the Mobile Readiness of American Fortune Top 500 Companies' Websites

Juyun Cho (Corresponding Author)

Computer Information Systems
Malik and Seeme Hasan School of Business
Colorado State University, Pueblo, CO, USA
joey.cho@csupueblo.edu

Jongheon Kim

Department of Information Systems
College of Business
Auburn University – Montgomery, AL, USA
jkim23@aum.edu

Abstract

As more and more users are getting to use smart phones and tablets due to the ease of use, portability, and a large range of free applications, organizations that use their websites as a vehicle to deliver important information to users should revisit their sites to check for any potential improvement for increasing mobile device users. This paper analyzes mobile readiness of the American Fortune top 500 company's websites. The performance of sites for various mobile devices is measured by several ways that scrutinize an actual page loading speed and 38 technical elements of the sites. Improving a performance of a website can significantly impact a user experience as well as organization's potential profit.

Keywords: Mobile Readiness, Usability, Responsive Web Design, Page Weight, Fortune 500 Companies, Websites for Mobile Devices, Mobile Ready Score

INTRODUCTION

Enjoying the continuous improvement and transformation of daily life, people appreciate enormous value from mobile computing more than ever before. People tend to less rely on the desktop in their digital media time, and the mobile technology swiftly expands to dominate a digital usage market, covering 65 percent of all US digital media time in 2015 (Sterling, 2016). Bezerra, et al. (2015) argued that consumers created great value from mobile technologies and that consumers from six countries thought mobile technologies could generate the value ranges from \$700 to \$6,000. The penetration rate of a smartphone that is fully capable of utilizing most of Internet services has more than doubled to 77 percent in 2016 from 35 percent in 2011 (Pew

research center, 2016). The sales growth of mobile devices is also phenomenal, showing 1.2 billion units sold worldwide in 2014, which is up 28.4 percent from a previous year (Gartner Research, 2015). It is not unusual that individuals own more than one phone (Abijith & Wamba, 2013). Recent reports indicate that more than a half of queries or searches are generated from mobile devices, 90 percent of Facebook users conduct their social networking service activities via a mobile platform, and that the incremental rate of mobile access is substantially higher than the one for overall usage (Protalinski, 2016).

Not only does a consumer experience a dramatic shift in usage platform, but also digital content providers, such as YouTube, Instagram, WallStreet.com, as well as virtual storefronts like Amazon or many other online retailers, are well aware of the paradigm changes in their industries. These companies are under great pressure to accommodate an easy access and a pleasant viewing experience from mobile platforms. Today mobile readiness not only provides a user with a ubiquitous access to relevant information but also improves communication among stakeholders and companies. Despite the awareness of business opportunities in the mobile market, many companies feel their mobile strategy is a challenging and realize usability of mobile solutions is greatly important for effective user experiences (Venkatesh & Ramesh, 2006; Adipat, Zhang, & Zhou, 2011; Hoehle, Aljafari, & Venkatesh, 2016).

Since introduction of smartphones and cellular-enabled tablets, there has been a consensus of erecting special mobile-only sites among web designers and user interface experts by stripping down and simplifying full desktop versions of web sites. They assumed the demands on mobile websites were bounded in limited services and functionalities that require less complex interactions compared to the desktop version of web sites (Lynch & Horton, 2016). However, it soon turns out that most mobile users want a full user experience from mobile access as the number of users who consider a smartphone as their primary computing device have grown significantly. Responding to the growing demand, one plausible approach web developers can take is to build a completely independent mobile web site from the PC version of the same web site. This process requires additional resources in computing and networking.

When flashing back to the situation in 1995, 70% of the American Fortune 500 companies did not even have their own website (Haun, 2012). Today we are unfortunately experiencing the same history again. Many of these companies are not ready for mobile acceptance yet. A study tested the dynamic adaptation of viewport for Fortune 500 web sites by using the Google PageSpeed Insights API test showed 44 percent of the web sites failed (Ewald, 2015). Another study, through content analysis, revealed that most of these web sites are not even suitable for delivering information and communicating with customers via smartphone, not to mention conducting a transaction (McCorkindale and Morgoch, 2013).

In our assessment, we employed a field study approach to be more objective. We collected data based on the measurements of physical and mechanical elements of the websites to evaluate the mobile readiness of American Fortune top 500 companies. To this end, we classified the measurements into three criteria that are recommended for contemporary websites by industry's leading designers and World Wide Web governing organizations.

LITERATURE REVIEW

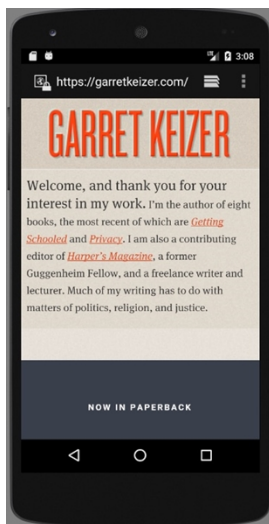
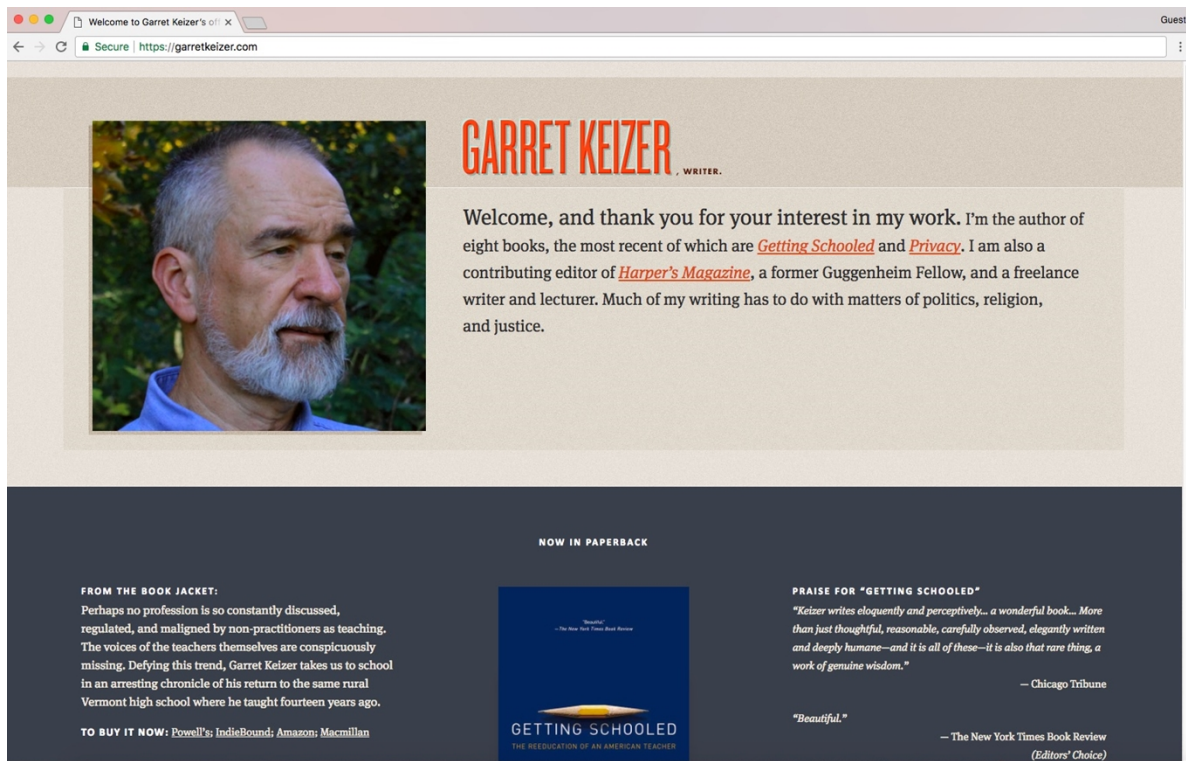
Despite the increasing number of mobile access, there is no clear standard of mobile interface and web design. Corporations are seeking either their own proprietary solution for mobile web presence or none at all. The reason is mainly because the mobile technology is still evolving and fast advancing so, it is almost impossible to adhere to a well-defined design standard. One of the pioneering attempts to analyze the mobile readiness was made by McCorkindale and Morgoch (2013). To assess mobile readiness, the researchers borrowed the five principles from the dialogic communication theory, which consist of dialogic loop, media access, return visit engagement, ease of interface, and conservation of visitors. All measuring criteria based on these principles, however, suggest more relevance to interactivity and communicability of general web sites. They neither reflect unique features or characteristics of mobile computing environment nor consider the following three important aspects.

Responsive Web Design

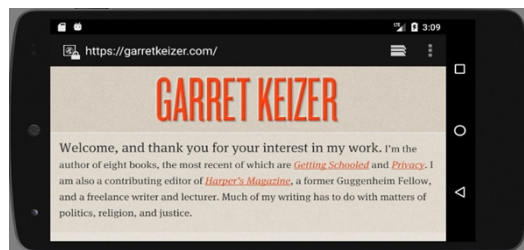
The term ‘Responsive Web Design’ (RWD) was firstly coined in 2010 by Ethan Marcotte in the magazine, *A List Apart*. After its introduction, it has greatly changed the web design industry, and many projects have been developed using this technique (Rekhi, 2013). Recognizing the phenomenal expansion of mobile devices and their usage, as well as the demand for non-stripped-down, dumbed-down experience from the users, RWD presented an embedding philosophy that holds mobile first design and content strategy, and it accompanies a technical approach as well to make website more adaptable across a variety of computing viewports such as desktop browsers, tablets, and smartphones. (Lynch & Horton, 2016). RWD is progressively enhancing a web page for different viewing contexts through coding techniques. In this way without additional efforts, it may work well in adapting different size of designs for various platforms out of a single web source. As of today, RWD is considered the most efficient and effective solution for improved mobile design, specifically regarding a content parity and prioritization. There are three core technical concepts built around in this approach;

- A flexible image refers to one that will not break the page layout as the browser viewport is resized. You may achieve this by using Cascading Style Sheets 3 (CSS3) or HTML5.1 picture element.
- A fluid layout refers to a webpage layout that is structured on the units proportional to the size of the browser window. CSS3 flexible box layout is one of approaches to make a web page fluid to fit in the viewport. This technique is highly effective in mobile web presentation because users frequently toggle the viewing orientation between portrait and landscape modes at their own needs (Hoehle & Venkatesh, 2015).
- Media queries, detecting a viewport size, render a single HTML web source differently depending on the viewport size for optimal viewing experiences.

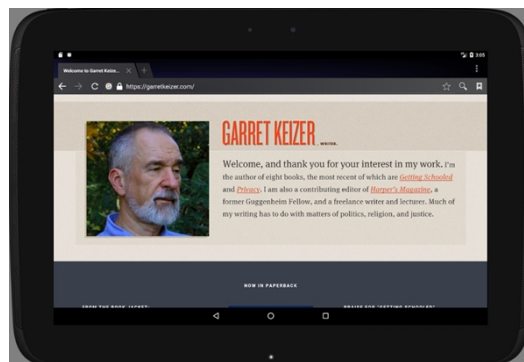
Applying these techniques, the figure 1 presents different viewport experiences from a single shared html source.



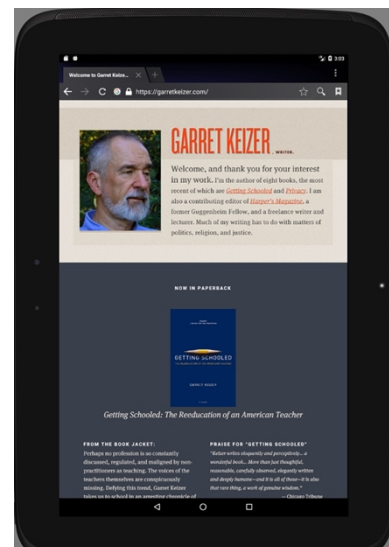
Nexus 5 Portrait View



Nexus 5 Landscape View



Nexus 10 Landscape View



Nexus 10 Portrait View

Figure 1. Different viewport experiences based on RWD (Source: <https://garretkeizer.com/>)

RWD is not just an addition of new technique or extra style sheets to web page code. It is rather a new design philosophy that offers a richer and more accessible experience to all audience regardless of the device to access. Consequently, it will be the most important determinant on user experience on the website from browsing devices.

User Experience, User Interface, and Usability

User experience (UX) refers to the user’s interaction with a product, application, or website, which essentially is realized through components presented on a web page called user interface (UI). It is a great challenge for a web developer to bridge the functional gaps between desktop PCs and mobile devices. In this regard, redesigning UI components that fit comfortably on a mobile device’s web browser enhances usefulness or usability of a website. One of early studies delving on the UI components specified seven UI components: Main screen, Toolbar, Uniform Resource Locator (URL) field, History screen, Multi-windows, Expand/reduce controls, and other components (Jung, Lee, & Lee, 2009). Yet there has been scarce research about the relationship between UX and usability; some researchers view that UX is an extension of usability and more inclusive, whereas others consider usability an equivalent concept to UX (Rusu, Rusu, Roncagliolo, & González, 2015). This equivocality mainly arises from the lack of consensus on the UX concept from academia. Hence, in this study we used these two terms interchangeably, and measurement items from these constructs were used indistinctively in our evaluation of mobile readiness. Usability, on the other hand, has been a main interest from human computer interface research stream over the last decade. It is viewed as a critical factor in the evaluation of website’s functionality, and prior studies proposed its definition as below.

Author	Definition
ISO 9241-11; Bevan, Carter & Harker, 2015	The extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use.
Nielson, 2012	Usability is a quality attribute that assesses how easy user interfaces are to use. The word "usability" also refers to methods for improving ease-of-use during the design process.
Thatcher et al., 2003	Usability is effective as a higher concept of accessibility and is the satisfied user interface design.
IEEE, 1990	Usability is the ease with which a user can learn to operate, prepare inputs for, and interpret outputs of a system or component.

Regardless of variants of its definition, the core theme lies on the notion of the ease of using a target object. In the web context, it refers to the measure of the quality of a user’s experience when interacting with a website. It is about how to make a website easy, effective, and enjoyable to a visitor (Felke-Morris, 2016). Many prior studies devoted to identifying the relevant constructs to usability. For example, Lee, Moon, Kim, and Mun (2015) found that simplicity and interactivity are positively related to usability. Usability.gov also suggests the following usability factors affecting the user’s experience: intuitive design, ease of learning, efficiency of use, memorability, error frequency and severity, and subjective satisfaction. The present study attempted to narrowly define the aspects of mobile usability to underlying physical and mechanical user experience on a webpage using mobile devices. In this way, we were able to

draw more objective assessments regarding mobile usability by excluding an emotional attachment or pre-occupied impression to the name of a company.

Page Weight

Today a web developer makes a relentless effort to get their website served to mobile users in seamless way. One of the biggest concerns is about web page weight. Even though a web site is designed under RWD standards using its core techniques, posting too many oversized image files is still undesirable and creates some glitches and loading issues (Baturay & Birtane, 2013). For instance, flexible image technique will resize a big image file fitting into the device's viewport width, but it requires to download the image file onto the device before resizing it. That is what impacts the performance and loading time of a web site. Simply saying, a web page weight is the size of a web page's contents including HTML, CSS, script, audio, video, images, etc. to be delivered to a user's device. Consequently, the more contents you have in terms of the number and the size, the heavier page weight and slower displaying on your devices. The importance of page weight can be viewed from two perspectives; user experience impact and market reach (Cremin, 2015). Clearly, the heavier your webpage, the longer it takes to load on a customer's device, which significantly degrades user experience. Considering the average internet speed on a 3G connection is around 2.5Mbps, and the average webpage weight of top 1,000 popular webpage is 14.36 Mbps (Everts, 2014), it will take about 5.744 seconds to load full contents of a webpage. Many studies report that it only takes 4 seconds for a user to start leaving the website after waiting for a page loading and presumably less for a mobile user. Yet as the high speed mobile network rolls out rapidly and expands its coverage quickly, the majority of mobile users relies on 3G connection (Chambers, 2016), and a slow-start congestion control strategy of transmission control protocol makes real life load times significantly slower than in a perfect laboratory conditions. On the other hand, the quality of the website content is another order-winning factor to attract many browsers though. Balancing a page weight and rich content puts a great dilemma on the web developer's shoulder. In addition to waiting time, page weight also involves usage cost of mobile network. There is nothing like a free bandwidth in reality even unlimited plan places a limited cap for a data usage plus roaming charges on the out-of-network connection

RESEARCH METHODOLOGY

To measure the mobile readiness of Fortune top 500 companies, three tools including PageSpeed Insights, Alexa 1,000 benchmark, and MobiReady were utilized. The first tool, PageSpeed Insights, provided by Google Inc. analyzes the content of a web page and checks to see if a page employs common performance best practices measured by the two rules shown in table 1. As shown in figure 2, the PageSpeed Insights generates a performance score ranged from 0 to 100 points and classifies a site as one of the following three categories based on the score: 1) Good (88 and higher points): The page uses most common performance best practices and should deliver a good user experience, 2) Needs work (between 60 and 87 points): The page uses some common performance best practices but misses some optimizations that may result in a slow rendering, and 3) Poor (between 0 and 59 points): The page is not optimized and most likely delivers a delayed rendering. In addition to a performance score, the PageSpeed Insights also

produces recommendations that can be prioritized and applied to improve a site. Due to the fact that a user’s network connection speed is different, the PageSpeed Insights only looks attentively at the network-independent facets of a page performance including the server configuration, the HTML structure of a page, and its use of external resources such as images, JavaScript, and CSS (Google Inc., 2017).

Table 1. Two rules used by PageSpeed Insights (Source: <https://developers.google.com/speed/docs/insights/rules>)

Rules	Items
Speed Rules	Avoid landing page redirects; Enable compression; Improve server response time; Leverage browser caching; Minify resources; Optimize images; Optimize CSS delivery; Prioritize visible content; Remove render-blocking JavaScript; Use asynchronous scripts
Usability Rules	Avoid plugins; Configure the viewport; Size content to viewport; Size tap targets appropriately; Use legible font sizes

As shown in figure 3, the second tool, Alexa 1,000 benchmark, benchmarks the company’s mobile ready score against the distribution of scores of the top 1,000 Alexa sites as measured by MobiReady. The possible lowest and highest score of a benchmark test is 0.0 (poor) and 5.0 (good) respectively. We notice that majority of the top 1,000 Alexa sites fall between mobile ready score 3 and 4.

The third tool, MobiReady (<https://ready.mobi/>), is provided for mobile web designers, developers, and marketers as a tool to evaluate a website’s mobile-readiness. It utilizes industry best practices and standards such as W3C standards, Yahoo’s YSlow, and Google’s PageSpeed guidelines. MobiReady offers several useful reports as shown in figure 4 through figure 6. Figure 4 shows simulated displays of an actual home page in three different screen sizes. Figure 5 shows a page weight in term of bytes and represents if a downloaded page is light or heavy as a color-coded bar. Figure 6 shows particular webpage test results of 38 technical components. The test results are identified into three categories – major fails, minor fails, and passes. The actual meaning of each test is discussed in the next section.

The full list of fortune 500 companies and their websites were obtained from the site of Fortune 500 (<http://fortune.com/fortune500/list/>). An obtained URL of each company is used as an input to both PageSpeed Insights and MobiReady. Except for companies, which causes an error while fetching and analyzing a page, 499 companies’ sites were analyzed by PaeSpeed Insights and 477 were analyzed by MobiReady.

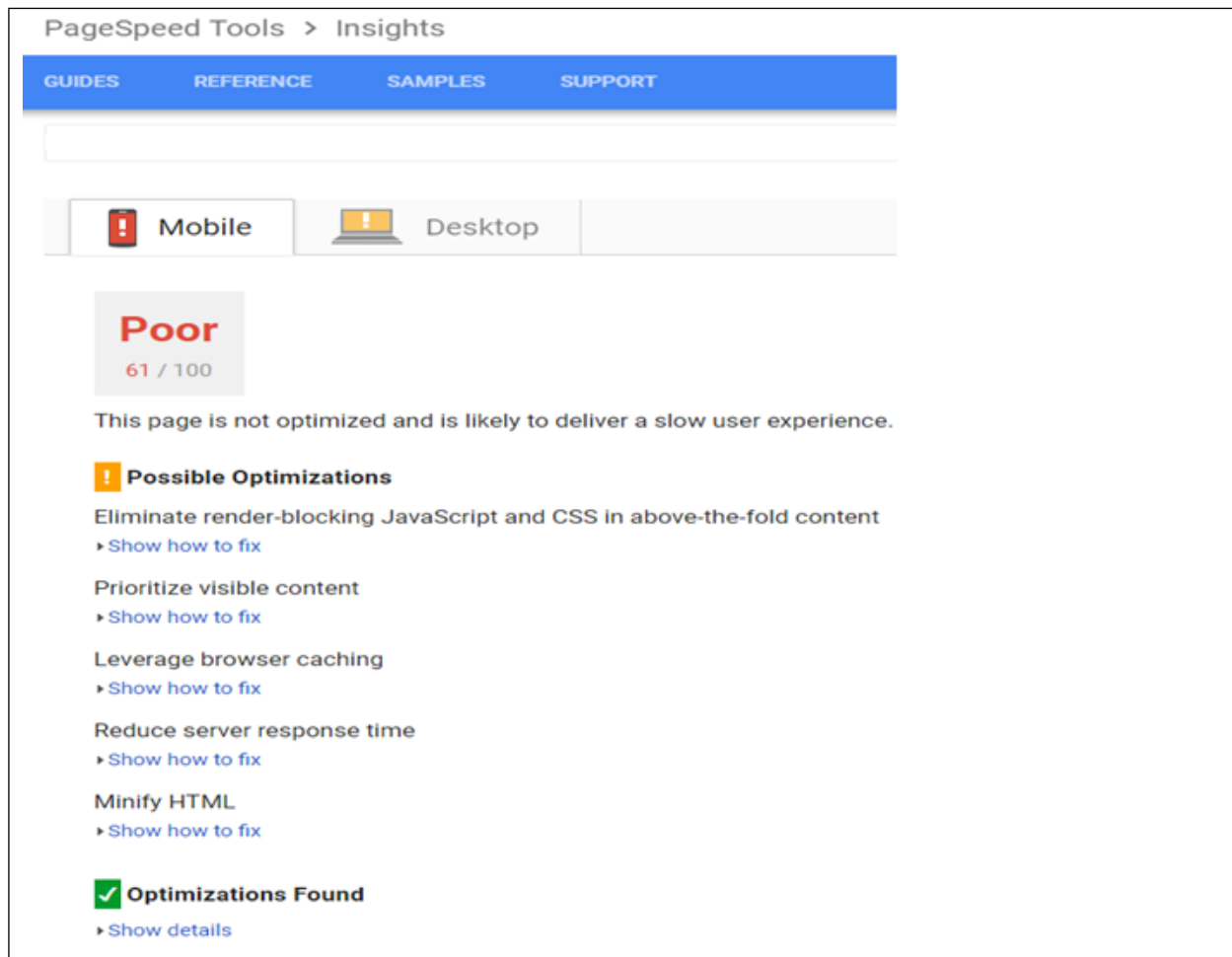


Figure 2. An example of Google PageSpeed Insights (source: <https://developers.google.com/speed/pagespeed/insights/>)

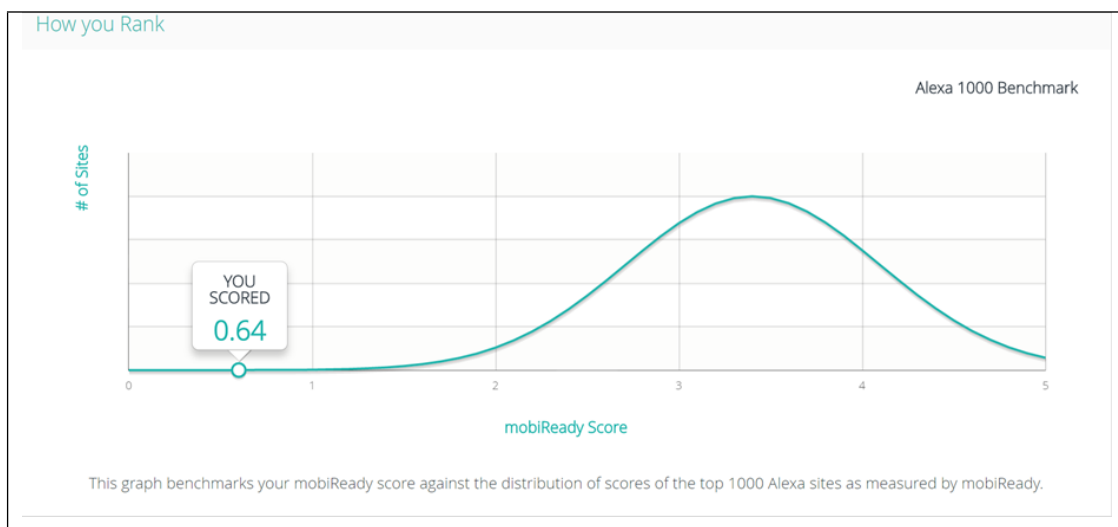


Figure 3. An example of Alexa 1,000 Benchmark (Source: <https://ready.mobi/>)



Figure 4. Visualization in different devices (Source: <https://ready.mobi/>)



Figure 5. Page weight (Source: <https://ready.mobi/>)

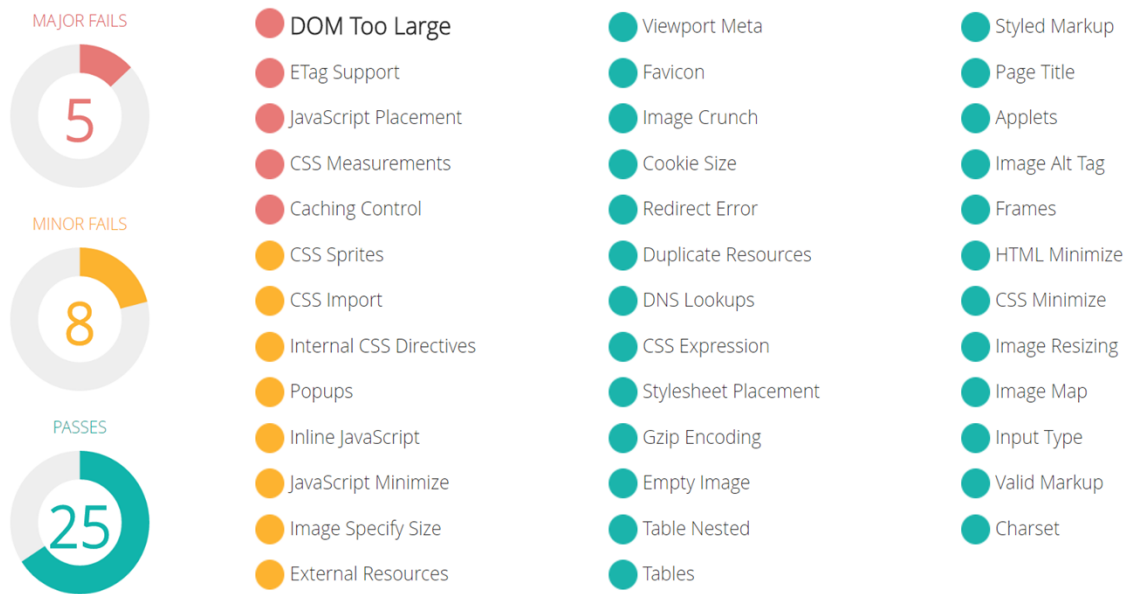


Figure 6. Webpage test results (Source: <https://ready.mobi/>)

RESEARCH RESULTS AND DISCUSSION

Page Speed

A basic statistical report on the five test items is shown in Table 2. Page speed in the first column provided by Google PageSpeed Insights represents the performance of a page for mobile devices. This column shows a wide range of values from 8 to 100 points with an average value of 53.96 and a standard deviation of 13.59. Further analysis on the distribution of a page speed as shown in figure 7 and table 3, displays that most companies’ performance falls into middle section between 30 and 79 points, more specifically, 330 (66.1%) companies that are under 59 points are marked as a “Poor” and 165 (33.1%) companies that receive between 60 and 79 points fall into a “Needs Work” category. Only 4 (0.8%) companies that gain 88 or higher points receive “Good” category. Surprisingly, only a small fraction of Fortune 500 companies are turned out to be mobile ready in terms of page loading speed. This test result indicates that almost all of Fortune 500 companies have not apply common performance best practices suggested by Google PageSpeed Insight including optimizing images, eliminating render-blocking JavaScript and CSS, leveraging browser caching, and enabling compression. It is also highly considered that a low score is correlated to a slow user experience though it is not always true. Figure 8 proves that among four technical items – Images, HTML, CSS, and JavaScript - images are used most by 328 companies and JavaScript is the second most used by 136 companies.

Table 2. Basic statistics of technical components

	Page Speed	Score by Alexa 1,000 benchmark	Major Fails	Minor Fails	Passes
Min	8	0.36	1	1	12

Max	100	4.03	10	15	34
Average	53.96	1.26	5.74	8.86	23.41
STD	13.59	0.76	1.66	2.578	3.65

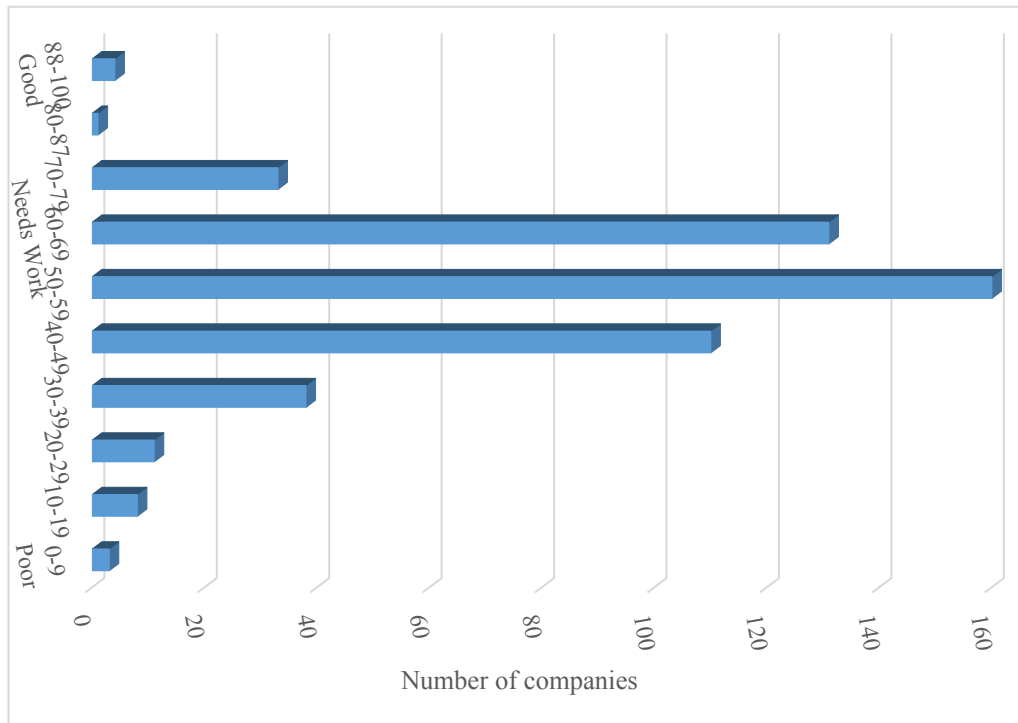


Figure 7. Page speed of Fortune 500 companies

Table 3. Distribution of page speed

Grade	Needs Work			Good				Total			
Score	0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-87	88-100	
#	3	8	11	38	110	160	131	33	1	4	499
%	0.6	1.6	2.2	7.6	22.0	32.1	26.3	6.6	0.2	0.8	100

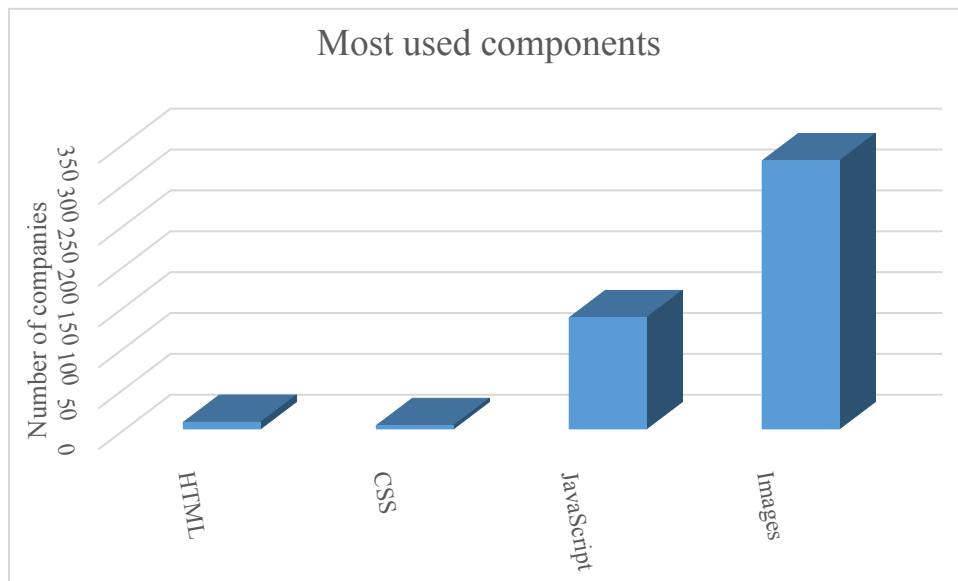


Figure 8. Most used components in companies' website

Alexa 1,000 Benchmark

The second column of table 2 shows a score created by Alexa 1,000 benchmark, which has a minimum value of 0.36 and maximum value of 4.03 with an average value of 1.26 and a standard deviation of 0.76. Further analysis of Alexa 1,000 benchmark score as shown in figure 9 and table 4 indicates that only one company (0.2%) is in the range of 4.0 and 5.0 point, 19 companies (4.0%) are between 3.0 and 3.99 point, and 257 companies (95.8%) are below 3.0 point. This test result shows that the mobile readiness of majority of companies is below 60% of benchmarked companies.

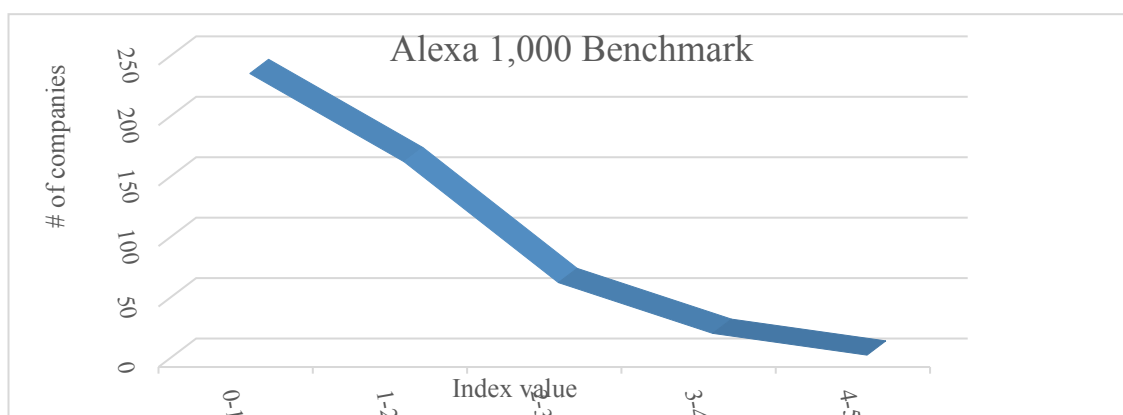


Figure 9. Alexa 1,000 Benchmark

Table 4. Analysis of a score of Alexa 1,000 benchmark

Grade	Needs Work				Good	Total
Score	0.0-0.99	1.0-1.99	2.0-2.99	3.0-3.99	4.0-5.0	
# of Companies	234	161	61	19	1	476
Percentage	49.2	33.8	12.8	4.0	0.2	100.0

Test of 38 Technical Components

The last three columns of table 2 show statistics on the major fails, minor fails, and passes of 38 technical components. Table 5 shows the full list of the 38 technical components with descriptions. In average, companies have 5.74 major fails, 8.86 minor fails, and 23.41 passes. Further analysis on the major fails as shown figure 10 illustrates that only 48 (8.61%) companies have three or less major fails and 399 companies (83.8%) have 4 to 7 major fails. Figure 11 also shows that only 18 (3.8%) companies have three or less minor fails and 396 (83.2%) companies have more than 7 minor fails. These two figures show that majority of companies have a lot of critical problems as even 2 or 3 major fails can cause a significant inefficiency in loading their webpages into mobile devices, which eventually can lead to a bad user experience. Many companies' sites should be re-designed and re-written to accommodate the industry best practice and standard.

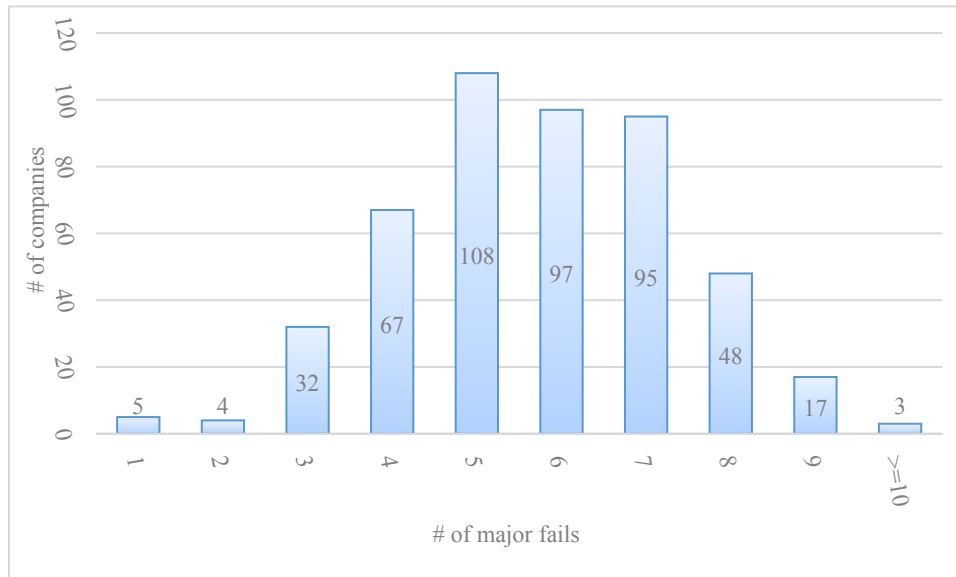


Figure 10. Number of major fails

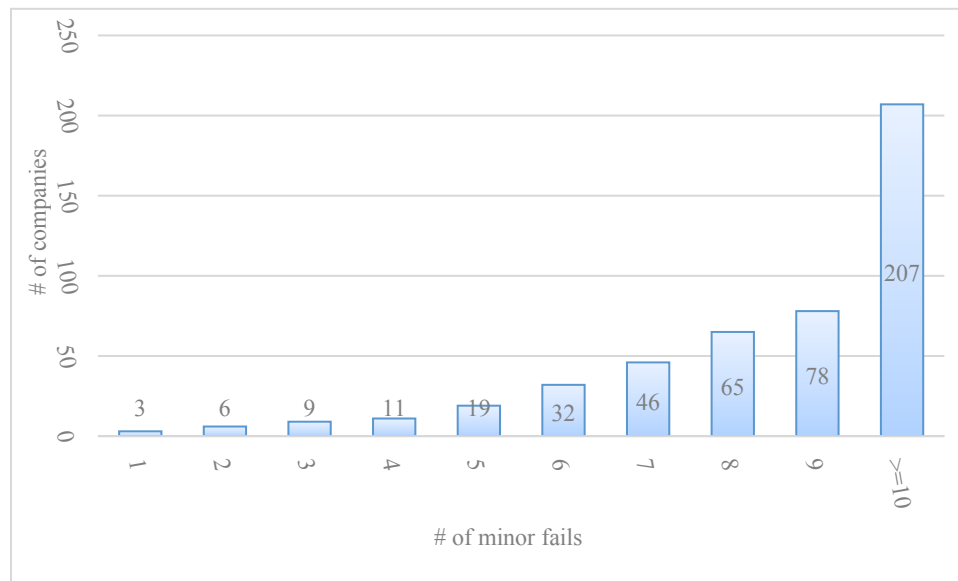


Figure 11. Number of minor fails

Table 5. List of 38 technical components (Source of description: <https://ready.mobi>)

Criteria	Items	Description
RWD	CSS measurement	Absolute dimensions and positions in CSS directives should be avoided as they will not render correctly on all device types.
	Viewport meta	Viewport meta tag should exist to define device scaling.
	CSS expression	CSS should not use the expression keyword as it will impact rendering speed and causing problems on certain device types.
	Applets	Applet tags should not be used as native web technologies can provide fuller rich experiences across device types.
	Frames	Documents should not contain frame, frameset or iframe as they will not render well across device types.
	Image map	Use of Image Maps is strongly discouraged as they will not render well across device types and often provide a poor touch experience.
	Table Nested	Nested HTML tables should never be used as they will not render well across all device types.
	Tables	HTML tables should not be used as they are unlikely to render well across all device types.
UX, UI, & Usability	DOM too large	The total number of DOM elements should be less than 700 to avoid complexity that will affect rendering and user experience.

	Favicon	The favicon will be downloaded automatically so should be less than 2kb in size and should have a far-future Expires header.
	Internal CSS directives	External style sheets should be used to allow the client to cache CSS separate to content.
	Popups	Link targets of _self, _parent or _top should be avoided as only desktop fully supports the tabbed browsing experience.
	Image specify size	Image dimensions should always be included and images should not be resampled at run-time as this will slow rendering of the page.
	Style sheet placement	Style sheets should be included at top of document to avoid jittery rendering of page content.
	Empty image	Image tags should always be populated with file sources, or should be created at runtime using JavaScript.
	Page title	All webpages should have appropriate title tags to help guide the user to the page content and purpose.
	Image alt tag	Image tags in markup should have descriptive alt tags or they should be left empty for unimportant design elements.
	Input type	Input field types should be correctly specified, not left blank - alternatively they should be created at runtime by JavaScript.
	Valid markup	Document should specify a valid markup doctype and adhere to it with valid HTML.
	Charset	Page character encoding should be set to UTF-8 or other suitable page encoding scheme.
Page Weight	Image crunch	All images should be optimized to reduce file size, and the appropriate image type should be used for each image asset.
	DOM too large	The total number of DOM elements should be less than 700 to avoid complexity that will affect rendering and user experience.
	Etag support	All page assets should use appropriate Etag headers to enable client-side caching and speed up future page loads.
	JavaScript placement	JavaScript includes should always be included at the end of the document to avoid blocking the page loading.
	GZip encoding	HTTP response should be compressed using server-side configuration of GZIP or similar compression technology.
	Caching control	Dynamic and static page components should use appropriate caching controls to speed page loading.
	CSS sprites	CSS image assets should be combined into sprite files to avoid expensive HTTP overhead.

Inline JavaScript	Inline JavaScript code should not be used, instead JavaScript should be collected into a single minified include file.
HTML minimize	HTML markup should be minimized to reduce file size and to speed up transit time between server and browser.
JavaScript minimize	JavaScript files should always be minimized to reduce transit time and help up speed page load.
CSS minimize	CSS should be minimized to reduce transit time and speed up page loading as much as possible.
External resources	External resource count should not exceed 20 as each additional asset loaded will directly affect page load time.
CSS import	The CSS import directive should not be used as it better to inline style sheet data into one minified file.
Cookie size	Total cookie size should not exceed 1kb, session cookies can help eliminate excessive cookie data.
Redirect error	Page redirects will slow page load and directly affect user perception of the webpage speed.
Duplicate resources	Duplicate CSS or JavaScript includes should be avoided as they are redundant but may affect page load time.
DNS lookups	More than 6 distinct domains should not be referenced by one page as each imparts a direct speed penalty.
Styled markup	HTML should not contain basefont, bdo, center, del, dir, font, ins, menu, s, strike or u elements.
Image resizing	Images should not be resized dynamically at run-time and should always have correct dimensions specified.

It would be interesting to analyze the top ten technical components in the major and minor fails. As shown in table 6. The number one major failure is a JavaScript Placement test (87%), which determines if a page has JavaScript includes in inappropriate places. To have an optimal page load, JavaScript includes should be grouped together at the end of the page markup. If JavaScript includes are placed at the top of a HTML page, a page-loading will be blocked while the JavaScript files are downloaded. Other technical components such as CSS Measurements (85%), Etag Support (77%), Image Crunch (59%), and Caching Control (55%) are included in the top five major fails. In the top ten minor fails, an Inline JavaScript test (92%) was ranked first. This test determines if a page makes use of inline JavaScript code. Requiring a web browser to pass markup for JavaScript code slows processing and makes web application increasingly breakable. Moving all JavaScript code to dedicated JavaScript include files are recommended because it provides a clean separation of markup, style, and code. Internal CSS Directives (87%), CSS sprites (84%), Popups (78%), JavaScript Minimize (64%) are identified among the top five minor fails along with Inline JavaScript.

Table 6. Top ten major and minor fails

Major Fails	Minor Fails
-------------	-------------

Rank	# of companies	%	Name	# of companies	%	Name
1	436	87	JavaScript Placement	458	92	Inline JavaScript Internal CSS
2	420	84	CSS Measurements	435	87	Directives
3	384	77	Etag Support	419	84	CSS Sprites
4	294	59	Image Crunch	388	78	Popups
5	276	55	Caching Control	318	64	JavaScript Minimize
6	184	37	Style sheet Placement	283	57	External Resources
7	169	34	Gzip Encoding	251	50	Image Alt Tag
8	169	34	Frames	233	47	Favicon
9	130	26	DOM Too Large	203	41	CSS Import
10	120	24	Image Resizing	194	39	HTML Minimize

As shown in table 5, we subjectively grouped the 38 technical components into the three categories - Responsive Web Design (RWD), UX/UI/Usability, and Page weight. Some of components might be related to more than one category. In this case, the most appropriate category is chosen instead of cross listing the components over two or three categories. For example, an Image Map component can belong to all three categories but it is placed into the RWD category because it is related mostly to this category.

As shown in table 7, we identify 13 major fails and 21 minor fails out of 38 technical components and group them together into the three categories to answer the following questions: 1) Do Fortune 500 companies have a responsive web for various screen size of mobile devices?, 2) Are Fortune 500 companies compliance with UX/UI/Usability?, and 3) Do Fortune 500 companies have a light web page to expedite loading speed for mobile devices? We notice that four major failed and three minor failed technical components contribute to RWD and each occupies 45.8% and 17.0% respectively. An UX/UI/Usability category has two major failed and eight minor failed technical components and each occupies 31.5% and 35.0% respectively. Finally, a page weight category has seven major failed and nine minor failed technical components and each attributes to 49.4% and 43.0% respectively. The page weight category has the most failed major and minor technical components. The number of technical components with the number of companies shown in table 7 informs that a large number of Fortune 500 companies cannot comfortably say “yes” to any of the three questions specified above.

Table 7. Major and minor fails associated with three categories

Categories	Major Fails (# of companies)	Avg. %	Minor Fails (# of companies)	Ave. %
RWD	CSS Measurements (420), Frames (169), Viewport Meta (96),	45.8	Table Nested (87), Tables (87), Viewport Meta (1)	17.0

Image Map (1)				
UX/UI/Usability	Style sheet Placement (184), DOM too large (130)	31.5	Internal CSS directives (435), Popups (388), Image Alt tag (251), Favicon (233), Empty image (53), Charset (48), Input type (20), Page title (14)	35.0
Page Weight	JavaScript Placement (436), Etag support (384), Image crunch (294), Caching control (276), Gzip encoding (169), Image resizing (120), DNS lookups (47)	49.4	Inline JavaScript (458), CSS sprites (419), JavaScript minimize (318), External resources (283), CSS import (203), HTML minimize (194), Duplicate resources (61), Styled Markup (58), Redirect error (5)	43.0

CONCLUSION

The objective of this study was to analyze the mobile readiness of American Fortune top 500 companies' website. Google PageSpeed Insights was used to check if the Fortune 500 companies have light web pages for the speedy loading. Also, Alexa 1,000 benchmark and Mobi Ready tools along with a 38 technical components test were used to exam how the companies are doing compared to other 1,000 benchmarked companies and what major/minor technical failures companies have. In addition, present study checked if the companies implemented a responsive web to accommodate different sizes of mobile devices and were compliance with UX/UI/Usability. Despite of increasing mobile device user population, majority of American Fortune 500 companies' websites are not mobile ready and seem to be still using websites designed for desktop computers. The study results reveal that except for a handful number of companies, most of companies have a lot of critical problems and that companies' sites should be re-designed and re-written to accommodate the industry best practice and standard.

References

- Abijith, A., & Wamba, S. F. (2013). Business value of RFID-enabled healthcare transformation projects. *Business Process Management Journal* 19(1), 1-28.
- Adipat, B., Zhang, D., & Zhou, L. (2011). The effect of tree-view based presentation adaptation on mobile web-browsing. *MIS Quarterly* 35(1): 99-121.
- Baturay, M. H., & Birtane, M. (2013). Responsive web design: A new type of design for web-based instructional content. *Procedia-Social and Behavioral Sciences*, 106, 2275-2279.
- Bevan, N., Carter, J., & Harker, S. (2015). *ISO 9241-11 revised: What have we learnt about usability since 1998?* Paper presented at the International Conference on Human-Computer Interaction.
- Bezerra, J., Bock, W., Candelon, F., Chai, S., Choi, E., Corwin, J., ... Varas, A. (2015). The mobile revolution: How mobile technologies drive a trillion-dollar impact. Retrieved November, 2017, from https://www.bcgperspectives.com/content/articles/telecommunications_technology_business_transformation_mobile_revolution/
- Chambers, D. (2016). Mobile Network Statistics for 2016. Retrieved August, 2017, from <https://www.thinksmallcell.com/Opinion/mobile-network-statistics-for-2016.html>
- Cremin, R. (2015). Understanding web page weight. Retrieved August, 2017, from <https://mobiforge.com/research-analysis/understanding-web-page-weight>
- Everts, T. (2014). Page bloat update: The average top 1000 web page is 1795 KB in size. Retrieved August 2, 2017, from <https://blog.radware.com/applicationdelivery/wpo/2014/12/page-bloat-update-average-top-1000-web-page-1795-kb-size/>
- Ewald, B. (2012). Are the Fortune 500 ready for mobile search? Retrieved April 12, 2017, from <https://techcrunch.com/2015/04/12/are-the-fortune-500-ready-for-mobile-search/>
- Felke-Morris, T. (2016). *Web development and design foundations with HTML5*. Hoboken: Pearson.
- Gartner Research, (2015). Worldwide mobile device sales in 2014. Retrieved August 19, 2017, from <https://www.gartner.com/newsroom/id/2996817>
- Google Inc. (2017). "About PageSpeed Insights". Retrieved September 11, 2017, from https://developers.google.com/speed/docs/insights/about?hl=en-US&utm_source=PSI&utm_medium=incoming-link&utm_campaign=PSI
- Haun, L. (2012). Almost 90% of the Fortune 500 doesn't have a mobile optimized career site. Retrieved from <https://www.ere.net/almost-90-of-the-fortune-500-doesnt-have-a-mobile-optimized-career-site/>
- Hoehle, H., Aljafari, R., & Venkatesh, V. (2016). Leveraging Microsoft 's mobile usability guidelines: Conceptualizing and developing scales for mobile application usability. *International Journal of Human-Computer Studies*, 89, 35-53.

- Hoehle, H., & Venkatesh, V. (2015). Mobile Application Usability: Conceptualization and Instrument Development. *MIS Quarterly*, 39(2), 435-472.
- IEEE. (1991). IEEE Standard Computer Dictionary: A Compilation of IEEE Standard Computer Glossaries.
- ISO 9241-11, I. (1998). Ergonomic requirements for office work with visual display terminals (VDTs) - Part 11 Guidance on usability, *International Organization for Standardization*.
- Jung, J.-Y., Lee, J.-Y., & Lee, J.-S. (2009). *A study on comparison of usability of mobile fullbrowsing browser*. Paper presented at the Korea HCI Conference, Seoul, Korea.
- Lee, D., Moon, J., Kim, Y. J., & Mun, Y. Y. (2015). Antecedents and consequences of mobile phone usability: Linking simplicity and interactivity to satisfaction, trust, and brand loyalty. *Information & Management*, 52(3), 295-304.
- Lynch, P. J., & Horton, S. (2016). *Web style guide: Foundations of user experience design*. New Heaven & London: Yale University Press.
- McCorkindale, T., & Morgoch, M. (2013). An analysis of the mobile readiness and dialogic principles on Fortune 500 mobile websites. *Public Relations Review*, 39(3), 193-197.
- Nielsen, J. (2012). Usability 101: Introduction to usability. Retrieved July, 2017, from <https://www.nngroup.com/articles/usability-101-introduction-to-usability/>
- Pew Research Center. (2016). Mobile fact sheet. Retrieved October, 2017, from <http://www.pewinternet.org/fact-sheet/mobile>
- Protalinski, E. (2016). Over half of Facebook users access the service only on mobile. Retrieved from <https://venturebeat.com/2016/01/27/over-half-of-facebook-users-access-the-service-only-on-mobile/>
- Rekhi, S. (2013). Square pegs and round holes: How to make e-learning more mobile responsive. Retrieved July, 2017, from <http://www.saffroninteractive.com/square-pegs-and-round-holes>
- Rusu, C., Rusu, V., Roncagliolo, S., & González, C. (2015). Usability and user experience: What should we care about? *International Journal of Information Technologies and Systems Approach (IJITSA)*, 8(2), 1-12.
- Sterling, G. (2016). All digital growth now coming from mobile usage, comScore. Retrieved November, 2017, from <https://marketingland.com/digital-growth-now-coming-mobile-usage-comscore-171505>
- Thather, J., Waddell, C., Henry, S., Swierenga, S., Urban, M., Burks, M., & Bohman, P. (2003). *Constructing accessible web sites*. New York, Apress.
- Venkatesh, V., & Ramesh, V. (2006) Web and wireless site usability: Understanding differences and modeling use. *MIS Quarterly*, 30(1), 181-206