

Evaluation of WebPages performance W.R.T UI/UX developed using different frameworks

Naveen Kumar, Arvind Kalia, Rakesh Kumar



Abstract: Last decade observed the exponential growth of World Wide Web (WWW) due to the growing trend of migration of each & every information on the web. In order to design the User Interface (UI) of web based application, a number of frameworks are used such as Bootstrap, WordPress, and Joomla etc. But sometimes the use of Dynamic HyperText Markup Language (DHTML) to design from scratch is preferred over frameworks. In this paper, research was carried out to compare the performance with respect to UI on different parameters of web-portals designed using frameworks viz-a-viz use of DHTML technology. Performance was compared using the tools, GTMetrix and Pingdom. Results can be used to facilitate the decision to select the framework or not, while designing the UI of webpages.

Index Terms: Content Management System (CMS), Dynamic HyperText Markup Language (DHTML), User Interface (UI), User Experience (UX), World Wide Web (WWW).

I. INTRODUCTION

Over the years, User Interface (UI) has evolved from Character User Interface (CUI) to Menu driven, Menu driven to Graphical User Interface (GUI), Computer based applications to mobile based applications and responsive web pages. As per Moore's law and Nielsen's Law processors speed increases double in every two years and user's bandwidth in every two years respectively. These two laws indicate that there is an exponential growth in hardware consequential to the growth of software technology. Internet users are also increasing at an exponential rate. In past 10 years, internet has become the need of all the people and necessitating the exponential increase in the development of websites and applications. HTML, CSS, JavaScript technologies are used for development of UI of webpages. There are a number of frameworks available, which are used to design and develop web applications. Building and deploying of the web applications is standardized in these frameworks. Code re-usability is the common activity used

in these frameworks, like providing the readymade libraries or templates, to automate the development process. [5], [8], [15] This paper contains 8 sections. First section introduces the basics for the experiments done. Section II contains the literature review for User Interface and web development. UI and UX are explained in section III. Then the basis for evaluation and tools are described in section IV.

Results of comparison of three webpages with different tools have been concluded in Section V. Section VI and VII shows the reasons and constraints for the derived results. Finally conclusions of the work are presented in section VIII.

II. LITERATURE REVIEW

Common frameworks available for web development are Bootstrap, small JavaScript Library (i.e. JQuery), small CSS Library (i.e. W3.CSS) and some other Content Management System (i.e. Joomla, Drupal, WordPress etc.)[1]

A survey has been carried out on 4000 users on different parameters to identify the applicability of available open source Content Management Systems (CMS). The results show that more than 70% developers use three main CMS: Joomla, Drupal and WordPress. The researchers suggested that if the requirements are not complex then user may choose Joomla, as it is cheaper than others. Drupal has been recommended for the requirements of multi-language, shopping cart facilities. WordPress has been judged between Joomla and Drupal.[2], [4] One of the key decisions, which have to be made by the developer when starting the development of a web application, is whether to use web application frameworks or to develop the application from scratch. Key advantages of web application frameworks include: (i) a complete environment for website development, (ii) interoperability, (iii) security, (iv) ease of maintenance, (v) fast development due to the reuse of Software components or building-blocks, (vi) a model or standard architecture that allows easy visualization of how the entire system works. Key disadvantages of web application frameworks include: (i) complexity and overhead of framework code, which in some situations visibly reduces application performance and creates greater burden for the underlying hardware, (ii) Security vulnerabilities in framework code affects applications built using it, (iii) Strict conventions hinder the application flexibility and developer's creativity. Advantages clearly outweigh disadvantages when application that is being developed is huge and very complex and developed by a

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team. Contrary to that, if the application is not big and simple and developed by one developer or a small team, common perception is that the benefits that frameworks bring is not sufficient to justify their use. [3] So it is a major task: (i) to choose which technology or framework should be used by the developer while developing the web-portals, (ii) to choose among the frameworks for code re-usability, (iii) to identifying the factors affecting the User Interface of the websites. [6], [7]

III. UI/UX

UI refers to space and method created as the junction between a user and a product. The goal of UI design is to facilitate effective operation of the product. User Experience (UX) refers to the experience of a person when using a product and it is subjective in nature because it is rooted in individual perception and thought with respect to the system. The important issues in UX design are: (i) experience of user, (ii) challenges in using that product, (iii) features of the product, and (iv) level of comfort in using that product. [9] - [11]

There are two main parameters i.e. Usability and Acceptability, dictating the ease of use of web based applications. Usability is defined as the extent to which a product or a service can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use [ISO 9241].[12],[14]

In past, different types of frameworks have been used for expeditious development of websites but lose their efficacy. It has been researched and found that if a website took more than 6 seconds to get loaded then user loses the interest, close the tabs and search for another options. So sometimes there is a tradeoff between fast development and efficacy. Development using the frameworks is fast but efficacy is sacrificed. [22]

So objective of the work is to take the decision whether the development should be carried out using frameworks or without frameworks (i.e. using DHTML technology). In order to achieve this objective, performance of a number of web-portals designed & developed using: (i) different frameworks & (ii) DHTML technology have been compared on a number of parameters.

IV. EVALUATION WORK

Evaluation of the DHTML technology and web development frameworks is done to find out which technique or framework is more suitable for web development. A web-portal of Department of Computer Science and Applications, Kurukshetra University, Kurukshetra has been designed by the researcher using DHTML technology. Similarly, another two web-portals have been designed using the readymade frameworks, the first one has been designed using *Bootstrap*, while the other one has been designed using *WordPress*. Comparison has been carried out using the different tools, to evaluate these frameworks on the basis of the main parameter i.e. Page Load Time. [13]

Page Load Time is a performance metric, which is a measure between two events i.e. when the user clicks a web link & page is fully loaded in the browser. It is generally measured in seconds. There are a number of comparison

tools available, but two have been taken into consideration, GTMetrix and Pingdom. Both tools are used to optimize the performance of the website. [18], [23]

V. RESULTS

Three web-pages, “Home”, “About DCSA” and “Contact Us” have been evaluated on the basis of Page Load Time. These web-portals have been compared and the results are represented in the form of tables and charts in the following section.

A. Home Page

The comparison of the Page Load Time of Home Page of the three different portals using the tools GTMetrix and Pingdom has been shown in the following table. The results indicates that web-pages, which have been designed using the technologies WordPress as well as Bootstrap are taking more Page Load Time as compared to the web-page which has been designed using DHTML technology.

Table 1: Home Page: Page Load Time (in Seconds)

Technologies	GTMetrix (in Seconds)	Pingdom (in Seconds)
HTML CSS JS	1.90	1.52
WordPress	3.70	2.31
Bootstrap	2.70	7.75

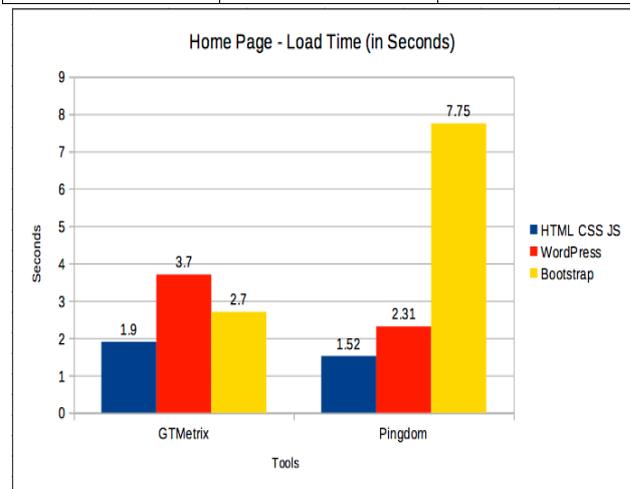


Fig. 1: Representation of Home Page: Page Load Time (in Seconds)

B. About DCSA

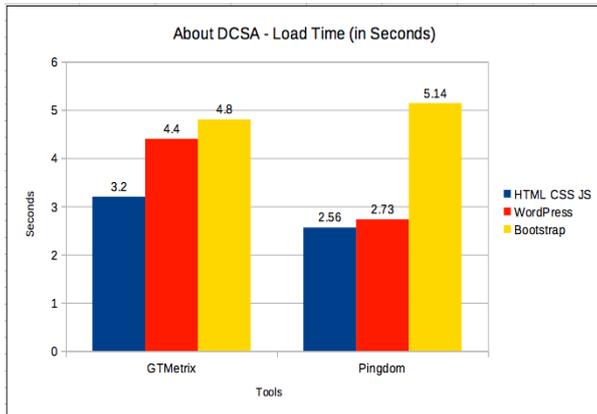
While doing the comparison of “About DCSA” page, again it has been observed that web-pages, which have been designed using the technologies WordPress as well as Bootstrap, are taking more Page Load Time as compared to the web-page which has been designed using DHTML technology.

Table 2: About DCSA: Page Load Time (in Seconds)

Technologies	GTMetrix (in Seconds)	Pingdom (in Seconds)
HTML CSS JS	3.20	2.56
WordPress	4.40	2.73
Bootstrap	4.80	5.14

Fig. 2: Representation of About DCSA: Load Time (in Seconds)

C. Contact Us



Similarly, the comparison of the Page Load Time of “Contact Us” web page of the three different portals using the tools GTMetrix and Pingdom has been shown in the following table. The results are again not different.

Table 3: Contact Us: Page Load Time (in Seconds)

Technologies	GTMetrix (in Seconds)	Pingdom (in Seconds)
HTML CSS JS	1.90	1.39
WordPress	3.90	3.31
Bootstrap	2.80	1.50

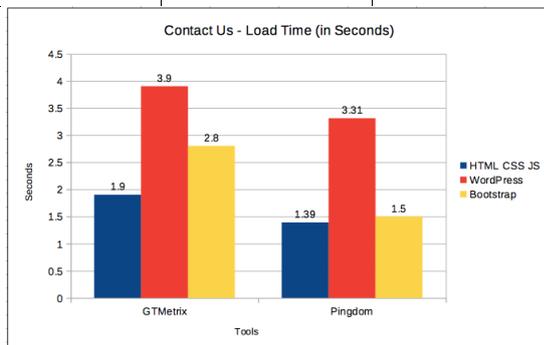


Fig. 3: Representation of Contact Us: Page Load Time (in Seconds)

So it is inferred on the basis of above results that Page Load Time is more when the pages are designed using frameworks. In order to find out the reason, analysis was done and factors have been recognized discussed in the following sections:

VI. REASONS

A. Unnecessary Stuff

Bootstrap has been bundled with a huge size of CSS and JavaScript components. It includes components or sub-components of tables, buttons, drop-downs, navigations, alerts and many more. Developers do not use all these components, only few get picked by them. So a lot of unnecessary stuff has not been used while development of web-pages, which makes the web-pages heavy and affect the Page Load Time. It has been observed that unnecessary code is added to webpage by WordPress resulting into the increase in size of the webpage, which in turn increase the load time. The extra code comes up from the list of predefined codes that come with the framework. Developer cannot choose to use them through the frameworks, which has been used. [16]

B. Plugins

WordPress uses several plugins. Plugins definitely do have the capability to affect Page Load Time. But there is no rule for “how much”. Some plugins, like backup and contact form plugins, should have no noticeable effect on the website. While others, like e-commerce plugins, security plugins are likely to add at least some time to Page Load Time. [19]

C. More Customization

Websites can start to look the same if developer doesn’t customize the styles and colors much. It will increase the line of code, which makes the website heavier. [16]

D. Server Resources

In case of WordPress, it is also observed that a lot of server resources are consumed by the Content Management System running on the server; because of creation of web pages, management of themes etc. This results into increase in load time. [17]

E. Themes

While designing a theme, there is always a tradeoff between beauty & efficiency. A number of beautiful themes are generally very poorly coded resulting into the increase in load time.

They generally include a lot of animation, graphics & complex layout. [21]

VII. CONSTRAINTS

It is extensible enough that anyone can adjust the features of bootstrap as per need. In the beginning, Bootstrap had some limitations, and at that time it was complicated to extend default styles.

Since a framework has a standard set of grids and selectors and other codes, it restricts the web-portal design. So for every new kind of design idea, which developers want to implement, it is mandatory to learn a new framework.

A. Creativity

Now, frameworks may save a bunch load of time, which developer usually spends in coding. But it restricts the creativity and a developer would have to come up with design ideas that fit into the requirements. [21]

B. Time

There will be requirement of lots of style overrides or rewriting files that can thus lead to a lot of time spent on designing and coding the website if the design tends to deviate from the customary design used in Bootstrap. [20]

C. Customization

It is compulsory for developer to go the extra miles, while creating a design otherwise all the websites will look the same if heavy customization has not been done. Styles are verbose and can lead to lots of output in HTML which is not needed. [17]

D. PHP Knowledge

In case of WordPress, PHP knowledge is required to do modification or change in the WordPress website. [17]

E. Loss of Data

Sometimes software needs to be updated to keep the WordPress up to date with the current browsers and mobile devices. Updating of WordPress version leads to loss of data so it requires the backup copy of the website. Modifying and formatting the graphics images and tables is difficult. [20]

VIII. CONCLUSION

In this paper, a lot of previous work has been reviewed and it is found that a major task is to decide whether the development should be carried out using frameworks or without frameworks (i.e. using DHTML technology). In order to achieve this objective, analysis has been done using different tools. The DHTML technology and web development frameworks have been compared to find out which technique or framework is more suitable for web development. The comparison parameter used was Page load time measured in seconds. It has been found that webpages, which have been designed using the technologies WordPress as well as Bootstrap, are consuming more Page Load Time as compared to the web-page which has been designed using DHTML technology. The factors, that affect the Page Load Time of the web-portals developed and designed using frameworks are: (i) a lot of unnecessary stuff, never used while developing the webpages, increase the physical size of the webpage, (ii) Plugins, server resources, Themes, in the web pages designed using the WordPress, increase the delivery time of the webpage. (iii) Standard Code generated by the frameworks required more customization and increase the line of code, which affect the Page Load Time. Finally it may be concluded that there is a tradeoff between ease of development and flexibility & efficiency. By using frameworks, the development is fast but efficiency and flexibility is compromised. By using DHTML to design UI, efficiency and customization is restricted by the knowledge and imagination of the developer respectively.

REFERENCES

1. S. K. Patel, V. R. Rathod, and J. B. Prajapati, "Performance Analysis of Content Management Systems Joomla, Drupal and WordPress", *International Journal of Computer Applications*, vol. 21, no. 4, pp. 39–43, May 2011.
2. C. Duarte, I. Matos, J. Vicente, A. Salvado, C. M. Duarte, and L. Carriço, "Development technologies impact in web accessibility", in *Proceedings of the 13th Web for All Conference on-W4A '16*, Montreal, Canada, 2016, pp. 1–4.
3. I. P. Vuksanovic and B. Sudarevic, "Use of Web Application Frameworks in the Development of Small Applications", *MIPRO Opatija, Croatia*, pp. 458–462, May 2011.
4. H. M. Mahdi, S. Excell Peter and Ali Maaruf, "User Interface (UI) Design Issues for Multilingual Users: A Case Study", *DX*, DOI.
5. J. Duckett, "HTML & CSS, Design and Build Websites", John Wiley & Sons, Inc. Indianapolis, Indiana, 2011, ISBN: 978-1-118-00818-8.
6. Brown, J; and Hollier, S. "The challenges of Web accessibility: The technical and social aspects of a truly universal Web", 2015, ISSN 13960466.
7. Fernandes, N., Batista, A. S., Costa, D., Duarte, C., and Carriço, L. "Three web accessibility evaluation perspectives for RIA", in *Proceedings of the 10th International Cross-Disciplinary Conference on Web Accessibility (W4A '13)*. ACM, New York, NY, USA, 2013.
8. "Nielsen's Law of Internet Bandwidth", Nielsen Norman Group. [Online]. Available: <https://www.nngroup.com/articles/law-of-bandwidth/>. [Accessed: 02-Jun-2019].
9. "The Definition of User Experience (UX)", Nielsen Norman Group. [Online]. Available: <https://www.nngroup.com/articles/definition-user-experience/>. [Accessed: 29-Jan-2018].
10. "The Difference Between UX and UI Design-A Layman's Guide", [Online]. Available: <https://careerfoundry.com/en/blog/ux-design/the-difference-between-ux-and-ui-design-a-laymans-guide/>. [Accessed: 23-May-2018].
11. L. M. Ming, L. M. Ming, and L. M. Ming, "UI, UX: Who Does What? A Designer's Guide To The Tech Industry", *Co.Design*, 07-Jul-2014. [Online]. Available: <https://www.fastcodesign.com/3032719/ui-ux-who-does-what-a-designers-guide-to-the-tech-industry>. [Accessed: 23-May-2018].
12. "User interface design-Wikipedia", [Online]. Available: https://en.wikipedia.org/wiki/User_interface_design, [Accessed: 23-May-2018].
13. "Web framework", Wikipedia. [Online]. Available: https://en.wikipedia.org/wiki/Web_framework, [Accessed: 02-Apr-2018].
14. R. J. Jacob, "User interface", 2003. [Online]. Available: https://en.wikipedia.org/wiki/User_interface_desig [Accessed: 23-May-2018].
15. "Moore's law", Wikipedia. [Online]. Available: https://en.wikipedia.org/w/index.php?title=Moore%27s_law&oldid=896103909 [Accessed: 08-May-2019].
16. "3 Tips for Speeding Up Your Bootstrap Website," SitePoint, 02-May-2018.
17. "24 Tips to Speed Up WordPress Performance (UPDATED)," WPBeginner. [Online]. Available: <https://www.wpbeginner.com/wordpress-performance-speed/>. [Accessed: 02-Jun-2019].
18. "Dashboard | GTmetrix." [Online]. Available: <https://gtmetrix.com/>. [Accessed: 30-Jan-2019].
19. "Do Plugins Affect WordPress Performance? Real Test Data," ThemeIsle Blog, 07-Nov-2017.
20. "Does coding webpages in bootstrap make them load slow? - Quora." [Online]. Available: <https://www.quora.com/Does-coding-webpages-in-bootstrap-make-them-load-slow>. [Accessed: 02-Jun-2019].
21. "The 10 Most Common Bootstrap Mistakes That Developers Make," Toptal Engineering Blog. [Online]. Available: <https://www.toptal.com/twitter-bootstrap/the-10-most-common-bootstrap-mistakes>. [Accessed: 10-Jun-2019].

22. "Web performance," Wikipedia. 28-May-2019.
23. "Pingdom Tools." [Online].
Available: <https://tools.pingdom.com/>. [Accessed: 10-Jun-2019].

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