Information and Knowledge Management
ISSN 2224-5758 (Paper) ISSN 2224-896X (Online)
Vol.13, No.1, 2023

Using Performance Metrics to Guide the Selection of a Website Content Management System -The Case of Joomla, Drupal and WordPress

Emmanuel Yanney[1*], Timothy Simpson[1], Kenneth Stoff Boadi[12]
1. Faculty of Applied Science, Takoradi Technical University, Takoradi, Ghana
2. Directorate of ICT Services, Takoradi Technical University, Takoradi, Ghana
* E-mail of the corresponding author: emmanuel.nyanney@gmail.com

Abstract
The most recent trend in website development is the usage of Content Management Systems (CMS). These systems provide user-friendly interactive interface for persons without prior computer coding knowledge to utilize them to create websites. Different kinds of content management system technologies are now available, hence, it becomes challenging for users/developers to decide on which one is best to work with. This study, researched into three popular CMS's namely, Joomla, Drupal and WordPress to explore which of these proposed three will be ideal for developing efficient website in terms of performance. This study resulted in researching into details the features common to all the three CMSs. These features were evaluated based on four performance criteria. The method this study used was a quantitative method. Practically, the researcher developed three websites using the three CMSs, and tested them against performance criteria namely, page load time, page size , number of cascading style sheet file and number of JavaScript files. The results or data collected through the page performance exercise was then tabulated, compared, and later analyzed. The study found that Joomla CMS created much JavaScript files as compared to all, and as a result was very interactive, WordPress also created much CSS file, as a result gives the best web layout. The researcher concluded that each of these CMS performed well in different criteria. As a result, the best CMS will depend on the interest of the developer for his or her site. These researched done will help readers and the academia in general to acquire knowledge that reveals the characteristics of the three CMS in terms of strengths and shortfalls.
Keywords: CMS, website, Wordpress, Joomla, Drupal content management system, developer
DOI: 10.7176/IKM/13-1-04
Publication date: January 31st 2023

1. Introduction

Websites have in recent times emerged as a very important tool in our everyday lives. Businesses and institutions use them extensively in their daily operations. Beside physical presence, virtual platform via website enable them to get in touch with clients and users both locally and internationally.

Websites have evolved tremendously over past years from it being made up of few collection, few texts and images shared on over a network to now made up content-rich multimedia and interactive platform accessible by everyone over the internet (Butkiewicz, Madhyastha, & Sekar, 2011). The internet has changed dramatically to an extent that it is hard to imagine a world without it. These changes have been gingered by the human need to access content from multiple sources, different volume and interactivity (Shailesh& Suresh, 2017).

Thomas, Hansson, &Breedt, (2005) noted that the building block of websites required users to have adequate programming knowledge in CSS, html, javascript and a host of other technologies to be able to develop webpages. Developing single web pages form a website the traditional way therefore demands tedious work of constructing pages one after the other with the aid of basic web authoring tools such as Adobe Dreamweaver.

The increasing desire of web developers to provide rich contents by incorporates third party services such as CDN, analytics and advertisement request by client has gingered developers to seek for advanced tools that can achieve that purpose and make website development and content deployment easier. Second, the need for quick delivery of websites has compelled developers to look for new tools that will enable them to meet deadlines while building websites for clients. Thirdly, diversity of user-devices capable of connecting to the internet has created a challenge for developers to build content which can be view and accessed by different device screens.

1.2 Content Management System

Content Management Systems, which is popularly known as CMS is a web-based computer application that is used to develop and manage digital content, most especially websites (Barker, 2016). Websites have become very relevant in today's world because of the desire of individuals, and business organizations establish web presence in the global digital space.

Due to a variety of factors, a sizable number of website developers have switched to using CMS as a tool to

construct and maintain websites. . One reason for popularity of CMS for website development has been attributed to the fact that Web developers do not need to practically write computer codes in the early stages of website development. CMS can therefore be used by persons who do not have computer programming background.

The research conducted by Shitote, Omieno, &Ondulo, (2018) revealed that CMS's has evolved over years from very primitive systems to complex and robust intelligible systems which can enable developers to construct websites more quickly. It now has user-friendly interfaces to build website structures, making the process of posting material online quick and simple. CMS provides developers with streamlined security, extensible third party plug-in, enhanced document management, collaborative publishing, and automated process of converting plain text into CSS, HTML and JavaScript associated files. The authors again noted that CMS has grown more advantageous for use because it provides a well-designed, structured platform for developing and publishing web site content. Websites can be developed and deployed at a faster rate than other methods.

Presently, there are many content management systems (CMSs) that may be used to create websites. Some examples include CompositeC, DotNetNuke, Joomla, WordPress, and eZ Publish (Grinberg, 2014). In the midst of multiplicity of CMSs how can developers chose between the best among the lot that satisfy users in terms of performance? Inventors of website development tools such as CMS are continually adopting various strategies to improve their platform meant for content creation and to dissemination of information to web developers (clients) and potential users (online users). Winning the heart of a client and users is a big challenge; due to high level of competition amongst various CMS technology driven platforms.A content management systems ability to provide maintainable and easily navigable structure allows the developer to develop websites quickly, hence making content publishing on the internet hustle-free to suit user preferences.

Studies show that although CMS comes with some advantages, developers and users tend to have performance issues with some websites created using some CMS. When performance issues are not resolved, studies show that 49% users abandon site or switch competitors websites after experiencing performance issues (Butkiewicz, Madhyastha, &Sekar, 2011; Schneider, Agarwal, Alpcan, &Feldmann, 2008). Therefore, there is a pressing need to strike a balance between website usability, particularly in terms of performance, and all other objectives.

1.3 Motivation for the study

A number of studies have been carried out on characteristics of websites to determine performance these websites using a broad spectrum of metrics using third party plug-ins (Shitote, Omieno, &Ondulo, 2018) but few studies exist with actual demonstration of the performance site quantitatively using CMS elements. In order to identify which CMS to employ for an effective website in terms of performance, this research conducts an experimental study that analyzes the three most popular CMS, namely Joomla, WordPress, and Drupal, based on four metrics, namely. Page size (PS), page load time (PLT), number of Cascading Style Sheet (CSS) and JavaScript Files (JS).

2. Methodology

2.1 Data source and collection procedure

The data for such a comparative study on the various CMSs (Joomla, Drupal and WordPress) were obtained through the page performance results of the respective CMSs. As a result, data was obtained for the purpose of this study by developing a webpage using the various CMSs, and data obtained from the page performance criteria such, page load time, page size, number of cascading style sheet, number of JavaScript file created. These data were tabulated and then analyzed for a comparison purpose.

2.2 Conceptual Framework

The diagram shows the CMS the conceptual framework for the study.

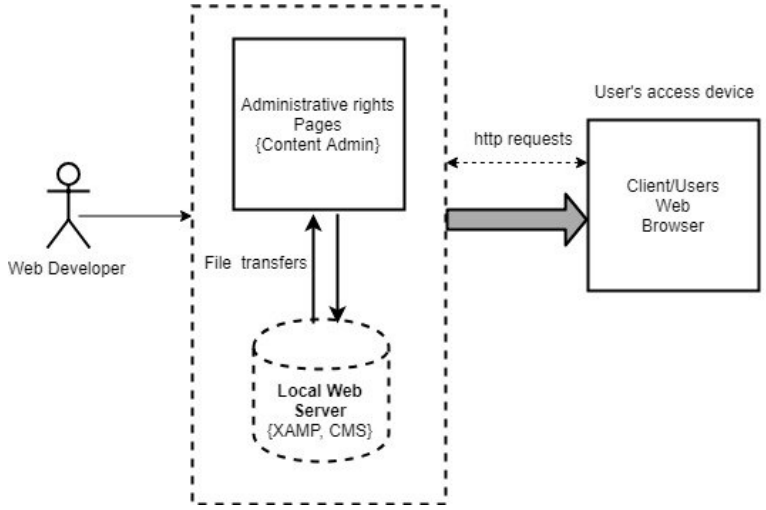

Figure 1.Conceptual Framework for the study

The conceptual framework in Figure 1 demonstrates that Web Developer deploys CMS on a local server by setting up CMS database and uploading initial installation files. Settings, installation of themes, plug-ins, modules and other third party apps are installed via administrative right pages. Contents in the form of text, images, audio and video are added using platform and file transfer options. Content creators are presented with administrative options to publish content based on level of access. Users can then access CMS Website on their web browsers when they connect to CMS Website.

CMS is hosted on a web server. Local Server has a minimum hardware specification for hosting CMS. XAMPP was installed and configured on the server. XAMPP is an open source installable software package developed by Apache Friends containing MariaDB, PHP, and Perl. (Friends, 2021). Operating System Environment for the Server is a Windows Based Operating system. Apache services runs on the server to render Web pages requested by client computers. MariaDB is a robust, scalable, and reliable database management system that comes along with XAMPP. PHP parser is a robust FastCGI for executing PHP code. All the CMSs used in this study contain .php files. Table 1 shows the hardware and software environment of the Local Server Used for the study

Table 1. System specification

Operating System	Microsoft Windows 10
CPU	Intel (R) Core ™ i7-10700 (2.90GHz)
Model	x-64-Based PC
Physical Memory (RAM)	8 GB
Hard Disk Drive	1 TB
Network Interface Card	Realtek PCI GbE Ethernet Controller
Browser	Mozilla Firefox

2.3 Method

This study used methodology known as Website Design Method, (WSDM) to obtain data used in this study. The data gathering process was an adaptation from research conducted by Butkiewicz, Madhyastha, &Sekar, (2011). In Website Design Method (WSDM), a simple webpage will be created using each of the CMS and hosted on a local server to enable the researcher examine the page performance of the CMSs by running each of the pages created and observing page performance criteria like, page size (PS), page load time (PLT) number of Cascading Style Sheet (CSS) and JavaScript Files (JS).

The page performance criteria like, page size (PS), page load time (PLT) number of Cascading Style Sheet (CSS) and JavaScript Files (JS) will enable the researcher acquire data for the quantitative analysis or acquire data for the research.

The page size affects the page performance of many website. As a result the page size for all the three CMSs will be recorded and tabulated after the pages have been created. The research will study how the page sizes of the various pages created with the respective CMS and how it affect the page performance by running each of the pages respectively.

Size of pages with text only was recorded as well as page size of pages with both text and object for the purpose of this study. This study aims the compare how three deployed CMS websites namely Joomla, WordPress and Drupal performs when accessed on the User's browser.

2.4 Performance criteria

2.4.1 Page size (PS) comparison

Heilmann (2010) explained that page sizes of website affect it performance. A page with a smaller size loads faster than a page with a bigger page size. As a result this research will study and compare various webpages created both with text only, and both text and object. The various page sizes will help a developer to decide on a CMS, since the page size will affect the performance of the website.

There are different factors that determine the page size of a website. Factors like, images, JavaScript, font, videos and advertising (Heilmann, 2010).

Images: Images on webpages make a page attractive and convey a lot of information as compared to text only. Some pages by created CMS create default images and this adds up to the size of a page.

JavaScript: JavaScript also helps to add up interactivity to a page, and this enable a webpage to get a lot of attention. But another issue is, the moment this is created, it also adds up to the size of a webpage. Some CMSs create default interactivity at the initial stage of the website creation, and this add up to the page size.

Videos: Videos also convey a lot of messages as compared to text. It also gives the page a lot of attention since users will only watch the video and get all the information needed. This also add up to the page size

Font: The font of page content is also very important factor in a webpage design. If the font is good, it attracts users to a page because it makes content of the page to be read easily.

Pages with only textual information have different sizes as compared with pages with both textual information and other web objects like calendar or picture gallery. The study examined the page size with only textual information as well as the page size with both textual information and picture gallery object. Pages with only textual information was run to determine by how fast or slow the pages open on the website. A page with picture gallery was also be run to determine its performance as compared with pages with only textual information.

2.4.2 Page load time (PLT) comparison

Also in the review of literature, the researcher noted that the time taken for a page to load the content is a concern to visitors as well as developers. A page that takes little time to load contents is more efficient than a page that need much more time to load content. As a result, the various pages will be run and the time taken by each respective CMS were recorded, and compared. The various websites were tested to see how quickly each one could load at a The PLT of a webpage is also determine by factors such as, page size, number of CSS file, JavaScript file and many more. Some of these factors (PS, CSS, JS) will be discussed below. Each of these webpages will be run using Mozilla Firefox.

2.4.3 Cascading Style Sheet (CSS) comparison

The number of CSS also has effect on the page performance of webpages. Because of this the study will examine the number of CSS created by each CMS. The various CMS was run to observe how they perform with the use of CSS. Butkiewicz(2011) in a study noted that, CSS file give good and better layout to websites. A website with a good layout is able to contain a lot of feautures and content on a page, because it helps to manage a lot of space on the webpage. As a result, this research studied how it affect the page performance

2.4.4 JavaScript file comparison

JavaScript enable interactive features to be created on a website. As a result, the level of interaction on the page increases with the amount of JavaScript. This research seeks to study the three CMSs to know which will create more JavaScript and also how it affects the page performance.

2.5 Procedure

An X-64 Based Computer which acted which was used as the server for hosting the websites. Each of the CMSs were installed on the local webserver. The following explains the various steps and activities were carried out in detail.

2.5.1 Installation of Joomla

Joomla was installed to create a simple website. To install Joomla, it requires a PHP based and a database driven server. All the files of Joomla were easily run since Joomla also contains PHP files. Joomla is then installed by coping the zipped file and pasting it in a directory named ‘htdocs’ in the XAMP folder. A web browser was then launched or opened, and the word ‘localhost’ is entered in the address bar of the web browser. A browser was then used to access the Joomla files, and the on-screen installation processed was then followed to complete the installation.

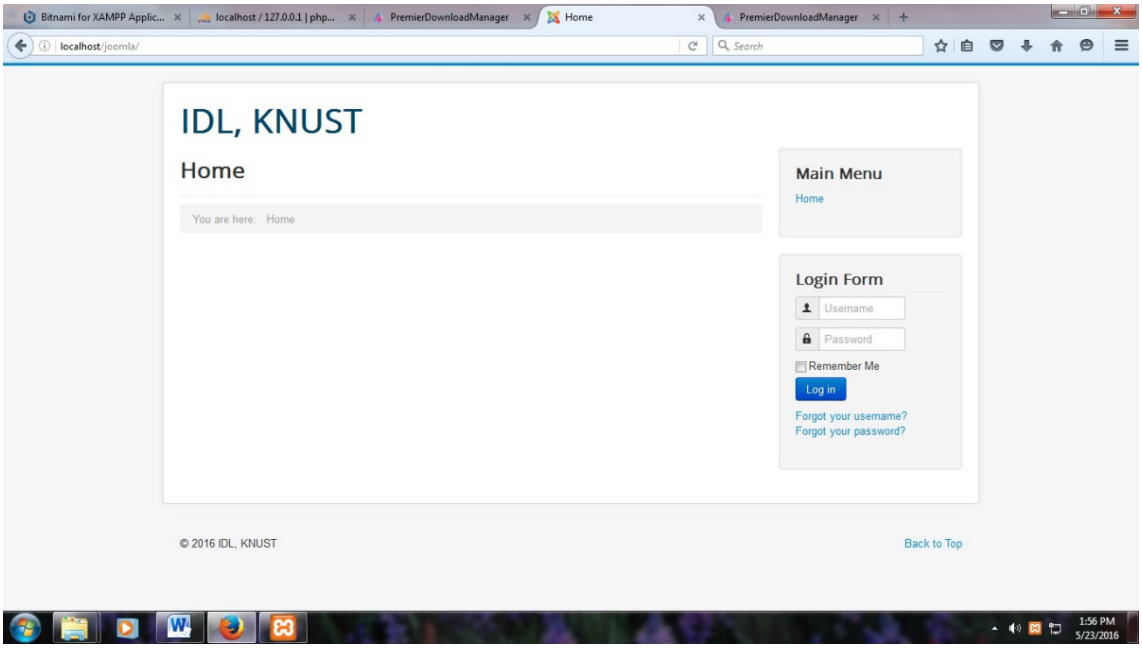

Figure 2. Front page of website built with Joomla CMS.

2.5.1 Website in WordPress

WordPress was used to create another webpage. WordPress is also PHP based and the XAMPP server was installed to make WordPress easy to use. A webpage in WordPress CMS is displayed in Figure3.

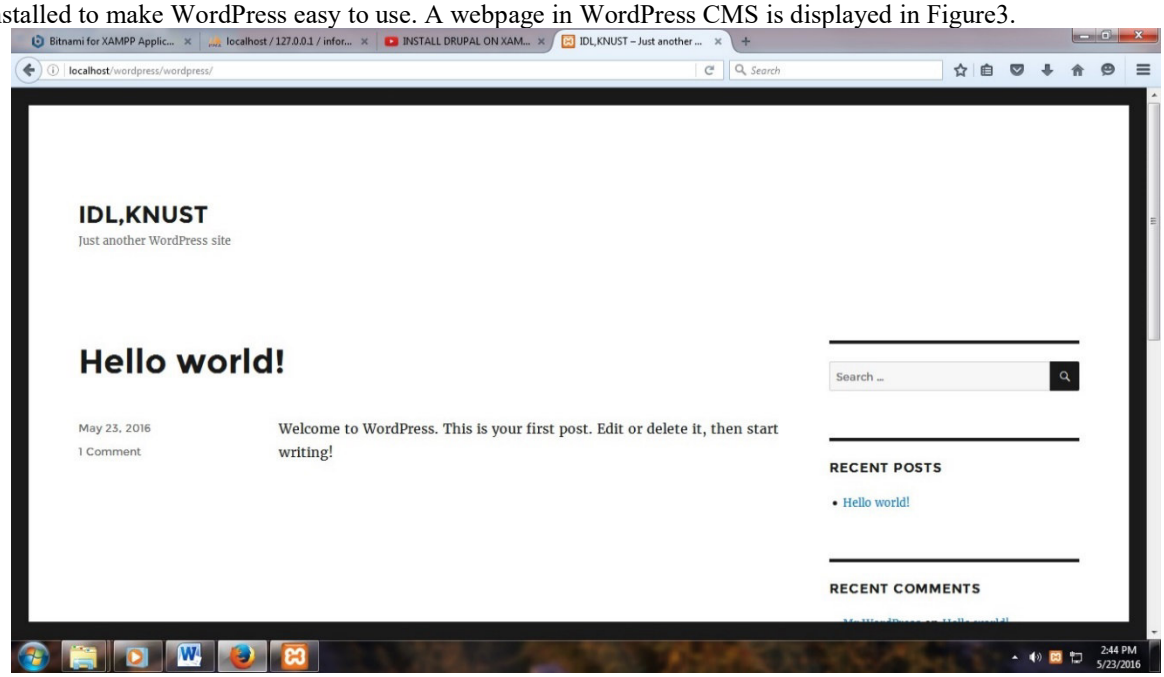

Figure 3. Front page of website built with WordPress CMS

2.5.2 Website in Drupal

Another page was created using Drupal which is also a PHP based CMS. The Drupal files were unzipped and then copied to the same directory ‘htdocs” in the XAMP folder. The Drupal installation was completed by accessing the Drupal file through a web browser. A website created with Drupal is displayed in figure 4.

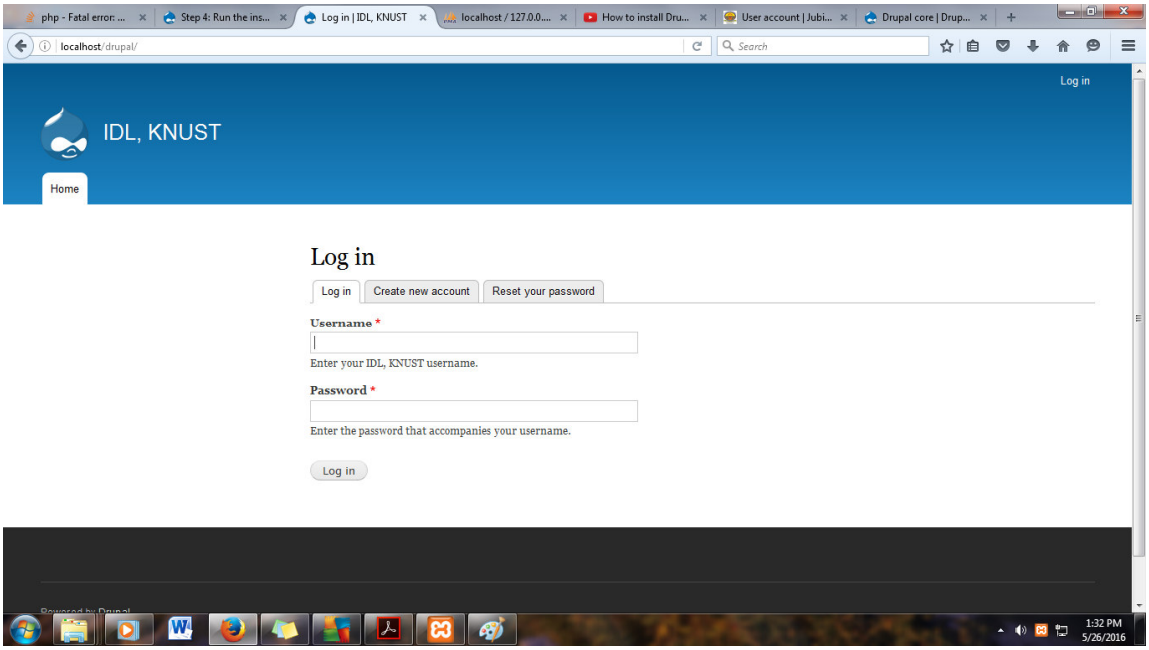

Figure 4 Front page of website built with Drupal CMS

3. Result

3.1 Page performance test

The page performance is a test undertaken to access how the pages of each specific content management system (CMS) under study will perform to meet user's needs. This is due to the fact that if a user's wants are addressed, they are more likely to return to a website.

A test was performed to check page performance for all three CMS: Joomla, Drupal and WordPress based on page performance test criteria: page load time (PLT), the page size (PS), number of cascading style sheet and JavaScript files. The page performance test gave the researchers the ability to assess how well users' needs were met by the various websites built with the various CMSs.

Data obtained from running each of the CMS to observe its page performance, and these results was presented in tables and charts. Data acquired from the various webpages designed using Joomla, WordPress and Drupal CMS and were then evaluated and analyzed.

Table 2. shows the result recorded after running each CMS with only text information on the webpage. The following times for PLT were recorded in seconds (s) with the help of a "stopwatch", the sizes of the pages also recorded in kilobyte (kb), the JS and CSS files were recorded by counting the number of files present respectively.

Table 2 Page parameters with text only

CMS	PLT	PS	JS	CSS
Joomla	9s	601.18kb	6	2
Drupal	5s	202kb	0	1
WordPress	6s	305.6kb	2	3

The page size of Joomla CMS recorded is 601.18kb, which is bigger than Drupal page size which is 202kb and also bigger than WordPress which is also 305.6kb. The researchers noted that, Joomla CMS creates default image folder containing images to display upon loading, and most of these images have bigger sizes than that of Drupal and WordPress. The index file created in Joomla makes references to a number of files whiles loading. The researcher noted that, the Joomla CMS also created number of Javascript file to be 6 when recorded, Drupal creating none and WordPress create two (2) JavaScript files. The Cascading Style Sheet also created in Joomla CMS is two (2) and in Drupal is one (1), and in WordPress is three (3). This research seeks to do a comparative study for the various differences in the records obtained and the effect it will have on the page performance of each CMS

Page performance for pages with both text and picture gallery object

An additional object was added to the web pages created to also examine how pages respond, or perform if they contains both textual information and other object. Below are the records for pages containing both text and other additional objects, example picture gallery object.

Page with picture gallery object

Table 3 shows the results performed on all three CMS using a picture gallery object on the webpages to examine

page performances.

Table 3: Page parameters with an object, picture gallery

CMS	PLT	PS	JS	CSS
Joomla	15s	802.18kb	8	7
Drupal	15s	506.1kb	2	7
WordPress	8s	400.1.6kb	2	4

From Table 3 it is realized that pages of all three CMS increased as a result of introducing an object on all pages. This also had effect on the page load time of all the three CMSs.

3.2 Graphical representations

A graphical chart representation is created to clearly see the effect each individual page performance criteria; being page load time (PLT), page size (PS), JavaScript files (JSF), and Cascading Style Sheet (CSS) had on the various CMSs.

Table 4. Page load time (PLT) comparison of pages with text only

CMS	PLT with text only
Joomla	9s
Drupal	5s
WordPress	6s

From Table 4., the study revealed that among all three content management systems, Joomla used a longer time (9s) to load a page with only text information. WordPress used six (6) seconds to load a page with only text information. The fastest was Drupal. It took five (5) seconds to load a page with text information only.

This information tells us that it is best for developers to use Drupal CMS to create a website that uses only textual information. This is because it takes less time (5s) for users to access the information. This is shown in Figure. 5 below.

Graphical representation of page load time comparison

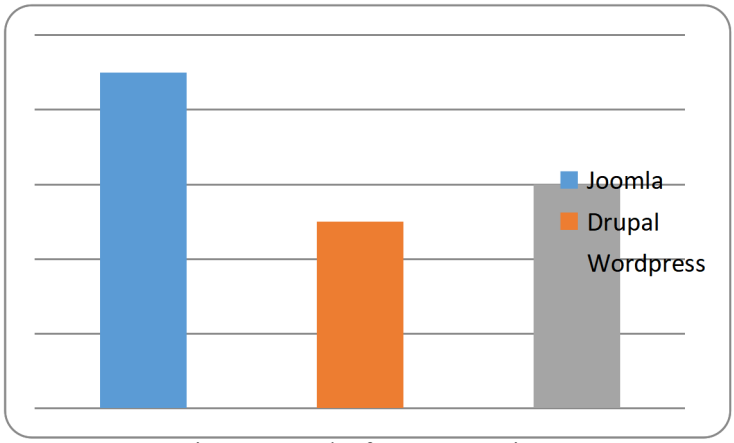

Figure 5 Graph of PLT comparison

Page size (PS) comparison

The various page sizes of the different CMS were also examined to see how the different page sizes, whether pages with only textual information or pages with additional object like picture gallery will affect the page performance of each CMS

Table 5. Page size (PS) comparison

CMS	PS with text only	PS with object
Joomla	601.18kb	802.18kb
Drupal	202kb	506.1kb
WordPress	305.6kb	401.6kb

From table 5, the study revealed that the page size of Joomla increased from 601kb to 802.1kb. The page size of Drupal also increase from 202kb to 506.1kb, and the page size for WordPress increased from 305.6kbto 401.6kb.

The page sizes of the various web pages increase as the content increases. And this is illustrated in Figure 6a shows a graph of the page size with only text and Figure 6b showing a graph of page size with both text and picture gallery object.

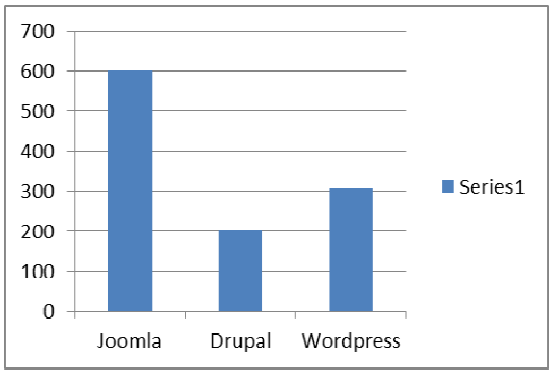

Figure 6 a graph of the page size with only text

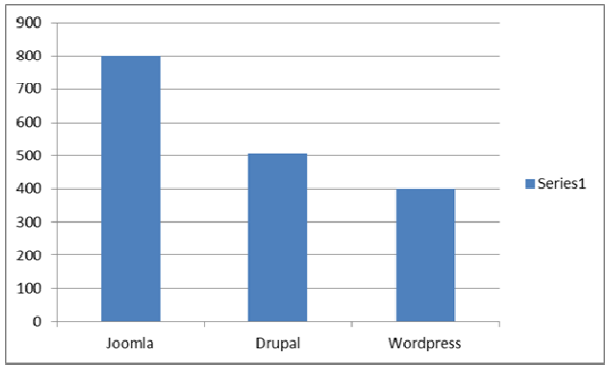

Figure 6b showing a graph of page size with both text and picture gallery object.

JavaScript comparison

A test was run to examine how JavaScript files affected page performance, and the result were taken to enable the researcher acquire some findings for the study undertaken. The various results were recorded for the effect of JavaScript files on page performance shown in table 4.5 below.

Table 6 JavaScript Comparison

CMS	JS with Test only
Joomla	6
Drupal	0
WordPress	2

From Table 6, Joomla CMS created the highest number (6) of JavaScript files with a page containing only textual information. It was followed by WordPress, but Drupal did not create any java Script files.

According to, Butkiewicz(2011) JavaScript files enable most websites to be very interactive. The results from the Table 6 tell us that a website created with Joomla is more interactive than Drupal and WordPress. The comparison of JS files of Joomla, Drupal, and WordPress is displayed in Figure 7.

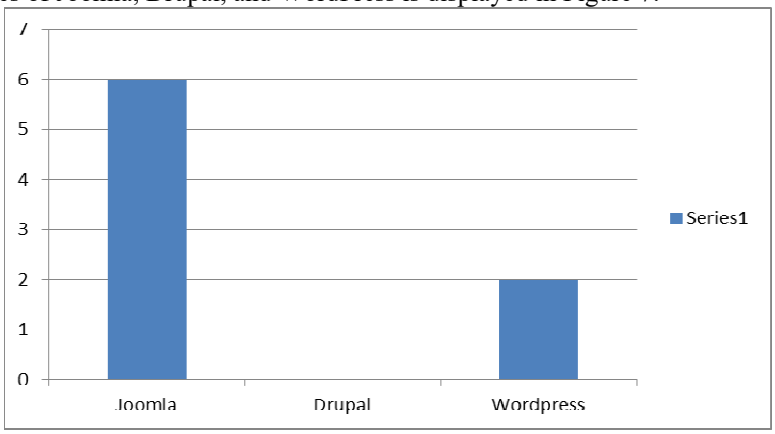

Figure 7 Graph of JS files comparison

Cascading style sheet comparison

Another test was run to examine the effect of cascading style sheet on page performance of various CMSs under study, and the result were recorded for a clearer decision or conclusion to be established. These records are shown below in table 7 below.

Table 7 CSS comparison with text only

CMS	CSS with text only
Joomla	2
Drupal	1
WordPress	3

Cascading style sheet (CSS) gives a website good layout (Butkiewicz, 2011). A web page with more cascading style sheet will have good layout than a page with less or no CSS file.

From Table 7, it can be seen that WordPress had more CSS (3) than Joomla and Drupal. This shows that WordPress gives a website good layout than the rest. Figure 7 shows graphical comparison of CSS files.

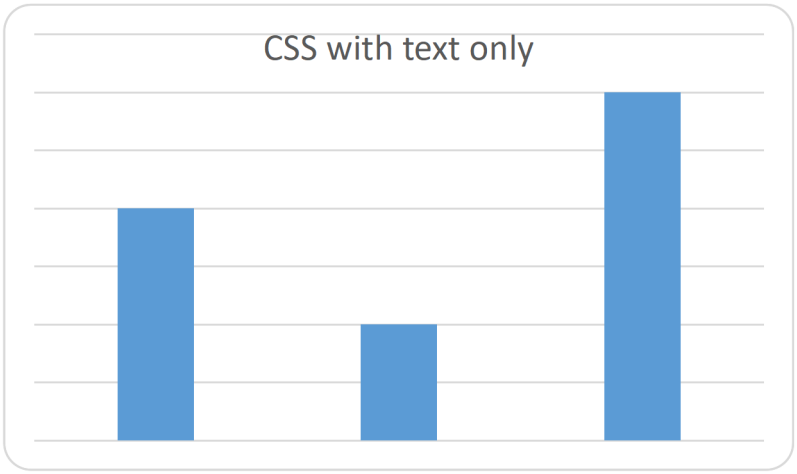

Figure. 8 Graph of CSS files comparison

Comparison of page parameters with object; picture gallery

In order to arrive at the goal of this research, the study examined the page performances of the different CMSs by introducing additional object or content on the pages created. In this case the object added to the page content was picture gallery.

Page load time (PLT)

Another test was run to examine the page load time of each CMS which has an additional object on the page like a picture gallery. Table 8 below shows the page load time recorded for all CMSs when an additional object like a picture gallery was added to the page of each CMS.

Table 8 Page load time comparison with picture gallery object

CMS	PLT with object
Joomla	15s
Drupal	15s
WordPress	8s

Table 8 shows that the page load time for WordPress is less than Drupal and Joomla for a page with both textual information and additional object like picture gallery. A developer is likely to use WordPress to create a website since it uses less time in loading a page. Users are also likely to visit a page that takes less time to load than the one which uses a longer time to load. Figure 9. shows a graphical representation of Table 8

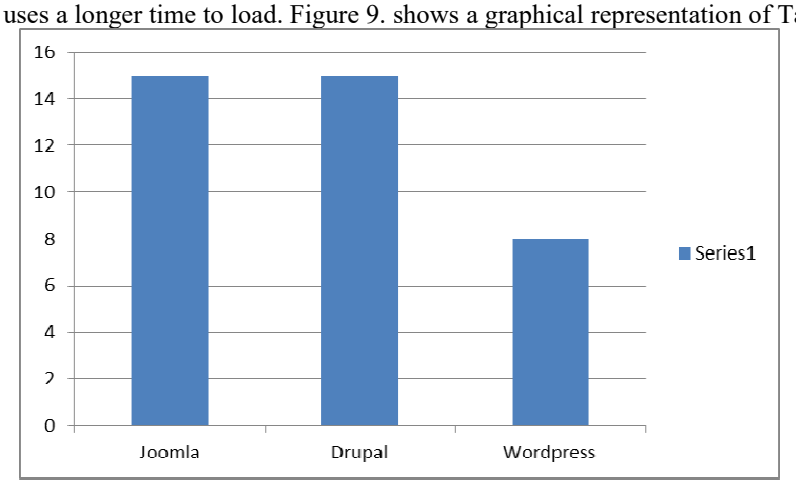

Figure 9 PLT comparison with gallery picture object

Page size (PS) comparison

A test was run to examine the page sizes of all CMSs after adding an object like picture gallery to the page. The result were recorded as shown in table 9 for a comparative study of the three CMSs

Table 9. PS comparison

CMS	PS with text only	PS with object
Joomla	601.18kb	802.18kb
Drupal	202kb	506.1kb
WordPress	305.6kb	401.6kb

Table 9 shows the comparison of PS of the various CMSs. The effect on page performance of each of the

CMS shows that Drupal had the smallest PS (202kb) as compared with Joomla and WordPress. The results revealed that developers will opt for Drupal when developing a webpage which has only text information. However, WordPress will be the best CMS for developers when developing a webpage with both text and additional object. The information has been represented below in figure 10a and figure 10b.

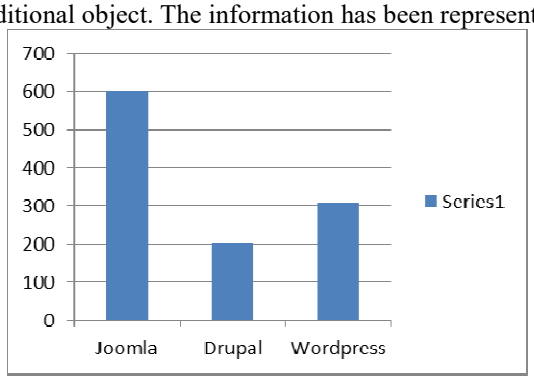

Figure 10a graph of PS with text

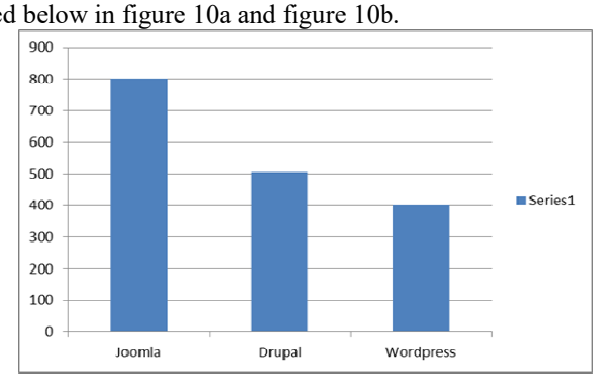

Figure 10b Graph of text and picture object

JavaScript file (JS) comparison

A test was run to also examine how the JavaScript created by the various CMS also affected the page performance of the various CMS. The result was recorded in table 4.8 below, for the purpose of this research.

Table 10. JavaScript (JS) Files Comparison

CMS	JS with text and object
Joomla	8
Drupal	2
WordPress	2

Table 10 shows the comparison of JS files in the three CMS. A webpage with more JS files is more interactive. And from Table 10, it can be seen that Joomla had more JS files than Drupal and WordPress. This results from the study revealed that, developers are likely to use Joomla to create websites if they want more interactive features on their page, because it is more interactive. Users are also likely to visit a page which is more interactive. The figure below represents a graphical comparison of CMS on JavaScript file

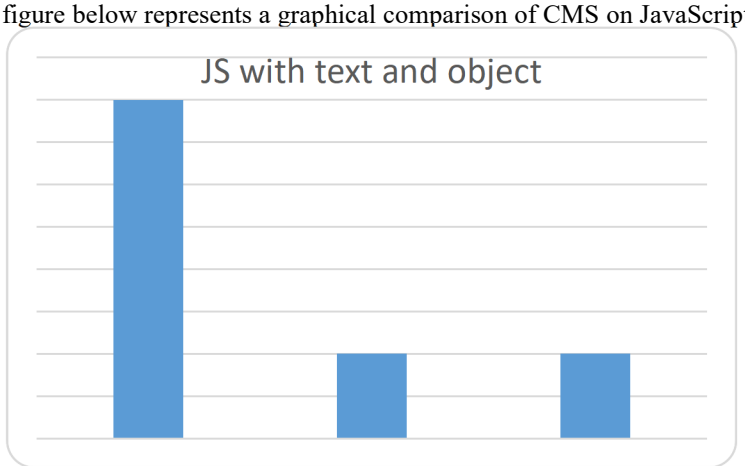

Figure. 12 JS file comparison

Number of CSS comparison

A test was also run to examine the effect CSS on a page of both textual information and an object like picture gallery will have on page performance of the CMS used in creating a particular website. The table below 11. shows the records of data obtained for comparison on CSS

Table 11. Number of CSS comparison

CMS	CSS with text and object
Joomla	7
Drupal	7
WordPress	4

Table 11 shows the comparison of CSS between Joomla, WordPress, and Drupal CMS. The results revealed that both Joomla and Drupal had the highest number of CSS. And a website with the highest number of CSS gives it a good layout.

It can be seen from Table 11 that a developer who wants to have a good website layout has to consider either Drupal or Joomla. Another consideration such as the page load time as well as JS files can also be factored before a decision can be made between Joomla and Drupal.

The figure below is a graphical representation on data obtained for CSS files for each of the CMS

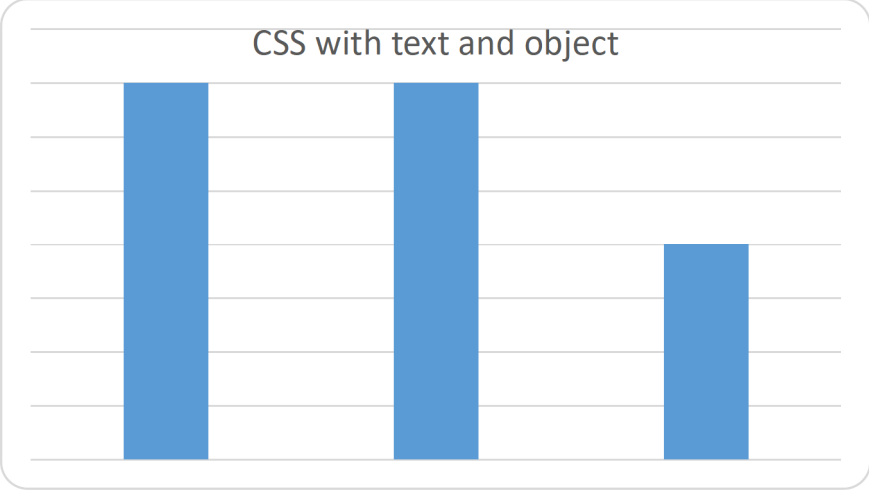

Figure. 13 CSS file comparison

The overall analysis of the results reveals the following:

i. Drupal content management system (CMS) is the best CMS to use when developing web pages with only text information since it uses fewer seconds to load and it has less page size as compared to Joomla and WordPress.

ii. Joomla CMS creates a high number of JS files than Drupal and WordPress. This makes it the best CMS to choose when developing website which is more interactive.

iii. WordPress gives best web page layout since it created the highest number of CSS files.

The comparison of webpages that use text information and other additional object or content also revealed that:

iv. WordPress is the best CMS to use when it comes to text information and other objects. This is because it takes less amount of time in loading pages as compared to Joomla and Drupal

v. Joomla is the best CMS when it comes to the use of JavaScript files.

vi. A content management system which gives a website a good layout is either Drupal or Joomla. This is because both create the same number of CSS files in a webpage. But developers can decide between Joomla and Drupal in the case of page load time (PLT)

4. Conclusion

Different web pages were developed using three CMSs under study (Joomla, Drupal and WordPress) to examine how well each of these CMSs will respond to users in terms of their page performance. Some of the page performance criteria studied were, page load time (PLT), page size (PS), number of JavaScript (JS) files created, and number of cascading style sheet (CSS) file. After the test run of each webpage created by the respective CMSs, it was discovered that, different CMS perform differently with respect to the page performance criteria, which will be mentioned in the conclusion in this chapter. As a result, the research deduced that, one CMS cannot be considered as the best CMS over all, because each of them performs uniquely depending on the need of the website developer. This experimental study therefore fills the gap in research by presenting with quantitative evidence, how each CMS performs based on performance criteria common to all the three CMS.

References

Addey D, Ellis J, Suh P., Theimecke. D. (2002). Content management system (Tools of the trade)

Barker, D. (2015). Web Content Management: Systems, Features, and Best Practices (First ed., Vol. 1). New York: O'Reilly. Retrieved January 7, 2018, from https://www.oreilly.com/library/view/web-content-management/9781491908112/

Butkiewicz, M. (2011). Understanding Website Complexity:Measurement, Metrics and Implementation. 10-15. Retrieved January 8, 2018, from https://users.ece.cmu.edu/~vsekar/papers/imc191-butkiewicz.pdf

Butkiewicz, M., Madhyastha, H. V., & Sekar, V. (2011). Understanding Website Complexity: Measurements, Metrics, and Implications. ACM.

Bhattacharjee, S. (2011). Evaluation of Content Management Software with Comparison among Joomla,WordPress and Drupal. 17-21.

Boiko, B. (2002). Content management bible. (Second, Ed.) Reno, NV, U.S.A: Wiley & Sons. Retrieved

December 5, 2018, from https://www.abebooks.com/book-search/title/content-management-bible/author/boiko-bob/

Cederholm, D. (2005). Bulletproof web design (Third ed.). Berkeley, CA 94710. Retrieved December 8, 2018, from http://ptgmedia.pearsoncmg.com/images/9780321808356/samplepages/0321808355.pdf

Chaturvedi, B. K. (2009). Media Management. Berkeley, CA 94710: Global Vision Publishing House. Retrieved March 6, 2018, from http://ptgmedia.pearsoncmg.com/images/9780321808356/samplepages/0321808355.pdf

Clarke, A. (2015). Difference Between WAMP, LAMP, MAMP AND XAMPP. Berkeley: O'Reilly Media.

D Shivalingaiah and Umesha Naik. (2009). Open source software for content management. Pondicherry University.

Damian, A. I. (2016). Comparative Study Of Web Design Methodologies. Florida. Retrieved March 9, 2018, from https://users.ece.cmu.edu/~vsekar/papers/imc191-butkiewicz.pdf

Mican,D. Tomai N., Coros, I. R (2009). Web Content Management Systems, a Collaborative Environment in the Information Society.

Friends, A. (2021). What is XAMPP? Retrieved from XAMPP: https://www.apachefriends.org/index.html

Grinberg, M. (2014). Flask web development: Developing web. Beijing. [Online] Avaliable https://doc.lagout.org/programmation/python/Flask%20Web%20Development_%20Developing%20Web%20Applications%20with%20Python%20%5BGrinberg%202014-05-18%5D.pdf

Heilmann, C. (2010, January 6). Website Performance: What To Know and What You Can Do. Retrieved August 15, 2016, from smashing magazine: https://www.smashingmagazine.com/2010/01/page-performance-what-to-know-and-what-you-can-do/

Schneider, F., Agarwal, S., Alpcan, T., & Feldmann, A. (2008). The new Web: Characterizing AJAX traffic. . In Proc. PAM.

Shailesh, K., & Suresh, P. (2017). An Analysis of Techniques and Quality Assessment for Web Performance Optimization. Indian J. Comput. Sci. Eng., 8(2), 61–69.

Shitote, S., Omieno, K., & Ondulo, J. (2018). Investigating Optimization Strategies that Determine Performanc of CMS Websites in Organizations (Vol. 7). International Journal of Advanced Research in Computer and Communication Engineering.

Thomas D, Hansson D. H, Breedt L. (2005). Agile web development with Rails (Third ed.). Retrieved May 8, 2018, from https://pragprog.com/book/rails1/agile-web-development-with-rails