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COMPARISON OF WORDPRESS, JOOMLA AND DRUPAL

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Content management systems are software applications that allow users to create and manage their website's content without having any prior programming knowledge. There are numerous content management systems available that provide better accessibility, optimization and security at minimal cost with a maximum user-friendly system. However, it requires deep research and literatures to study and compare the most important criteria of CMS while making selection.

The objective of this thesis was to study three popular content management systems and compare their features on five important criteria. This thesis aims to provide a systematic review of three most commonly used CMS products WordPress, Joomla and Drupal. The comparison was made on the most important criteria such as system requirements, creating contents, admin panel user experience, search engine optimization, community support and the results were presented by comparing the individual features of those five criteria. The results were obtained from literatures, facts and web research.

The study concludes that WordPress is most suitable for beginners and novice developers whereas Joomla was found to be most applicable for the creation of large content websites which offered highly enriched customization features. On the other hand, Drupal was found to be applicable for developers with good programming skills for high-level customization and creation of complex websites. This study aims to help the users understand three most popular CMS products and analyze their critical features to apply in any website development project.

KEYWORDS:

WordPress, Joomla, Drupal, web publishing system, web development, website, content management system

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LIST OF ABBREVIATIONS

API	Application Programming Interface
ASCII	American Standard Code for Information Interchange
CMS	Content Management System
CSS	Cascading Style Sheets
FTP	File Transfer Protocol
HTML	Hyper Text Markup Language
HTTPS	Hypertext Transfer Protocol Secure
LDAP	Lightweight Directory Access Protocol
MySQL	My Structured Query Language
PHP	Hypertext Pre-Processor
SQL	Structured Query Language
URL	Uniform Resource Locator
UTF-8	8-bit Unicode Transformation Format
UX	User Experience
W3C	World Wide Web Consortium
XHTML	Extensible Hypertext Markup Language

1 INTRODUCTION

Website development and management can be complex and tedious work from the perspective of a non-programmer and a novice developer. CMSs addresses this issue of huge learning curve for the developers by creating software applications that lets common users and novice developers to create and update website with minimal or no programming knowledge. However, CMS is a broad topic and covers different frameworks. The lack of enough information on comparison of various CMS has created confusion among the users to make the adequate use of CMS. There have been few research literatures conducted in the comparison of several CMS [1] [2], these lack enough simplicity and generalization to make the users clear understating from high level perspective. This thesis presents the theoretical comparison of different CMS based on the most important features.

There are several open source CMS available and this study focusses on the most popular CMS namely, WordPress, Drupal and Joomla. These systems are popular and widely used due to their better functionalities and better user experience. However, there are limited studies that explore the reason for their popularity. Most of the surveys and papers are focused to support the specific CMS for web development. This thesis has explored these three frameworks and made a comparison focusing on five important criteria while making a selection for any beginner, entrepreneur or a business. The five criteria highlighted in this study are namely system requirements, creating contents, admin panel user experience, SEO, Community Support. The comparison is based on the systematic review of these five criteria and the results are based on the comparison of the features in terms of those criteria.

The goal of this thesis is to provide a theoretical overview of the CMS so that a user gets general idea on the CMS features and strengthen their ability to decide among the features which may fit their web project goal. Going through those CMS features and comparing them in this report, users can see the difference on what the various system offers, and which may be preferred in terms of specific features.

This thesis is organized as follows: The chapter 2 focuses on the detailed description of CMS and their features. The chapter presents the general working process of CMS, stats of CMS in Nordic countries and general comparison of CMS. Chapter 3 demonstrates the installation of each CMS. The installation process and the complexity are shown in this chapter. Chapter 4 gives the overall system review on the most important criteria used for comparison. It provides the information on understanding the difference of using each CMS. Chapter 5 shows the results in terms of those criteria with their features. Chapter 6 discusses the results of the comparison. The conclusions of the study are in chapter 7.



Picture 1. Thesis Structure

2 CONTENT MANAGEMENT SYSTEM

2.1 CMS Overview

A CMS is a software program that lets a user to create and manage the web contents without technical skills or programming. [3]. There are many CMS available in the market when looking for the complete CMS package and users can be overwhelmed with the number of choices to fit the best one for any project. Approximately, there are between 250 to 350 different CMS active on the market. These CMS vary from simple development tools to complex enterprise systems. The first consideration is what CMS requirements are needed to support the planned project (IONOS Digitalguide, 2020). Users should decide on the important areas for the project's development when looking for a software solution to any online project. For example: the development of a school or a university website needs to have multiple access for students, teachers and administrators. This type of website must have complex authentication process. A CMS offering this type of feature may be an ideal solution for this website.

CMS has many advantages over static websites. Static websites are hard to maintain and costly. As we know, many of the website owners prefer to use static web pages for better security reasons. As the static web pages use HTML or JavaScript to develop pages, they are very difficult to update without special program as well as training. Mostly, those websites are hard to maintain and cost expensive (TheeDigital, 2018). CMSs were introduced for better web design experience and easy maintenance. Databases are used to store, edit and retrieve the content of the website. The databases stores every page as a plain text, as a result the site is easily editable, easy to search and allows to manipulate the content of the site. Generally, CMSs are capable of converting the text into the HTML and necessary code (Web Developer Juice, 2011). Wordpress, Joomla and Drupal are the most popular CMSs available as open source web publishing system. These programs can be modified to a higher-level extent because of their open source nature. Any small business or large business can use these CMS to run their websites for their own purpose. CMSs are also easy to install because their interface is simple and easy instructions are available for developers. Developers all around the globe are making it popular with their large online community dedicated to help other people using the software [5].

Essentially, a CMS can be divided into web content management, blog publishing and social communities [3].

Web content management

The main purpose of web content management is to create and manage online content together from a single portal. The workflows need multiple access to the administration which involves secured authentication process. Another thing to ensure is that the multimedia content for a website is processed optimally. Other important areas include user permission management, website search capabilities, article management system and multilingual feature. [3]

Blog publishing/ news

This type of application is related to blogging and news publication, as the name suggests. Content preparation, extended links, categorization and function to link social media platforms are particularly important. A good blogging website determines good interaction with the users and controls the publication entries. Quickly and easily creating content is another important factor for blog website. Also, publishing the content directly onto a mobile device can be an important factor for this type of application [3].

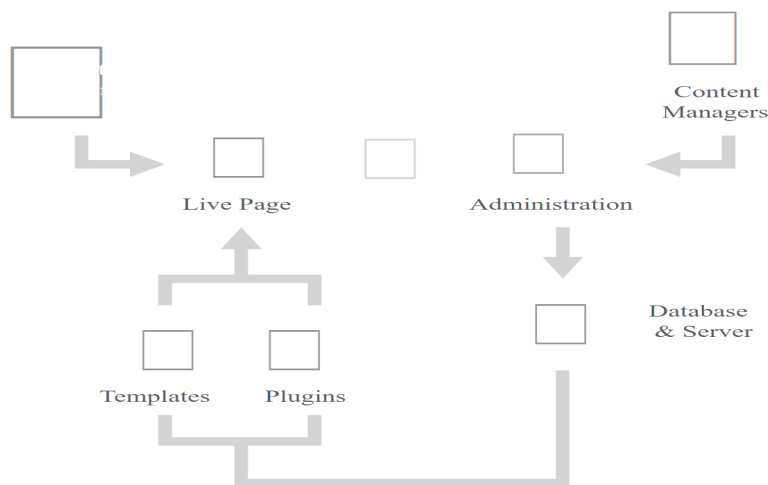
Social publishing / communities

It requires complex functions to develop large online communities because online communities are targeted at active user groups rather than passive readers. The content of social publishing are created by community members and website's administration. The content created by community members are referred as user generated content. The architecture of social publishing website are mostly modular in design and web 2.0 functions can be implemented for further extension. [3]

2.2 Working process of CMS

Normally, a CMS uses server-side scripting languages such as PHP to make a call for your content from a database. These databases can be of any type, MySQL, SQL servers etc., to serve dynamically to website. The same method is applied to publish,

edit, add or remove functionalities on website through backend. Backend is often regarded as administrative portion. Extended functionalities and customization of features may vary and depends on the programming ability. The goal of a CMS is to design a platform in such a way that nonprogrammer can find it easy to use (Coale, 2011). Picture 2 shows content managers and administration make a request with database server to locate and call a content using server-side script such as PHP, then serve it dynamically to the live page through templates and plugins. Also, a content delivery from a live page to administration is made using same process.

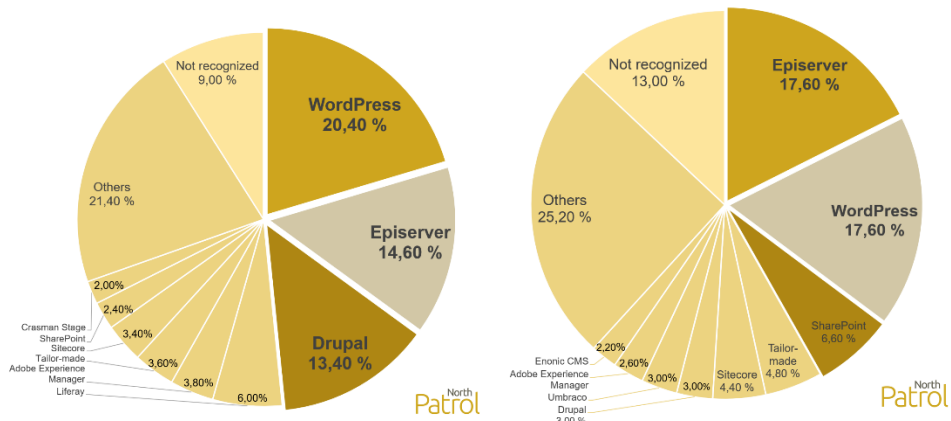


Picture 2. CMS working process [6]

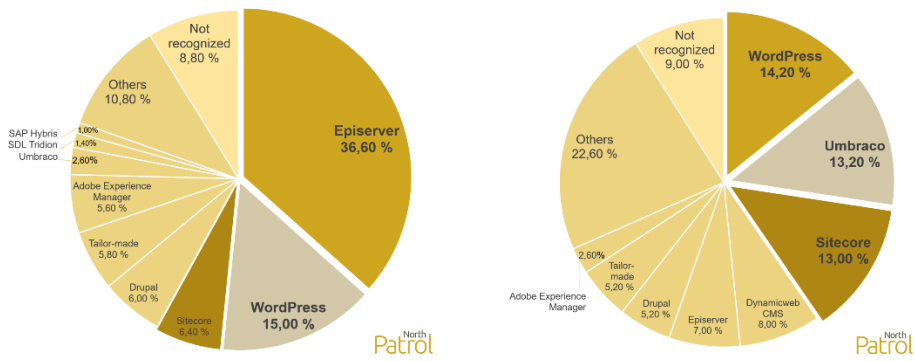
2.3 CMS in Nordic Countries

According to survey, (“Content management system market shares in biggest Nordic companies”, 2019) based on examination of the largest companies in Finland, Sweden, Norway and Denmark, EPiServer is the most commonly used CMS in the Nordic countries followed by Wordpress. The survey selected top 500 companies in Finland, Sweden, Norway and Denmark and also carried out a survey on top 2000 and top 100 companies in Nordic region.

Picture 3 and 4 below highlight the preferred CMS as per country.



Picture 3. Preferred CMS in Finland(left) and Norway (right) [7].



Picture 4. Preferred CMS in Sweden (left) and Denmark (right) [7].

As per average revenue generated, Adobe Experience Manager have the highest income generated in the Nordic countries with Finland as an exception where Sitecore generated the maximum revenue.

However, it is a different scenario worldwide. Picture 5 below highlights the top 10 CMSs worldwide.

	2019 1 Apr	2019 1 May	2019 1 Jun	2019 1 Jul	2019 1 Aug	2019 1 Sep	2019 1 Oct	2019 1 Nov	2019 1 Dec	2020 1 Jan	2020 1 Feb	2020 1 Mar	2020 1 Apr	2020 2 Apr
WordPress	60.4%	60.6%	60.7%	60.8%	61.0%	61.2%	61.4%	61.5%	61.8%	62.1%	62.4%	62.7%	63.1%	63.1%
Joomla	5.2%	5.2%	5.1%	5.0%	5.0%	4.9%	4.9%	4.8%	4.7%	4.6%	4.5%	4.4%	4.3%	4.3%
Shopify	2.7%	2.7%	2.8%	2.9%	2.9%	3.0%	3.0%	3.1%	3.2%	3.4%	3.5%	3.7%	3.7%	3.7%
Drupal	3.4%	3.4%	3.3%	3.3%	3.2%	3.2%	3.1%	3.0%	3.0%	3.0%	2.9%	2.9%	2.8%	2.8%
Squarespace	2.7%	2.7%	2.8%	2.8%	2.8%	2.8%	2.8%	2.8%	2.8%	2.7%	2.7%	2.6%	2.5%	2.5%
Wix	1.9%	1.9%	1.9%	2.0%	2.0%	2.1%	2.2%	2.2%	2.3%	2.3%	2.3%	2.3%	2.3%	2.3%
Bitrix	1.2%	1.2%	1.2%	1.1%	1.3%	1.3%	1.3%	1.3%	1.4%	1.5%	1.6%	1.6%	1.7%	1.7%
Blogger	1.3%	1.3%	1.3%	1.3%	1.4%	1.4%	1.4%	1.4%	1.5%	1.5%	1.6%	1.6%	1.6%	1.6%
Magento	1.8%	1.7%	1.7%	1.7%	1.6%	1.6%	1.5%	1.5%	1.5%	1.5%	1.4%	1.4%	1.4%	1.4%
OpenCart	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.9%	0.9%	0.9%
PrestaShop	1.4%	1.4%	1.4%	1.4%	1.4%	1.3%	1.3%	1.2%	1.2%	1.1%	1.1%	1.0%	0.9%	0.9%

Picture 5. Top 10 CMS system worldwide market share trends after April 2019 [8].

Combining reports from Nordic countries and worldwide, Wordpress, Joomla and Drupal are top three popular CMSs.

2.4 Wordpress

WordPress is a PHP and SQL based open-source web application created in 2003. Initially, it was created as a blogging system but with its popularity and ease of use, it developed further as a website CMS. WordPress is free to use and modify for any purpose without license fees (WordPress.org, 2018).

One of the most popular and effective blogging tools on the market is WordPress as it has some competitive advantages. It has different versions to match the needs of bloggers. For example: wordpress.com is a self-hosted version. Likewise, another version of WordPress is multiuser WordPress. Multiuser WordPress are suitable for any organization offering blog-writing opportunities to its members. One popular feature of Wordpress is its ease of use which is widely appreciated by the developers. The software is extensible to the extent with its ease of use API and resources. Users perceive it as convenient in finding additional tools and features, plugins and add-ons to determine the needs for their website. Also, Wordpress is widely known for its large online community that helps with most of the issues arising amongst the developers in any case. [10] [13].

WordPress creators use the latest technology for development ensuring the system provides modern features and works smoothly in every platform. Developers are regularly updating plugins that can be easily added to the site and extend its use. Also, Wordpress provides flexibility in modifying the code and accordingly. Once the user downloads the installation package, all the features can be found inside of it and are installed manually. [11].

Whether it is a beginner, intermediate developer or more experienced users, Wordpress is effective for all levels of designers and developers. Users find many useful features regarding content management of the website. Content managers are effectively monitoring the traffic resulting in better analyze of the website [13].

The features of WordPress are explained below [12] [13]

A. Full-standard compliance: It is necessary for wordpress generated code to comply with the standards of the World Wide Web Consortium(W3C). W3C is known as an internationally recognized community who are actively working on developing web standards to provide full potential of the web. It also ensures the interoperability with varying browsers and also ensures the compatibility with next generation tools. Therefore, this is one of the important features of WordPress.

B. No rebuilding: WordPress makes it easier for developers to change the appearance and content on the site. Instead of regenerating whole static pages, pages are quickly displayed on the Wordpress page.

C. Wordpress pages: Users can create pages easily that may not relate to blog. This means that WordPress pages are designed to be a simple web page which is important when implementing websites rather than a page.

D. Wordpress themes: Several options are found as theme selection in order to change the appearance and design of the website. Developers are attracted to variety of themes to change the design very swiftly. Administrators on the other hand also find maintaining the website to be cost effective and easy.

E. Easy installation and upgrades: It is easy and quick to install and update the Wordpress into newest version available.

F. Typographical niceties: WordPress uses Texturize engine that is capable to convert plain ASCII into correct XHTML entities form.

2.5 Joomla

Joomla is another open-source CMS which was previously known as Mambo. It was officially launched and recognized as Joomla in 2006. Its working platform is any internet browser. Joomla is most popular for its ease of administration as the users find the update process easier. Also, it is flexible to use different templates according to the site flexibility. Joomla is freely used by anyone regardless the developers experience and can be copied and modified to the site needs [14] .

Joomla is most popular among the developers because they find easy to customize the interface which makes design easier. Designing the site is referred to be “backbone” while developing the site with Joomla. Without editing the code, developers can modify

the system easily which gives them more freedom while tasking the site as a result even beginner are able to create high end websites. Joomla has a variety of features and hundreds of plugins are available to easily build the site [13] [15].

Joomla has a large community working regularly to create and update the extensions. Some are free and some extensions are premium to use. Some premium features can be a large aid when developing business website, since it can be costly to hire a designer to create similar functions [15]

While the root stands as a 'core' in the system, coding for system changes can be a little overwhelming. Usually, beginner with no experience find difficult in using the software. Therefore, Joomla is best suited for people having basic level of web development experience [13] .

The list follows the top features of Joomla discussed below [13] [18]

A. User Management: Users are allowed to configure personal edits through a registration system approach. Joomla is supportive of nine different user groups that can be divided accordingly with the permission to access, edit, publish, or administrate the website. Regarding user authentication and authorization, Joomla uses several protocols such as LDAP, OpenID and Gmail.

B. Media Manager: The media manager supports with organizing and managing media files. The configuration is very convenient in that it is able to work with any type of file. Images can be rendered quickly at any time while working with articles as media manager is configured into Article Editor tool.

C. Language Manager: Joomla supports several convenient languages according to user ease and uses UTF-8 encoding. Users can showcase the website in one language whereas the administration panel can have another language option.

D. Contact Management: Joomla provides the user best option to find the contact information they want. Users can create multiple contact forms for specific user or user groups.

E. Search: The most important part for a website user is often searching the information they are looking for. Joomla is also popular for its search feature. Users are provided with variety of search items and also helps with search statistics for administrator.

F. Content Management: Organizing and managing the content of the website is hassle free. The administrator has a full control over the content and can be organized in any way he/she wants. The content can also be archived and published later. It is convenient for any user to organize the text and graphics in an appealing way through WYSIWYG editor.

G. Menu Manager: Users can create menus as much as they want using Menu Manager as some websites may need several menus. Menu hierarchy can differ according to content structure and the navigation way is freely selected.

H. Template Management: Templates are very important in Joomla as they are able to customize the design of the website easily. The entire website can use a single template or different templates for different parts.

I. Integrated Help System: Joomla contains a built-in help system for developers if any system issues encounter. Those instructions are found in English and also contains help tools assisting with any problems. Also, an application checks if the system is using the latest version available and troubleshooting is easy with the system information tools and resources with it. Additionally, online resources are also available for better help and support.

J. System Features: Several system features are available that are used by administrators for easy maintenance. There are plenty of options to optimize page loading such as page caching and GZIP page compression. Debugging mode and error-handling can be helpful while troubleshooting issue. The FTP layer eases the administrator task allowing file operation without changing other system files. This results to operate website easily and results in increased security.

2.6 Drupal

Drupal was released in 1999 as an open source content management application by Dries Buytaert. Drupal was made open source after short time of release as lot of developers were interested in the application. Drupal is issued with the terms of the General Public License, which authorizes the user to freely download and share the platform [19].

Drupal is helpful when creating complex websites because the coding is flexible, and it combines more advanced features. Advanced developers can find easily modifiable code that saves them a great deal of time and it is also suggested for beginners who are interested in coding rather than using templates. Also, Drupal has a wide online community to help developers with website development. Drupal has been emerged rapidly since its release because there are numerous developers in their community actively looking for bugs and errors that is handled fast and effectively. This also ensures the users that they are using the modern platform and that the quality and usability are always good [20].

Drupal is designed as a modular system. The functionalities of the system are based upon the module or group of modules and how they work. A single module can run a feature or only change the feature style. All the necessary modules to build the website can be found on the installation package and it is also possible to download and use additional features found in the Drupal online community when creating large websites [13].

Beginners may find Drupal complex because some people suggest Drupal is not so designer-friendly and the features are hard to use. People with few experiences in web development can find Drupal as more costly and lengthy. Drupal is a good option for experienced developers who enjoy mostly with coding and exploring complex features [13].

The features of Drupal are explained below [21] [23].

A. Organize and Find: User can find various option to organize and find the content on a website. They work as a great tool for administrator to arrange, categorize and create content in more effective way. Drupal core search and breadcrumbs are few examples of these tools. Node queue is another option for organizing content allowing users to collect nodes in an arbitrary ordered list for any purpose.

B. Creative Content: Drupal makes easy maintaining the content and managing different content types. With its easy and flexible handling, users can handle different content like text, video, podcast or blog.

C. Administer: Administrator have a variety of options to set user accounts and permissions in Drupal. Any user can have single or multiple roles and administrator is allowed to set the user permission for different users.

D. Build: Drupal makes building websites rapid with minimum programming. Users does not necessarily have to start from the beginning when deploying new websites because Drupal also provides the feature that consists of a ready-made configuration for a website according to the website purpose.

E. Design and Display: There are numerous Drupal themes that can help while designing the graphics of the website with no-coding. Also, any designer can create custom theme and make it available to use for others.

F. Connect: It is suitable to connect with third party services and websites with Drupal. Some important features like aggregation, feeds and search engine capabilities are helpful while connecting to other web services. Also, it is easy connecting social platforms for reaching larger audiences as well as external media and file services are connected easily.

2.7 General Comparison of CMS

Table 1 summarizes the CMSs with the general information, popularity, use cases, ease of use, etc. so that the reader can get the distinctive observation on the three CMSs and define the suitable CMS for any specific requirements.

Table 1. Comparison for WordPress, Joomla and Drupal.

	WordPress	Joomla	Drupal
Released date	2003	2003	2001
Founder	Matt Mullenwegg	Mambo	Dries Buytaert
Number of websites	75 million	2.8 million	1.1 million
Downloads	160 million	75 million	25 million
Market Share	62.4%	7.2%	4.8%
Free themes	3000 +	1000 +	2000 +
Free plugins	44 k +	5k +	26 k +
Cost	Free	Free	free
Frequency of updates	40 days	36 days	30 days
Best used for	<ul style="list-style-type: none"> • Newbie • Pro • Business • Ecom 	<ul style="list-style-type: none"> • Pro • Business • Ecom 	<ul style="list-style-type: none"> • Pro • Business • Ecom
Installation time	5 mins	10 mins	10 mins
Level of skill needed	Beginner	Intermediate	Advanced
Big companies using the platform	<ul style="list-style-type: none"> • TechCrunch • Mashable • Time • CNN 	<ul style="list-style-type: none"> • Harvard University • Linux • MacDonald • Ikea 	<ul style="list-style-type: none"> • Taboola • NBC • Patch

Table 2 compares the advantages and disadvantages of the following three CMSs .

Table 2. Advantages and Disadvantages of WordPress, Joomla and Drupal

	WordPress	Joomla	Drupal
Advantages	<ul style="list-style-type: none"> • User-friendly • Easy SEO integration • Responsive sites • Great support 	<ul style="list-style-type: none"> • Powerful system • Ecommerce ready • Active Developer community • High functional extensions available 	<ul style="list-style-type: none"> • Strong foundation • Multi-sites capability • High Scalability • Speed performance
Disadvantages	<ul style="list-style-type: none"> • Needs high security • Frequent updates on site • Slow load times 	<ul style="list-style-type: none"> • Small module marketplace • Plugins compatibility issue 	<ul style="list-style-type: none"> • Less developers • Wide learning curve

3 INSTALLATION

A web server is required to host any webpages. The requirements for a web server can vary for each CMS to work best and fast. To start with the comparison of CMS, a web server is chosen to install each CMS with a local web server Xampp.

3.1 Web server

Web server is derived from the computer's hardware or a software application which helps to distribute the web content to the clients through the internet.

The main goal of a web servers is to host websites and deliver it to client's browser. However, web servers can host different types of applications like gaming, data storage and other high-level applications. [24]

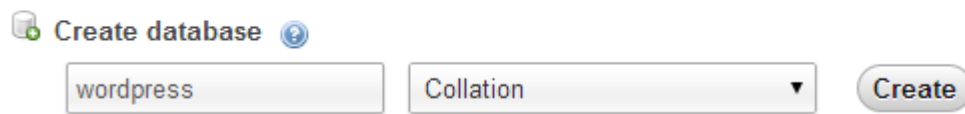
3.2 Xampp

Xampp is a free and open source server application to create, manage and debug sites locally on a computer. It is well known for easy installation and use. Upon installation, a fully functional apache server containing MariaDB, php and Perl is available. The main feature of xampp is that it is easy to use and works fast. [25]

Xampp was installed on author's personal computer. It is quick and easy to install xampp and includes apache, php, MySQL and phpMyAdmin in a package which is a perfect fit to host selected CMS system.

Before installation of the CMS, three different databases are created on the web server. This can be done in phpMyAdmin after xampp server is installed. PhpMyAdmin is the tool which comes in xampp installation package.

Databases



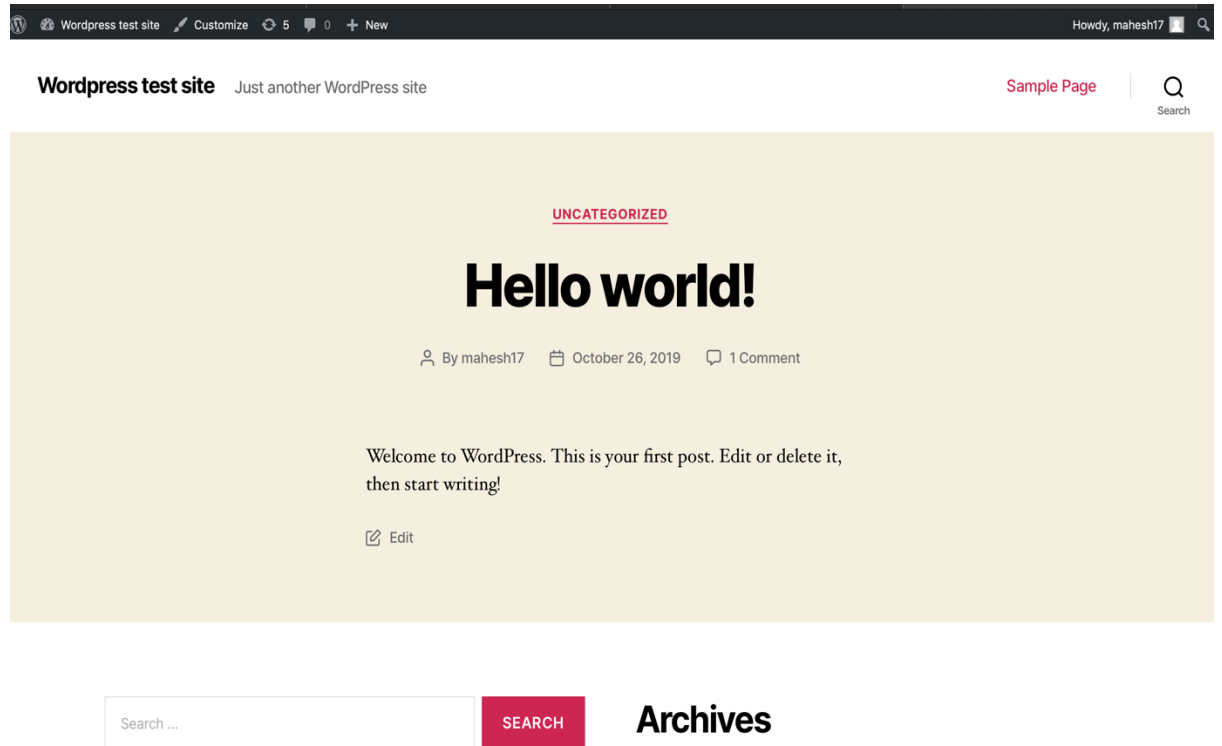
Picture 6. Creating database in phpMyAdmin.

The CMS installation files were downloaded from their respective official webpages and the author created three folders in the home directory and inserted the folders with the installation files in the htdocs folder. Example: C:/Xampp/htdocs/wordpress/. Now, the installation can be started by going to the address localhost/wordpress in the browser with the installation guide on the screen.

3.3 WordPress Installation

To get started with the installation, it is recommended to create a configuration file named wp-config.php which contains the database information for the webpage. The next step is to go through the address localhost/wordpress and get started with the installation. After that, it asks the user to fill the form with database information (database name, username, password, database host, table prefix). The database information needs to match the information created in wp-config.php file for successful installation of the WordPress.

Next step is to fill the form with the site information, username, password, email that is used when accessing the admin panel of the webpage. Now, the installation is completed, and the author can proceed with further development of the page. Overall, the installation is quick and easy. A sample of test page can be viewed below



Picture 7. Wordpress test page.

3.4 Joomla Installation

Getting started with Joomla installation, there are few simple steps for Joomla installation. First step is to select the language and fill a form with site information, username and password for accessing admin panel. Then a quick pre installation check is made by the installer to check the web server compatibility. Next step is for database configuration. The database must be configured with the database name, host name, username, password, database type. Then there is an option to configure FTP settings. This is a mandatory option and can be easily configured later. The last step asks the user to delete the installation folder for security reason. A test page sample can be viewed below

Joomla test site Search ...

[Home](#) [About Us](#) [News](#) [Contact Us](#)

Creating Your Site

Details ⚙️

Written by Joomla
 Category: Uncategorized
 Published: 18 April 2020
 Hits: 163

Joomla! is all about allowing you to create a site that matches your vision. The possibilities are limitless; this sample site will get you started.

There are a few things you should know to get you started.

Every Joomla! website has two parts: the Site (which is what your site visitors see) and the Administrator (which is where you will do a lot of the site management). You need to log in to the Administrator separately with the same username and password. There is a link to the administrator on the top menu that you will see when you log in.

You can edit articles in the Site by clicking on the edit icon. You can create a new article by clicking on the Create Article link in the top menu.

To do basic changes to the appearance your site click Home, Site Settings and Home, Template Settings.

To do more advanced things, like edit the contact form, manage users, or install a new template or extension, login to the Administrator.

Some quick tips for working in the Administrator

- To change the image on all the pages: Go to the Module Manager and click on Image Module.
- To edit the Side Module: Go to Extensions. Module Manager and click on Side Module.

Side Module

This is a module where you might want to add some more information or an image, a link to your social media presence, or whatever makes sense for your site.

You can edit this module in the module manager. Look for the Side Module.

Login Form

Remember Me

[Forgot your username?](#)
[Forgot your password?](#)

Picture 8. Joomla test page.

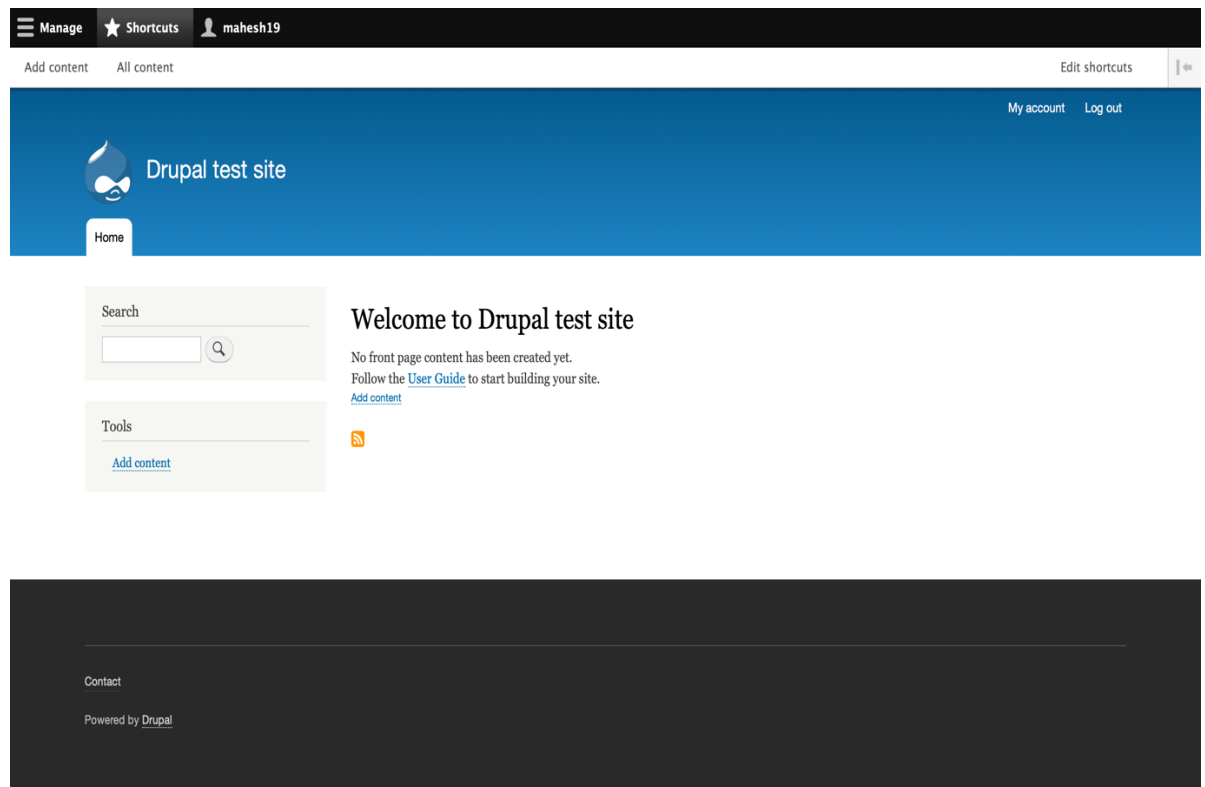
Now, the Joomla is installed on the web server and can be accessed with the web browser with the address. The installation for Joomla is also quick and easy and takes no more than ten minutes of time.

3.5 Drupal installation

Drupal installation can be done in several ways depending on the version being used. The first step is to choose the type of installation. Commonly, Drupal asks to select a type of installation based on the user requirements.

- **Standard:** this installation enables all the settings and modules
- **Minimal:** this installation enables only minimum setting and modules

After the type of installation is chosen, next step is to fill the database information as Joomla and WordPress. Users need to set the permission to read, write and execute Drupal files while installation and it can be changed later after the site is configured. Then, it needs to create a username and password for the admin panel while installation. Overall, the installation is simple and intuitive for Drupal. A test page sample can be viewed below



Picture 9. Drupal test page.

3.6 Conclusion

Generally, the installation is almost similar to each other. All three-system installation are quick and simple with the installation guide available. Drupal can take some time to set the folder access for beginners. The installation processes took no more than ten minutes for the author to install each system.

4 SYSTEM REVIEW

This chapter consists of a detailed overview of the CMS platform. The author had spent several months researching and testing with the CMS system and analyzed following things which is discussed in this chapter:

- System requirements for each system is compared with a table of comparison that is helpful when searching required hosting
- The author created pages for each system and described the options available while creating pages
- The author used admin panel, explored their features and concluded with the user experience of the platform
- Large number of sources were discovered for better SEO and plugins needed to make optimization fast
- The author read many of the articles for the documentation provided by the community of developers

4.1 System Requirements

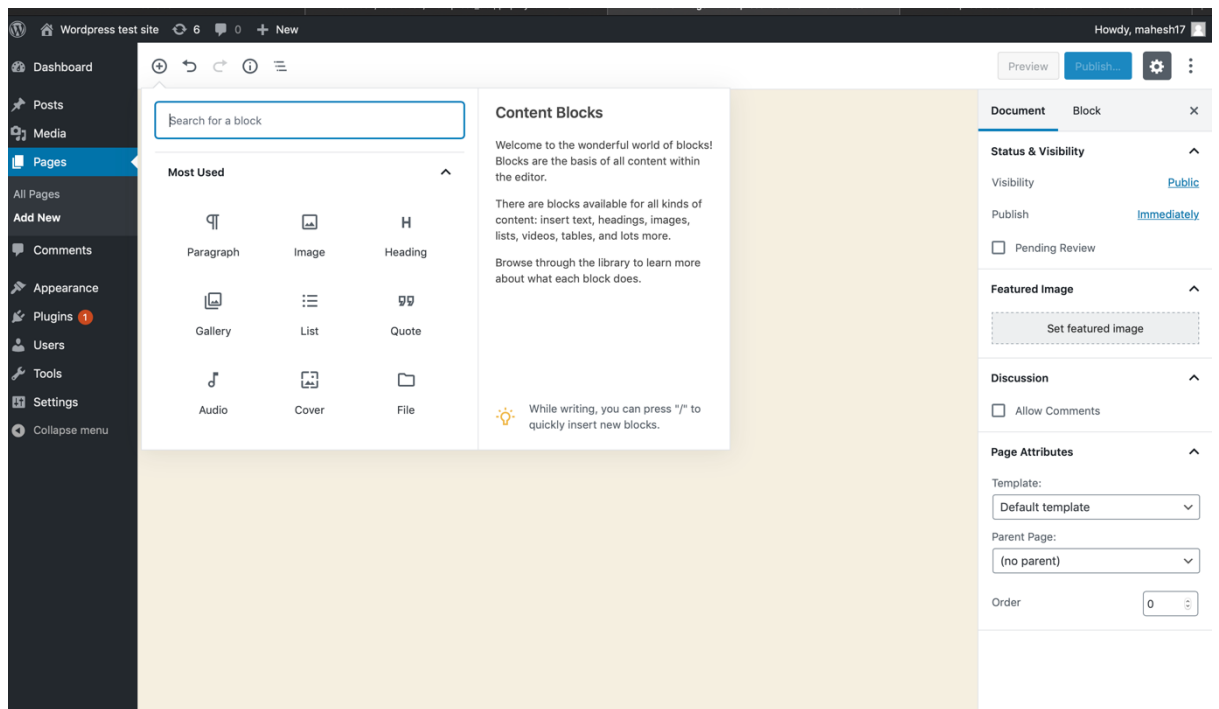
Table 3 compares the minimum system requirements for a webserver needed before installation of each CMS.

Table 3. System requirement comparison.

	Wordpress 3.x	Joomla 3.x	Drupal 7
MySQL	5.0 +	5.1 +	5.1 +
PostgreSQL	-	8.3.18 +	8.3 +
The mod rewrite Apache module	default	-	-
Nginx	1.0 +	1.0	1.0
Microsoft IIS	7	7	7
Apache	2.x +	2.x +	2.x +
PHP	5.6.20 +	5.6.10 +	5.2.5 +

4.2 Creating pages

WordPress is simple while creating a page. Various contents like picture and videos can be directly added to the visual editor. Users can upload the picture from PC, insert from URL or select the uploaded picture inside the admin panel. Various options can be found when uploading or inserting the picture to the page. Users are allowed to edit the alignment, title, caption, size and description of the picture. Each page can be assigned with a different template during creation and the pages can be published immediately or on a desired date. The visibility of a page can be changed to private or public. Page status can be configured accordingly.



Picture 10. Creating page with wordpress.

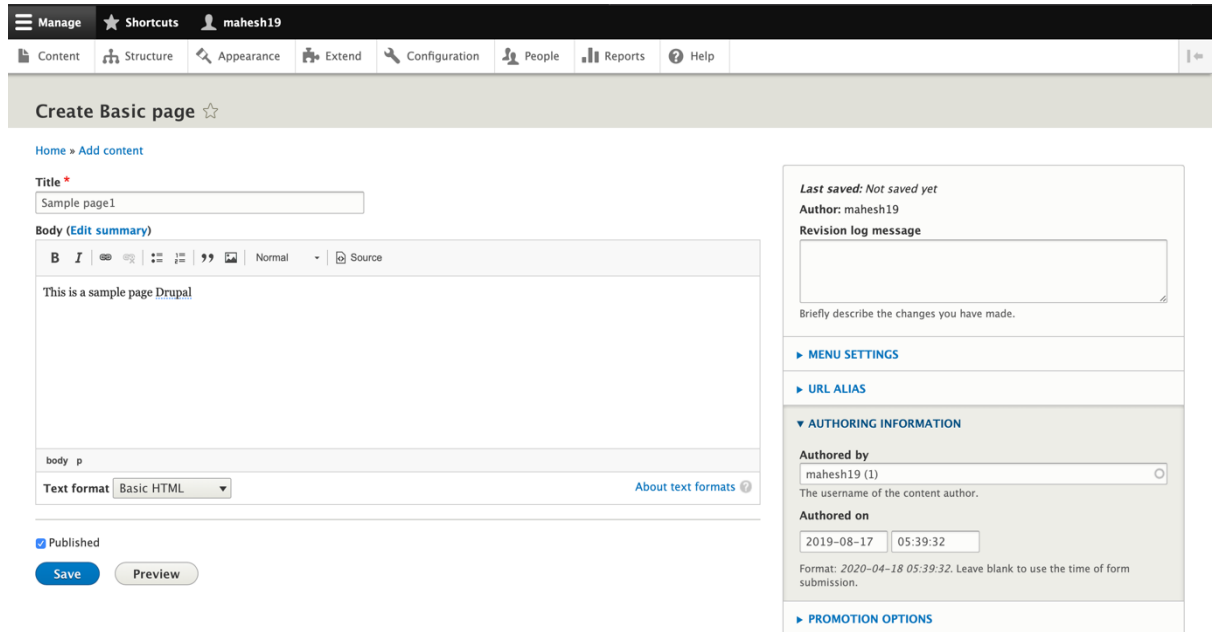
Joomla pages are created with menu, articles, components and modules. Users can select the type of page they want to create. Joomla has more options while creating a page. Almost every option like WordPress can be found by creating different menu items. Page status and visibility can be changed accordingly. There are plenty of other options for publishing a page. Users are allowed to set the start date and finish date to publish

the page and the pages are unpublished automatically. Likewise, other options like meta tags, meta description, user group, modified user can be configured easily. Typically, it can take longer time to understand and make use of every possible options.

The screenshot shows the Joomla! administrator interface for creating a menu item. At the top, there is a toolbar with buttons for 'Save', 'Save & Close', 'Save & New', and 'Cancel'. Below this is a 'Menu Title' field and an 'Alias' field set to 'Auto-generate from title'. A navigation bar includes 'Details', 'Options', 'Link Type', 'Page Display', 'Metadata', and 'Module Assignment'. The main form is divided into two columns. The left column contains 'Menu Item Type' (set to 'Create Article'), 'Link' (set to 'index.php?option=com_content&view=form&layout=edit'), 'Target Window' (set to 'Parent'), and 'Template Style' (set to '- Use Default -'). The right column contains 'Menu' (set to '- Select Menu -'), 'Parent Item' (set to 'Menu Item Root'), 'Ordering' (with a note 'Ordering will be available after saving.'), 'Status' (set to 'Published'), 'Default Page' (with 'Yes' and 'No' radio buttons), 'Access' (set to 'Public'), 'Language' (set to 'All'), and a 'Note' field. At the bottom, a status bar shows 'View Site', '1 Visitors', '1 Administrator', '0 Messages', and 'Log out', along with the Joomla! version '3.9.15' and copyright '© 2020 Joomla! test site'.

Picture 11. Creating page with Joomla.

Drupal creates page with tags and HTML. It does not contain visual editor in the admin panel. It can be somewhat inappropriate for absolute beginner to navigate through the system. Because Drupal assumes users to have basic coding skills, users get overwhelmed with the options. However, Drupal's pages are able to edit the content directly from front end. Additional modules are required for configuration to extend the limited options for creating the contents.

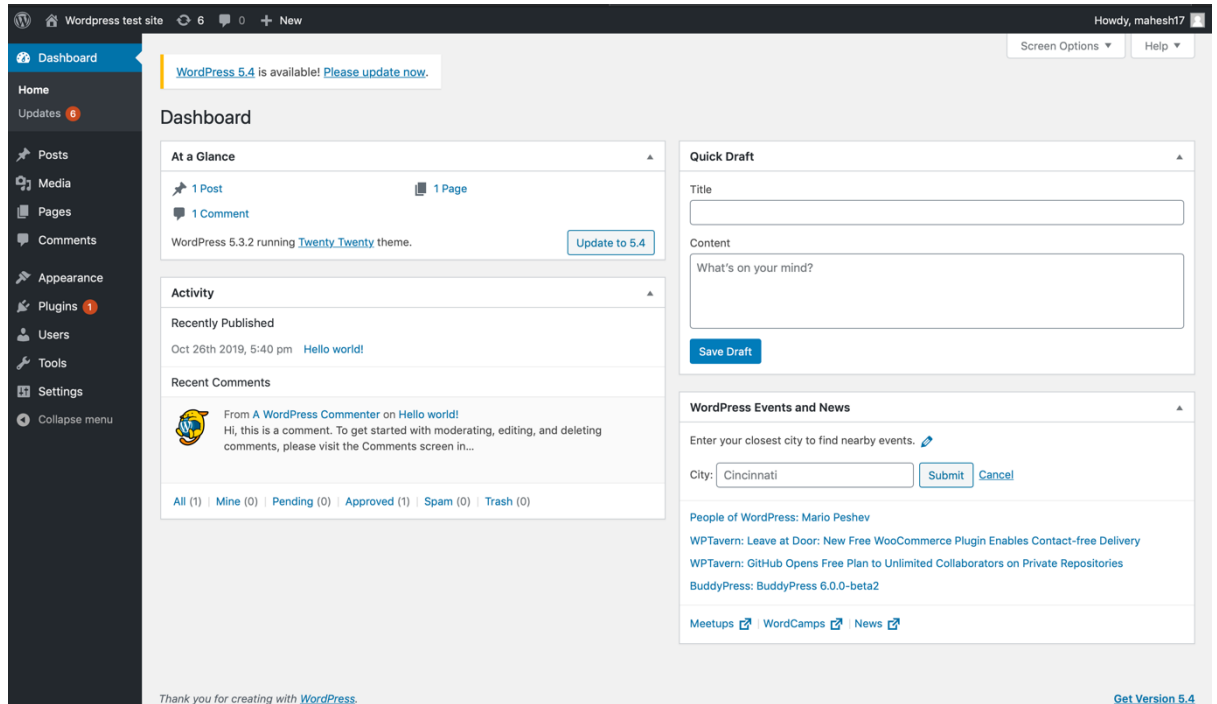


Picture 12. Creating pages with Drupal

4.3 Admin panel user experience

WordPress

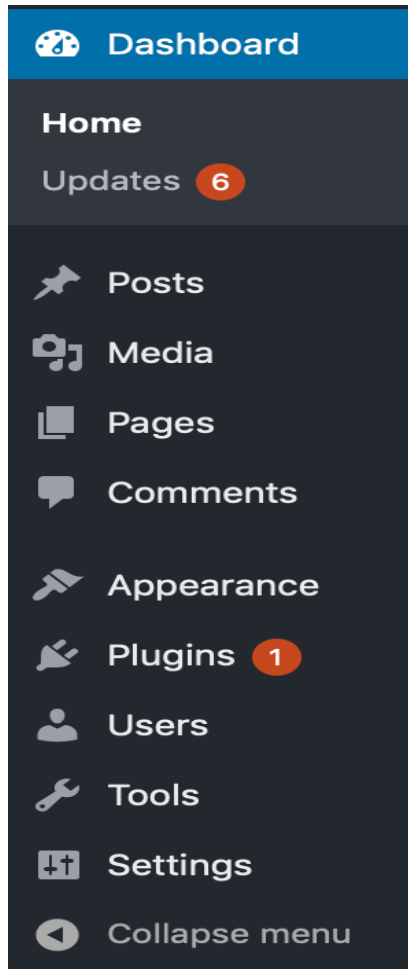
WordPress has nice and user-friendly interface. The main menu is located on the left side. Each of the settings and functions can be navigated easily due to logically structured of the menu. The theme files can be directly customized from the back end appearance menu. It has a large plugin directory in the plugin section where users can select the plugin and install it quickly. Besides that, users can search and download the plugin for specific features. Compared to Joomla, WordPress has less functionality for menu items.



Picture 13. Wordpress admin panel.

Main menu includes:

- Post: create, edit and manage posts/ categories
- Media: upload and edit media files
- Pages: create and edit pages
- Comments: manage comments
- Appearance: change themes, edit theme files, create menus
- Plugins: install and update plugins, change plugin settings
- Users: create and manage users
- Tools: additional tools for WordPress
- Settings: Configuration for WordPress



Picture 14. Wordpress admin panel menu.

Joomla

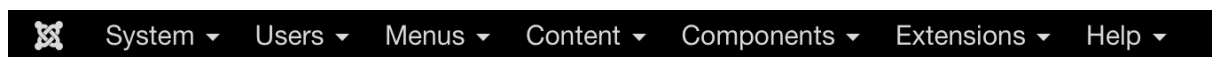
The Joomla interface can be a little difficult to navigate for beginners. The menus are located on top and on the left side. There are several options on the menu, and it can be hard to find the specific function. The modules are configured with numerous options in such a way that users can get misled while looking for specific configuration. However, Joomla menu are much comfortable for basic level of experienced users and can be tweaked easily with the variety of options. It has good user experience of the admin panel once the user explores basic handling of the system.

The screenshot shows the Joomla! administrator interface. At the top, there is a navigation menu with items: System, Users, Menus, Content, Components, Extensions, and Help. A notification banner at the top center states "Joomla! 3.9.16 is available" with an "Update Now" button. The left sidebar contains a menu with the following sections: CONTENT (New Article, Articles, Categories, Media), STRUCTURE (Menu(s), Modules), USERS (Users, No Urgent Requests), CONFIGURATION (Global, Templates, Language(s)), EXTENSIONS (Install Extensions), and MAINTENANCE (Joomla! 3.9.16 Update now!, All extensions are up to date). The main content area features a blue alert box for post-installation messages, a "LATEST ACTIONS" table with three entries, a "RECENTLY ADDED ARTICLES" table with three entries, a "POPULAR ARTICLES" table with three entries, and a "LOGGED-IN USERS" table with one entry.

Picture 15. Joomla admin panel.

Top menu includes:

- System: contains detailed information on system and global configuration
- Users: create and manage users, user groups, access level
- Menus: create and manage menus
- Content: upload media files, create, edit and manage articles/categories
- Components: banner information, contacts, updates, newsfeed
- Extensions: upload and install templates, modules, manage languages and plugin
- Help: documentation links, forums and support links



Picture 16. Joomla admin panel top menu.

The left side menu has quick access for following features:


- Adding article
- Article manager

- Categories
- Media manager
- Menu manager
- Module manager
- User manager
- Global configuration
- Template and language manager
- Installing extensions
- Maintenance

CONTENT

-  New Article
-  Articles
-  Categories
-  Media




STRUCTURE

-  Menu(s)
-  Modules

USERS

-  Users
-  No Urgent Requests.



CONFIGURATION

-  Global
-  Templates
-  Language(s)

EXTENSIONS

-  Install Extensions

MAINTENANCE

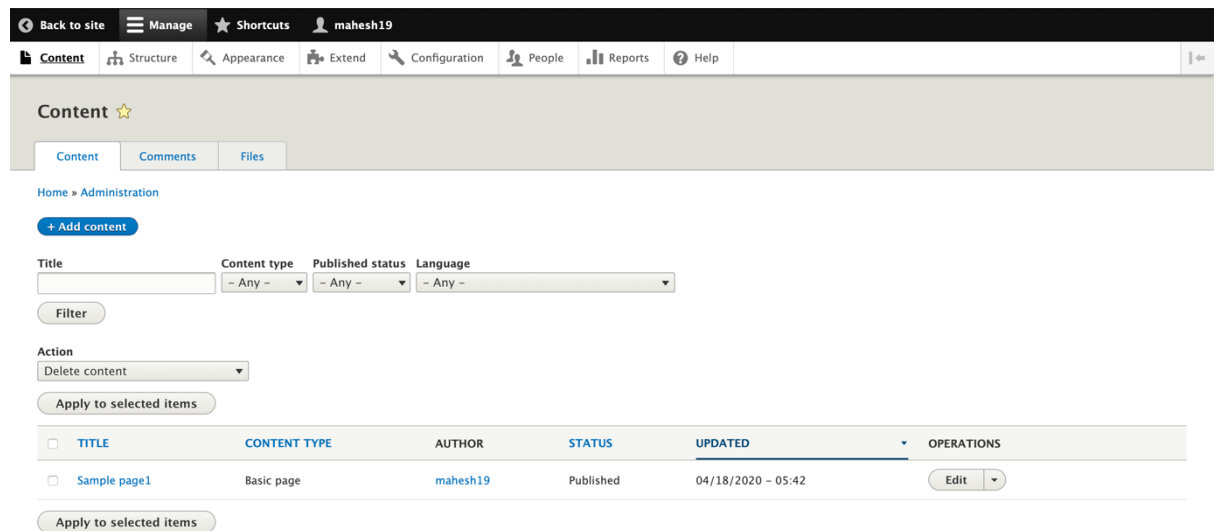
-  Joomla **3.9.16**, Update now!
-  All extensions are up to date.

Picture 17. Joomla admin panel side menu.

Drupal

The user interface of Drupal is user friendly and comfortable. Admin panel is located on the top of the page and is accessed all the time while viewing the page. Drupal admin panel is developed in such a way that user can navigate through the front end and admin

panel from the same page. Drupal is capable for developing custom back end functions with ease of code. It provides the necessary functions and modules to setup the administration according to the user group. However, those high functional administration needs additional modules to install and customize.



Picture 18. Drupal admin panel.

Main menu includes:

- Dashboard: homepage of admin panel
- Content: manage content
- Structure: manage menus, block, content types and taxonomy
- Appearance: manage themes
- People: manage users and access level
- Extend: configuration of modules
- Configuration: configuration option for users, content, media, interface, development, system, web services
- Reports: error message reports
- Help: support and help



Picture 19. Drupal admin panel menu.

4.4 SEO optimization

WordPress

Thousands of plugins are available in the WordPress directory for optimal optimization of a page. It contains a built-in SEO setting to configure permanent links, meta-keywords, description and others. Users are allowed to insert tags into the post. One of the powerful SEO plugins is YOAST SEO which is mostly popular among the developers. WordPress sites are light weight, so the site loads faster than others. Users are allowed to add alt tag for every image which leads to better optimization. Users can create links between the post with some amazing plugins that is helpful for the search engines to crawl through the pages. Also, it is easy and intuitive to create custom 404 page.

Joomla

Joomla is known for user-friendly CMS for optimization of pages. Users have full control over a website SEO. The latest version of Joomla is equipped with a large number of options for better optimization of the site. Users are free to enable SEF URL addresses and it is possible to rewrite the URL according to user's needs. It also allows to configure global settings, meta keywords and meta description to every single post.

Drupal

At the release of the system, Drupal was meant to be user friendly for the search engines. It is known as a robust system available in the market, but it needs heavy customization to make the system flexible and better optimization. The installation package comes with image ALT tags and pre- configured robots.txt file. However, it is necessary to customize different modules in order to work for all other modules and the search engines properly

Table 4 compares the basic SEO features. The table presents on how the features are supported with the system.

Table 4. SEO comparison.

	Wordpress	Joomla	Drupal
URL	Easy customization, creates a link automatically	Index.php generates URL, inserts with title automatically	Needs to create manually
404	available	available	available
Sitemap	Not available	Not available	Not available
Title	Needs additional plugin to configure	Pages and articles can customize meta titles	Needs configuration with modules
Description	Needs additional plugin to configure	Pages and articles can customize meta description	Needs configuration with modules
Modules	One module works for website optimization. Example: Yoast SEO	Single module or multiple plugins can be used. Example: Custom Page Title, JCrawler	Needs multiple modules. Example: globalredirect, path_redirect, xmlsitemap, search 404, meta tags

4.5 Documentation

WordPress

WordPress documentation are well organized and good to understand that are found under the name Codex. All the clear instructions about installation to advance system configuration are available on the documentation. It focuses on the needs of developers and guides through the technical areas of coding a website to build custom themes and plugins. There is a full guidance with the case examples of the topic to fully understand

the core aspects of the system. Plenty of languages are used to write the documentation. The documentation is clear, understandable and users find easy navigating through different topics on the system.

General topic includes:

- Using themes
- Theme development
- Writing a plugin
- WordPress features overview
- Downloading, installing and upgrading WordPress
- Frequently Asked Questions

Joomla

Joomla documentation is good and developer friendly. It has a large online community that welcomes users to collaborate, develop and contribute to the system and anyone interested in learning. There are more than 8,000 articles written and maintained by the Joomla community members. It consists all the in-depth topic for installation, security, SEO, templates, content management, menu management and others to understand the core features of it. However, some of the areas of Joomla is still in a research and development phase as it has a great potential for making the best configuration possible with the website. Therefore, it is recommended to explore other places, forums and tutorials for more solutions available.

General topic includes:

- More on Joomla
- Beginners
- Administrators
- Developers
- Core Developers

Drupal

Drupal documentation are sometimes confusing. It is not trivial to find what you are looking for once you are developing the system further. The topics and technical

challenges are stacked under the chunk of articles and are difficult to find the specific solution for system changes and configuration. Some of the pages and articles are left incomplete but members can contribute to create or complete the documentation. Drupal allows members to create, edit and contribute to documentation files if you are a registered user. It also shows the status of the page if the issue has been resolved or not.

General topic includes:

- Understanding Drupal
- Installation
- Multilingual guide
- Theming
- Administration
- System Requirements
- Extending Drupal
- Mobile guide
- Distributions
- Testing

5 RESULTS

System requirements

Table 5, 6 and 7 presents the system requirement options in terms of web server compatibility, available database server and required PHP. The working environment of each CMS were compatible with the previous versions and may vary with the current versions. It is suggested to use the recommended versions to avoid the incompatibility issue while using the system.

Table 5. WordPress system requirements.

Wordpress	Working environment	Highly recommended
Web Server	Any environment that supports php and MySQL	Apache or Nginx
Database Server	MYSQL 5.0 +	MYSQL 5.6 +, mariadb 10.1 +
PHP	5.6.20 +	7.3 +

Table 6. Joomla system requirements

Joomla	Working environment	Highly recommended
Web Server	Apache 2.0, Nginx 1.0, Microsoft IIS 7	Apache 2.4, Nginx 1.8, Microsoft IIS 7
Database Server	MYSQL 5.1, SQL Server 10.50.1600.1, PostgreSQL 8.3.18	MYSQL 5.5.3+, SQL Server 10.50.1600.1 +, PostgreSQL 9.1 +
PHP	5.6.10 +	7.3 +

Table 7. Drupal system requirements

Drupal	Working environment	Highly recommended
Web Server	Previous version worked on apache 1.3, Nginx (0.7.x, 0.8.x, 1.0.x, 1.2.x), Microsoft IIS (5, 6, 7, 8), PHP Built-in web server	Apache 2.x, Nginx (1.8.x, 1.9.x), Hiawatha, Microsoft IIS 7
Database Server	MySQL 5.0.15, 5.1.30, mariaDB 5.1.44, percona server 5.1.70 + with PDO, PostgreSQL 8.3 +, SQLite 3.3.7 +, Microsoft SQL server, Oracle, MongoDB	MySQL, MariaDB, Percona
PHP	5.2.5 or higher	7.2 +

The above tables result that Apache or Nginx is highly recommended for all of the platforms for better web server compatibility. One key element of Drupal is its compatibility with Hiawatha web server which is most powerful and secure web server available. Drupal has a wide range of available databases than others . As the core foundation for all the system is PHP, it is highly recommended to use php versions 7.x + for all the CMS platform.

Creating content

Table 8 compares creating content options, methods and terms of page creation. The table presents the difference while creating content and also shows how the terms are distinguished for each system.

Table 8. Creating content with Wordpress, Joomla, Drupal.

Wordpress	Joomla	Drupal
Wordpress creates content as a 'page' or 'post'	Joomla creates content using 'articles' and content editor tools	Drupal creates content using different content types. 'page' and 'story' are the basic content types in default. Other content types include blog entry, forum topic, book page, poll
Single post or 'blog' can be created using 'post'	Blog posts can be created using 'article manager'	A single post can be created enabling 'blog entry' content type
A basic page can be created through a 'post' or 'page'	A basic page can be created adding a 'article' and/or from a selection of 'menu item type'	A basic page can be created adding a 'content item' to the site
Custom page can be created by creating 'page template'	Custom page can be created by creating custom 'content layout'	Custom page can be created by creating custom modules
WordPress has built-in visual editor while creating content	Joomla also has built-in visual editor while creating content	Drupal needs modules to setup for integrating visual editor
WordPress uses 'page layout' to structure content which is configured with themes	Joomla uses 'content layout' or 'module position' to structure the layout which is configured with templates	Drupal uses modules to layout the content and are configured with themes

From the above table, it is concluded that creating content is user friendly with WordPress as it features simple page creation with either 'page' or 'post'. Joomla uses articles to create simple blog page and other pages can be created with various 'menu item type' as it has large number of configuration options available. Drupal provides high

functionality to the content as it has various 'content type' specified. Creation of custom pages for all CMSs need basic level of HTML and/or CSS coding.

Admin panel user experience

Table 9 covers the admin panel features and their usability. It describes the individual features and how the functions are different from one another. The results from this comparison are valuable when looking for specific functions and user requirements.

Table 9. Admin panel UX of Wordpress, Joomla, Drupal

Admin features	Wordpress	Joomla	Drupal
Login dashboard	User friendly backend interface, quick links to basic pages	Strong back end foundation, various menu options to navigate	Similar to website front-end, displays user page. however, highly customizable
Front end admin toolbar	Quick links to backend for user profile, content creation and theme customization	Additional menu items to configure basic site settings within front end, creating and editing articles, editing modules within front end	Access to all admin pages, fewer clicks to navigation
Creating content	Intuitive and user-friendly interface, visual editor experience	User friendly interface, publishing options, metadata settings, visual editor for creating content	Flexible content editing, field-based content editing, needs modules for visual editing
Editing content	Navigation link from frontend to backend	View and Edit links within front end	Quick links to view and edit contents within front end

Admin features	Wordpress	Joomla	Drupal
Managing media	Easy managing media, drag-to-upload feature, only grid format to view media	Easy managing media, drag-to-upload feature, grid and table format to view media	Customizable media types for advanced users, grid and table format to view media
Managing menus	Limited option for customization, menu display location is pre-defined on template	Wide range of customization, menu is displayed in any module position. Articles, categories, modules can be added to menu	Pages can be added to menu, custom module is needed to display menu anywhere
Managing user roles and permissions	Contains 6 pre-defined user roles i.e. super admin, administrator, editor, author, contributor and subscriber. Lacks front end user management, complicated to manage roles and permissions, works best with additional plugins	Contains 9 user groups i.e. public, guest, manager, administrator, registered, author, editor, publisher and super users. Good user management, front end user profile is available, managing roles and permission is comfortable	Contains 3 default user roles i.e. anonymous, authenticated and administrator. Good user management, front end user management is available, assigning permission and roles is easy

Admin features	Wordpress	Joomla	Drupal
Site status report	Tools menu displays 'site health' page, divided into critical issues and recommended improvements, shows updates on dashboard	Displays warnings in extensions, needs manual checkup, shows updates on dashboard, needs additional plugin to generate site health status	Contains site status and health status in 'status report' page, highlights critical errors and warnings
Plugins and modules	Large number of plugins, plugin library available in back end, easy installation of plugins	Many extended modules and extensions are available for almost every need, installation is easy and fast	Contains module list, extended modules are available to download and install, complexity in finding and installing modules

From the table above, it is concluded that the login dashboard of Drupal and WordPress are simpler than Joomla whereas the front-end tool bar of Joomla and Drupal are more convenient than WordPress as they provide front end editing function. Likewise, creating content is most user friendly for WordPress whereas editing content is flexible in Joomla and Drupal. Managing media is more convenient with WordPress and Joomla as Drupal needs to setup media types. Joomla and Drupal provide more functionality while managing menus whereas WordPress has limited functions to manage menus. Additionally, managing user roles and permissions are more comfortable with Joomla and Drupal as WordPress lacks front end user management. Drupal provides better site health report than others whereas installing plugins and modules are easy with WordPress and Joomla. Drupal is a bit more complex in finding and installing modules.

SEO optimization

Table 10 summarizes important SEO features and presents the results as if they are supported with system default or needs additional modules to configure. The table also guides the reader configuring the modules to achieve the desired SEO functions.

Table 10. SEO for Wordpress, Joomla, Drupal.

SEO features	Wordpress	Joomla	Drupal
Headings	Allows to set proper headings by default	Allows to set proper headings by default	Allows to set proper headings by default
Image ALT tags	Image ALT tags with default installation	'SEOFLI' extension creates ALT tags automatically	For Drupal 8, Image ALT tags with default installation
Robots.txt	'YOAST' plugin creates robots.txt file	Generates robots.txt file with default features	Generates robots.txt file with default features
Clean URLs	Able to set custom URLs with default features	Able to enable 'SEF URLs' through global configuration or by extension	'REWRITE MODULE' creates clean URLs
Meta tags	Meta tags are created with 'YOAST' plugin	Able to create meta tags with default feature	'METATAG MODULE' supports meta tags
Canonical tags	'YOAST' plugin supports to create canonical tags	'SH404SEF' supports canonical tags	'METATAG MODULE' supports canonical tags
Redirects	Creates redirects with 'YOAST' plugin	'SH404SEF' extension supports redirects	'REDIRECT' module supports for redirects
XML sitemap	XML sitemap are created with 'YOAST' plugin	'JSITEMAP' extension generates sitemap	'SIMPLE XML SITEMAP' module creates sitemap

SEO features	Wordpress	Joomla	Drupal
Page caching	'W3 TOTAL CACHE' plugin allows for page caching	Able to enable page caching with default feature	'CACHE API' module allows for page caching
Optimized images	'OPTIMOLE' plugin optimizes images	'PXLCOMPRESSOR' extension optimizes images	'IMAGE OPTIMIZE' module helps to optimize images
Accelerated mobile pages	Most of the themes are mobile friendly	Most of the templates are mobile friendly	'ACCELERATED MOBILE PAGES' module creates fast loading with mobile

In terms of SEO, all three CMSs provide enough good features either with plugins or system defaults. From the table, WordPress supports four features with system default while other features need plugins to setup. On the other hand, Joomla supports five features with system default while others need extensions. Drupal supports three features with system default while others needs setting up modules.

Community help and support

Table 11 presents the community support options available for developers. As this is the important factor to consider with CMS, different options are available for each CMSs such as user forum, community portal, documentation.

Table 11. Community Support for WordPress, Joomla, Drupal

Help & Support features	Wordpress	Joomla	Drupal
Support	User guides, documentation, user forum, articles	Documentation, community portal, articles, video training, user forum	Documentation, community portal, user guides, articles, videos, books

Help & Support features	Wordpress	Joomla	Drupal
User forum	Community based forum	Community based forum	Community based forum
Community portal	User forum is the only official community portal	Available with videos and training	Available with videos, training and articles
Documentation	Available through support section of the official website	Available on the official website	Available on the official website

The table shows the support features of each CMS with various guides, forums, videos, articles, documentation. All three CMSs has good community support. Joomla and Drupal have their huge official community portal whereas compared with others, WordPress has a large community outside of their official community support.

6 DISCUSSIONS

Chapter 5 showed the results of this study for each feature based on the important criteria of selection. As seen in the result section the comparison is based on the five important criteria. In terms of system requirements, Drupal and Wordpress are compatible with most of the web servers. Drupal has large number of supporting database servers among these three products of CMS. The core foundation of all three products is PHP but the version required may vary for each of these products. In terms of content creation, wordpress is most flexible and user friendly while creating contents. However, it doesn't allow front end content editing. Joomla allows large number of preconfigured options for creating content and also allows front end editing. Drupal is the most powerful in terms of high functionality and it also allows front end editing. In terms of Admin Panel User Experience, wordpress is the most user-friendly and flexible while Joomla has numerous options in the backend. Joomla is rich in configuration options for large size website. Drupal needs high level programming skills to build custom admin panel functions. In terms of SEO, all three products offer similar features. Most of the features need additional plugins for all the CMS platforms. Community support is good for all three platforms. The support for WordPress is abundant outside of the community as well.

7 CONCLUSIONS

This thesis focused on theoretical understanding of three CMS systems; Wordpress, Joomla and Drupal based on the five important criteria. The study concluded that there is no single winner among these 3 CMS products. This study found wordpress as the easiest and user friendly while lacking advanced features to support large commercial websites. On the other hand, Joomla offers numerous features for users to develop large websites, but it is not the easiest available tool for beginners. Drupal offers extensive functions which enables developers to customize heavy websites. However, Drupal is not designed for absolute beginners and it is assumed that the user has intermediate level of programming skills. The findings of this study will help individuals, entrepreneurs and businesses to make the right selection from different CMS products to create their websites.

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