



**USE OF CONTENT MANAGEMENT SYSTEMS IN BUSINESS:  
A COMPARISON OF OPEN SOURCE CONTENT MANAGEMENT  
SYSTEMS**

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USE OF CONTENT MANAGEMENT SYSTEMS IN BUSINESS:  
A COMPARISON OF OPEN SOURCE CONTENT MANAGEMENT SYSTEMS

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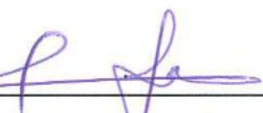
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## **ABSTRACT**

### **USE OF CONTENT MANAGEMENT SYSTEMS IN BUSINESS: A COMPARISON OF OPEN SOURCE CONTENT MANAGEMENT SYSTEMS**

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There are many Content Management Systems (CMSs) that have appeared and were adopted in the mid-1990s to satisfy the needs of providing optimal solutions in organizing business website content. Due to the many controversial arguments about what CMS is appropriate for a business website, this study aims to help decision makers and IT managers in businesses to decide on the best open source CMS. In this study, the latest versions of three widely used CMSs, namely WordPress, Joomla and Drupal, have been selected according to their market share. Our methodology has four steps. In the first step, while developing comparison criteria, we published an online survey that represents a pool of 76 candidate criteria to be determined according to IT experts' opinion according to their importance. We installed CMSs on online servers and we tested these systems according to absolutely essential and important criteria determined by experts in the field. We performed a functional analysis for each system, i.e., whether a system performs a specific criterion depending on a core feature "Built-in," or the system needs to be extended with a third-party extension "Plug-in." Our criteria covered the complexity of installation, social media integration, security, performance and usability features. Lastly, usability tests were conducted using the Post-Study-System-Usability-Questionnaire tool to discover which CMS offers the easiest learning curve. We concluded that Joomla is the best among its competitors because this system outperformed the other two systems and supported most of our criteria as core features. Furthermore, Joomla combines the flexibility of Drupal and the intuitive "User Friendliness" of WordPress

as it allows the creation of high-quality websites by non-technical users. Joomla also offers a moderate learning curve based on final usability test results.



**Keywords:** *Content Management Systems, WordPress, Joomla, Drupal*

## ÖZ

### İŞLETMELERDE İÇERİK YÖNETİM SİSTEMLERİNİN KULLANIMI: AÇIK KAYNAK İÇERİK YÖNETİM SİSTEMLERİNİN KARŞILAŞTIRILMASI

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İşletmelerin web sitesi içeriğini yönetebilmeleri için 1990'ların ortalarında ortaya çıkmış ve işletmelerce kullanılan birçok İçerik Yönetim Sistemi (İYS) bulunmaktadır. Bir işletme web sitesi için hangi İYS'nin daha uygun olduğuna dair karar verme sürecinin zorlukları nedeniyle, bu çalışma, işletmelerdeki karar vericiler ve BT yöneticilerinin kendileri için en iyi açık kaynaklı İYS üzerinde karar vermelerine yardımcı olmayı amaçlamaktadır. Bu çalışmada, yaygın olarak kullanılan üç İYS'nin (WordPress, Joomla ve Drupal) en son sürümleri pazar paylarına göre seçilmiştir. Araştırma metodolojimizde 4 aşama vardır. İlk aşamada, BT uzmanlarının görüşlerine göre karşılaştırma ölçütlerinin belirlenmesi sürecinde, daha önceki karşılaştırma çalışmalarından ve bizim eklediğimiz toplam 76 aday kriterin yer aldığı çevrimiçi bir anket düzenledik. İkinci aşamada, çevrimiçi sunucularda çalışmada kullanılan İYS'leri kurduk ve bu sistemleri test için hazır hale getirdik. Üçüncü aşamada, alanındaki uzmanlar tarafından çok önemli ve önemli olarak belirlenen kriterlere göre İYS'lerin karşılaştırmasını gerçekleştirdik. Bu süreçte her bir sistemin “Dahili” ve üçüncü taraf “Eklentiler” olarak sunduğu özelliklerin fonksiyonel bir analiz yaptık. Karşılaştırmada kullandığımız kriterler, kurulum, sosyal medya entegrasyonu, güvenlik, performans ve kullanılabilirlik özelliklerini kapsamaktadır. Son olarak, hangi İYS'nin en kolay öğrenme eğrisini sunduğunu ortaya çıkarmak için Çalışma Sonrası Sistem Kullanılabilirlik Anketi aracı vasıtası ile gerçek kullanıcılar ile kullanılabilirlik testleri yaptık. Çalışma sonuçları, diğer iki sistemden daha iyi performans göstermesi ve kriterlerimizin

çoğunu çekirdek özellikler olarak desteklemesi nedenleriyle Joomla'nın rakiplerinden daha iyi olduğunu göstermiştir. Ayrıca, Joomla'nın, Drupal'ın esnekliğini WordPress'in "Kullanıcı Dostu" arayüz özelliklerini birleştirerek teknik olmayan kullanıcılar tarafından yüksek kaliteli web sitelerinin oluşturulmasına izin verdiği ortaya çıkmıştır.

**Anahtar kelimeler:** *İçerik yönetim sistemleri, WordPress, Joomla, Drupal*

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## TABLE OF CONTENTS

STATEMENT OF NON-PLAGIARISM .....	iii
ABSTRACT .....	iv
ÖZ .....	vi
ACKNOWLEDGEMENTS .....	viii
TABLE OF CONTENTS .....	ix
LIST OF FIGURES .....	xii
LIST OF TABLES .....	xiii
LIST OF ABBREVIATIONS .....	xv
CHAPTERS	
<b>1. INTRODUCTION</b> .....	1
1.1 Aim of the Study .....	2
1.2 Significance of the Study .....	2
1.3 Research Questions .....	3
1.4 Related Works .....	4
<b>2. CONTENT MANAGEMENT SYSTEMS</b> .....	8
2.1 What is a Content Management System?.....	8
2.2 Types of Content Management Systems .....	9
2.2.1 Web Content Management Systems (WCMSs).....	9
2.2.2 Enterprise Content Management Systems (ECMSs).....	10
2.2.3 Digital Asset Management Systems (DAMSs) .....	10
2.3 Main Parts of a Content Management System .....	11
2.4 Content Management Systems Anatomy .....	12
2.4.1 Collection Phase .....	13
2.4.2 Management Phase .....	14
2.4.3 Publishing Phase .....	15
2.5 Content Management Systems Technical Overview.....	16

2.6 Problems of Classical Approaches to Web Content Updating.....	18
2.7 Benefits and Features of Content Management Systems .....	19
2.8 Content Management Systems Market Share .....	20
2.9 Content Management Systems Used in the Study.....	22
2.9.1 WordPress Content Management System .....	22
2.9.2 Joomla Content Management System.....	23
2.9.3 Drupal Content Management System .....	25
<b>3. METHODOLOGY.....</b>	<b>27</b>
3.1 Research Methodology Steps .....	27
3.1.1 Determining Comparison Criteria .....	28
3.1.2 Systems Installations.....	33
3.1.3 Systems Test and Assessment.....	40
3.1.4 Performing a Usability Test for Content Management Systems .....	40
<b>4. IMPLEMENTATION AND TESTING .....</b>	<b>45</b>
4.1 Section One: Systems Installation Criteria.....	45
4.2 Section Two: Usability Criteria.....	46
4.3 Section Three: Technical Requirements Criteria .....	51
4.4 Section Four: Platform Support Criteria .....	52
4.5 Section Five: Security Criteria .....	54
4.6 Section Six: Ease of Extension and Customization Criteria .....	58
4.7 Section Seven: Collaboration and Interactivity Criteria.....	64
4.8 Section Eight: Performance and Functionality Criteria.....	67
4.9 Section Nine: Other related Statistical Information .....	70
<b>5. RESULTS .....</b>	<b>71</b>
5.1 Testing Content Management Systems Results .....	71
5.2 Content Management Systems Assessment and Evaluation .....	76

5.3 Usability Test Results.....	84
5.3.1 Usability Participants Checklists .....	84
5.3.2 Post-Study Systems Usability Questionnaire (PSSUQ) Results.....	85
<b>6. CONCLUSION.....</b>	<b>89</b>
REFERENCES.....	93
APPENDIX A.....	96
Candidate Criteria Categorizations.....	96
APPENDIX B .....	100
Post Study System Usability Questionnaire Items .....	100
APPENDIX C .....	101
C.1 WordPress Participants Checklists.....	101
C.2 Joomla Participants Checklists.....	104
C.3 Drupal Participants Checklists .....	107
APPENDIX D .....	110
WordPress Content Management System Screenshots .....	110
APPENDIX E .....	124
Joomla Content Management System Screenshots .....	124
APPENDIX F.....	139
Drupal Content Management System Screenshots.....	139
CURRICULUM VITAE .....	151

## LIST OF FIGURES

Figure 1 Documentation survey as of 2010 .....	4
Figure 2 Installation survey.....	5
Figure 3 Digital content lifecycle.....	12
Figure 4 Workflow tasks in most CMSs .....	15
Figure 5 Client side/server side interactions .....	17
Figure 6 Dynamic client/server request and response procedure.....	18
Figure 7 CMS platforms by market share .....	21
Figure 8 Usage percentages of sites .....	21
Figure 9 WordPress CMS layers.....	23
Figure 10 Joomla CMS layers.....	24
Figure 11 Drupal CMS layers .....	25
Figure 12 Research methodology steps used in the study .....	27
Figure 13 Statistics for the Authorized Access Control criterion .....	31
Figure 14 MySQL database creation using the PhpMyAdmin tool.....	34
Figure 15 WordPress database connection .....	34
Figure 16 WordPress installation/required information.....	35
Figure 17 Joomla database connection phase .....	36
Figure 18 Drupal installation profile selection .....	36
Figure 19 A CMS package selection.....	38
Figure 20 CMS software setup/site settings.....	38
Figure 21 A CMS software setup/administrator's account creation .....	39
Figure 22 A CMS software setup/copying files process .....	39
Figure 23 An item included in PSSUQ questionnaire .....	44
Figure 24 WordPress push notification invitation .....	66
Figure 25 Linear comparison among CMSs .....	83

## LIST OF TABLES

Table 1 Demographics of participants .....	30
Table 2 The importance scale equivalent values.....	30
Table 3 Accumulated statistics for the Authorized Access Control criterion.....	32
Table 4 Live server installation recorded times .....	39
Table 5 Content Management Systems extensions.....	42
Table 6 An example of Usability test checklists.....	43
Table 7 Content Management Systems installation time.....	46
Table 8 CMSs supported Webservers .....	52
Table 9 CMSs recommended Hardware .....	52
Table 10 CMSs online forums support .....	53
Table 11 CMSs online manuals and users' guides .....	53
Table 12 Systems installation criteria results.....	71
Table 13 Usability section criteria results.....	72
Table 14 Technical requirements criteria results .....	73
Table 15 Platform support criteria results.....	73
Table 16 Security criteria results.....	74
Table 17 Ease of extension and customization criteria results .....	74
Table 18 Collaboration and interactivity criteria results.....	75
Table 19 Performance and functionality criteria results .....	75
Table 20 Related statistical information .....	76
Table 21 The equivalent grades of the Technical criteria.....	76
Table 22 Usability Section criteria evaluation.....	78
Table 23 Security Section criteria evaluation .....	79
Table 24 Ease of Extension and Customization Section criteria evaluation.....	80
Table 25 Collaboration and Interactivity Section criteria evaluation .....	81
Table 26 Performance Section criteria evaluation .....	82
Table 27 Systems total evaluation grades .....	83
Table 28 Total time averages of Usability checklists .....	84

Table 29 Systems Usability Success Rates .....	85
Table 30 WordPress PSSUQ calculations.....	86
Table 31 Joomla PSSUQ calculations .....	86
Table 32 Drupal PSSUQ calculations .....	87
Table 33 The PSSUQ Means comparison.....	88



## LIST OF ABBREVIATIONS

CMSs	Content Management Systems
GPL	General Public License
IT	Information Technology
W3C	World Wide Web Compliance
UI	User Interface
V.D.	Vulnerability Density
SSMM	Single Source Multiple Media
WCMSs	Web Content Management Systems
ECMSs	Enterprise Content Management Systems
DAMs	Digital Asset Management Systems
HTML	Hyper Text Markup Language
HTTP	Hyper Text Transmission Protocol
WYSIWYG	What You See Is What You Get
DNS	Domain Name System
CSS	Cascading Style Sheet
SAPI	Server Application Program Interface
GUI	Graphical User Interface
JDBC	Java Database Connectivity
W3Tech	World Wide Web Technology Surveys
URL	Uniform Resource Locator
RSS	Real Simple Syndication
PSSUQ	Post Study System Usability Questionnaire
SEO	Search Engine Optimization
A.E.	Absolutely Essential
V.I.	Very Important
N.I.	Not Important
HCI	Human Computer Interaction
IBM	International Business Machines
API	Application Program Interface
CAPTCHA	Completely Automated Public Turing test to tell Computers and Humans Apart
SSL	Secure Socket Layer
ACL	Access Control List
L.C.	Learning Curve

## **CHAPTER 1**

### **INTRODUCTION**

Nowadays, each business tends to gain “World global exposure” by publishing business details and advertising on the Internet using modern approaches that can help to reduce costs and time [1]. Because of these growing needs, radical changes have occurred in the past twenty years relating to content management. Agility and flexibility are new growing needs for most firms and large organizations, and this tends to increase control over their software costs. For this reason, most firms and businesses endeavor to loosen relationships with individual software vendors and traditional licensing models.

Content Management Systems (CMSs) appeared and were adopted in the mid-1990s to satisfy the need for optimal solutions to organize information, edit, and maintain the data of websites. There are many CMS packages available in the market, such as WordPress, Joomla, Drupal, and Typo3. Each system has its own features which users can utilize to fulfill their project requirements. Moreover, most of these packages are open source under General Public License (GPL) [2].

For any business, online presence is critical and the development of an online presence involves necessary human and financial resources as well as technical knowledge. Moreover, the final website must be created in a short period of time followed by the necessity to update and maintain the website’s content periodically in accordance with new information. The most important point here is how to acquire a simple and flexible software application that can deal with dynamic content in a modern environment in order to increase control over software costs and simultaneously satisfy security relating to digital content. Open source technologies can solve the aforementioned problem because these systems have proved that they are able to support flexibility and usability. Moreover, they also encourage creative work [2]. CMSs facilitate the creation, management and publishing of web content

by non-savvy technical staff in addition to these systems being supported by online communities involving a large number of web developers.

### **1.1 Aim of the Study**

Generally, businesses and other corporations are facing challenges for which a Content Management System is the most suitable for their needs. Selection of an ideal CMS among many options is a crucial decision to make for most businesses when there are needs to select such a system to implement their websites. This study aims to help decision makers as well as IT managers in businesses to determine the best available open source CMS between WordPress (version 4.6), Joomla (version 3.6), and Drupal (version 8.2) such that businesses can decide which system to use to build their own website(s) and manage their digital content. The systems examined in this study have been selected according to their market share as of 2017. More specifically, this study aims to analyze these systems and compare their features according to IT experts' opinions about the most important criteria for each system relating to installation complexity, performance, usability, extensibility, built-in features, social media support and cost.

### **1.2 Significance of the Study**

Many firms and organizations have started to use Content Management Systems for many purposes, including uploading, publishing, and managing content as well as managing their websites by assigning permissions to users to add or modify content. However, after a period of time, many difficulties and different challenges reveal themselves when there are needs to extend their websites to satisfy more complex functionalities. Another important issue when the question comes to mind is "What is the number of web developers or web designers required to achieve the necessary tasks with content, especially when increasing the number of web pages over time as well as increasing the number of website users. Moreover, making the wrong decision between these systems can waste time and money because migration from one CMS to another is a very difficult process and may require restructuring of the entire website; and there may be a potential failed project.

Another issue is that most businesses prefer to use these systems without good perception about their functionalities and core features because they have a misconception that makes them think that any one of these three CMSs is going to be a suitable solution for any project at any level of complexity.

Deciding upon which CMS to use must be done after a clear review of many factors, such as what is required from a website, and what are the prospective future adjustments. To illustrate, without a CMS, businesses may encounter the following scenario [1]:

- Businesses and firms have to search for a web developer or programmer and wait for a meeting.
- During the meeting, businesses and firms have that web developer understand the requirements to implement their website.
- A website developer devises an initial prototype of the project.
- Business and firms accept that prototype or suggest some changes to enhance it.
- The final model of the website will be received with a domain name after spending a large amount of money on a web developer's time and labor.

Using a CMS will eliminate the aforementioned scenario and keep costs and time to a minimum level. It furthermore helps to support dynamic pages, unlike static HTML code pages.

Due to the above variation and issues, it is not easy for decision makers and IT managers to select the best CMS that can meet their requirements. The results of this study will guide decision makers with regard to understanding the characteristics related to core features and functionalities of these three CMSs.

### **1.3 Research Questions**

The comparison results will provide an overview for clarifying each Content Management System's abilities after answering the following research questions:

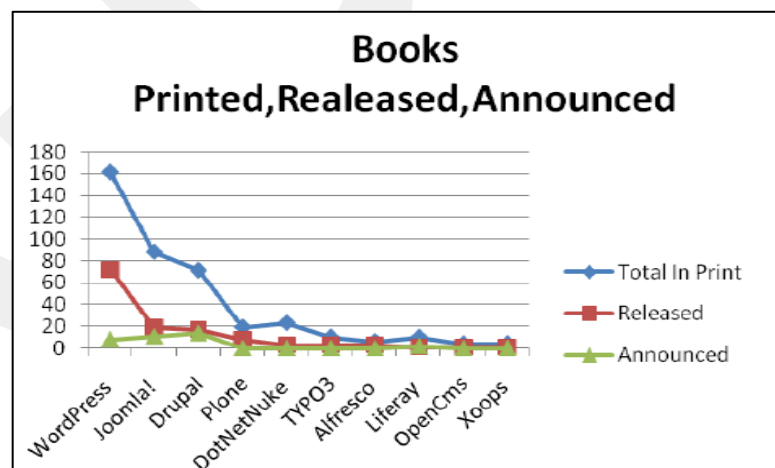
1. What are the criteria that are important for IT experts to compare open source Content Management Systems?

2. Among Joomla, Drupal, and WordPress, which Content Management System produces the highest evaluation score according to the criteria that are determined by the IT experts?
3. Among Joomla, Drupal, and WordPress, which Content Management System has the least installation complexity and the highest level of usability?

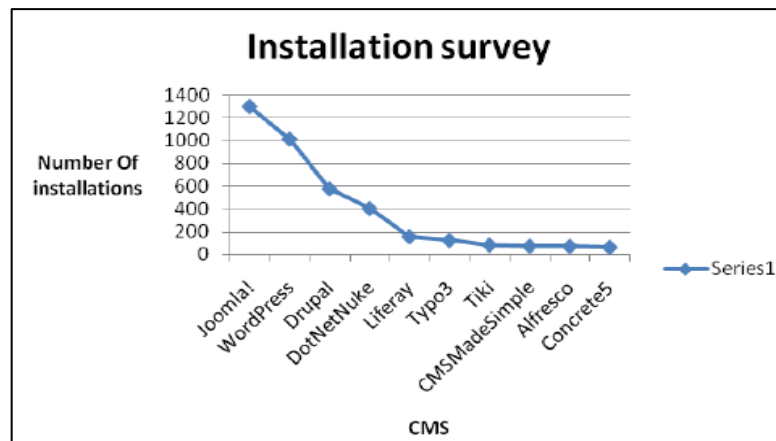
#### 1.4 Related Works

There have been many surveys and studies conducted to research and compare Content Management Systems [2]–[10]. As in [2], the authors performed a comparative analysis of 23 criteria that represent the main characteristics of Mambo CMS and its derivatives, which include Joomla and Elixes. These criteria represented the user interfaces (UI) of the systems, performance, core features and online support. A recommendation is made regarding user-friendly characteristics identifying their advantages and disadvantages such that the authors concluded that Joomla “has an excellent systematic solution and is more dedicated to small and medium sites” [2, p. 154].

Another comparison study has been conducted by Patel, S., V. R. Rathod, and Jigna B. [3]. In this study, the authors showed that WordPress, Joomla, and Drupal are the most efficient systems as compared to others according to their documentation and installation survey analyses, as shown in Figures 1 and 2.



**Figure 1** Documentation survey as of 2010 [3]



**Figure 2** Installation survey [3]

The authors in [4] have additionally compared web page performance criteria for WordPress, Joomla, and Drupal to determine which system performs better by hosting website pages on a live server and comparing a set of parameters that include page load time and page size. The study concluded that WordPress is the best system according to its least values of page load time.

Another comparative study was made by J. Chetan [5]. In this study, different open source CMSs, such as WordPress, Joomla, and Drupal, were evaluated according to the necessary factors considered important while selecting a CMS in order to determine their suitability for a scientific website as a research library. The author interviewed six participants from the media and education industry who worked and built websites using the described CMSs. The author concluded that Drupal has the required effectiveness for implementing two scientific websites.

Another comparison study has been made by Aakanksha M. and Apurva J. [6]. In this study, the authors explained the need for these technologies in the modern business environment and they compared seven CMSs. The study involved 31 criteria related to management, core features, performance and security. A conclusion had been made that showed Joomla, WordPress and Drupal share the same spot of security features. They also recommended that the Typo3 CMS can be used for specific websites requiring a massive amount of content as the system offers better performance than other systems. Joomla offers the best management for assets,

advertising and clipboards. The authors also concluded that all these CMSs offer an easy learning curve and the Alfresco system provides maximum ease of use to users. In [7], the author compared WordPress, Joomla and Drupal according to World Wide Web Compliance “W3C” such that the author built three websites using these platforms and all the websites were based on the same framework, i.e., the websites included similarly structured webpages. The author calculated a number of errors and warnings for each system inside each page, and based on an analysis after making some modifications to the web pages, the author concluded that Joomla is the best system and the system that is most compatible with the W3C.

In [8], the author performed a usability test for the WordPress user interface (UI) by using a heuristic walkthrough and task scenario method. The study aimed to identify the possible difficulties and challenges that end users may encounter with the system. The author concluded that WordPress is complex software and there are possible difficulties for end users in several areas, such as usability, terminologies and plugins.

Another study has been performed by Pedro Pico and Alberto Rodrigues da Silva [9]. In this study, the authors explained the benefits and the role of a workflow process in CMS environments including how business processes can be optimized when the software industry adopts a CMS with a workflow process. The authors gave some examples that considered workflow in CMSs as a set of stage transitions triggered and managed by human interaction in which website content may evolve and pass through the structure of an organization as well as the pertinent advantages that can be supported by workflow in a CMS, for example the automation of repeated steps to increase the organization’s productivity.

Another study relates to security and quality of WordPress extensions [10]. In this study, the authors endeavored to discover whether the ratings of plugins in an official repository can help users to predict a number of related vulnerabilities in a WordPress plugin. They compared the ratings of these extensions with vulnerabilities identified through static analysis. An open source static analysis tool was applied by the authors to detect potential vulnerabilities such that they compared their findings with user ratings. They downloaded samples of 322 randomized extensions from the

official WordPress repository and conducted their tests using the aforementioned tool that performs a static security analysis. In this security analysis, they calculated Vulnerability Density (V.D.), which indicates the number of vulnerabilities divided by the number of actual lines of code. They also considered and retrieved the number of downloads, as well as users' ratings for the tested extensions from the directory. After performing their analysis, they found that not every plugin with a high rating contained less vulnerability. The authors concluded that user ratings and download accounts did not help system users to determine and select secure extensions because of the possible risks involved. They came to the conclusion of "a weak non-linear correlation between user ratings and the number of vulnerabilities."

## CHAPTER 2

### CONTENT MANAGEMENT SYSTEMS

The aim of this chapter is to clarify the theoretical aspects of Content Management Systems and their roles in the business environment. In this chapter, the main types of CMS are reviewed. We concentrated on the stages through which information passes through these systems and which represent the anatomy of systems, as well as highlighting the technical overview related to client/server interaction. Furthermore, we present some of the limitations of the classical approaches related to content management and we additionally provide an overview about CMSs' market share.

#### **2.1 What is a Content Management System?**

A Content Management System CMS can be defined as a group of technologies and policies that can enable firms, businesses and other corporations to organize and manage web information. In other words, these systems are data repositories with the necessary tools such as content editors, content aggregation and authority with the objective to simplify online content creation and administration [11]. CMSs focus on the editing and creation of web page content as well as organizing links between pages. A CMS can integrate between a repository and authority, i.e., digital information can be stored in a database such that the system provides central storage for small information segments for later retrieval, revision and delivery [2], [11]. Furthermore, these systems are accompanied by a powerful publishing engine such that a system distributes requested content to the appropriate user at the appropriate time.

The content is the most important part of a CMS and the concept of "Content" refers to any unit of digital information, such as plain texts, audios, videos, documents, records and images. With built-in features and characteristics supporting each system, a CMS nowadays allows users to visualize, index, edit and publish content. Moreover, it supports more flexibility for novice users and designers in customizing content and a website's visual appearance. A CMS must perform various and

important functions, including administrative functions, content management and media management. Single Source Multiple Media (SSMM) refers to the management of workflow tasks, assets, the management of users and their roles. Furthermore, a CMS helps to satisfy the needs of importing and exporting content, content syndication, all of which can be customized by available extensions which are either plugins or modules [11].

The concept of “Management” refers to modifying content processes, such as adding new material, blogging content, updating and removing content. The concept of “System” refers to the web software system which is responsible for publishing processes and the organization of content. Many open source CMSs are available in the market as of the current year (2017). WordPress, Joomla and Drupal are considered the most popular systems according to their market share.

## **2.2 Types of Content Management Systems**

Digital content can be organized and processed by Content Management Systems such that these systems perform different purposes, including searches, browse, access and retrieval in collaborative workgroups. The most common types of CMSs can be broken down into the three following types:

### **2.2.1 Web Content Management Systems (WCMSs)**

Generally, these systems are the utilization of a Content Management System. A WCMS is a system that supports and provides webpage template design, editorial tools and web content workflow. These systems are dedicated to developing website environments and other projects related to Internet content delivery [11]. WCMSs act as a set of useful tools that help businesses and other organizations to manage the digital content of their websites without previous knowledge of markup languages (such as HTML) such that end users can perform content personalization. They also have the ability to review and approve web content prior to publication. All these facilities and benefits can be used and achieved by using one of the open source systems, e.g., *WordPress*, *Joomla* and *Drupal* that will be described in this study.

### **2.2.2 Enterprise Content Management Systems (ECMSs)**

An Enterprise Content Management System involves communications, processes, workflows and interactions with a group of stakeholders such that the system describes who is involved in a CMS and when they interact [12]. These systems are a set of software modules integrated into a central database to facilitate the management of all enterprise information, including corporate documents, records and all digital assets for internal use as well as external use with business partners and regulators. These systems help organizations to eliminate redundancies to achieve information consistency such that every application accumulates and delivers its content into a uniform repository to support the required information to other applications in turn [13]. In particular, these systems enable data sharing by many different business processes to support an organization's internal activities and they also allow data collection from different divisions in a business in order to improve business processes and decision-making processes because of their capabilities for knowledge capturing that exists in formal documents, reports and presentations. Most ECMSs enable employees at different levels of an organization to access and exchange information according to any privileges assigned to them by the system's administrator. Moreover, end users can reach external sources of information [14]. *Nuxeo* and *Alfresco* are open source ECMSs, wherein each system is a complete group of ECM components and services that support document management, digital asset management, human resources management and content aggregation.

### **2.2.3 Digital Asset Management Systems (DAMSs)**

Many firms and businesses have special needs to organize and manage unstructured digital objects such as photographs, graphic images, videos and audio content in publishing, broadcasting and entertainment projects. These systems can satisfy these needs and help to index and store media files [14], [26]. DAMSs specialize in managing rich media assets for later retrieval in media environments. These systems are usually called Media Asset Management [11]. A DAMS can help to catalog media file repositories by assigning and applying metadata and content categorization in order to grant systems users the ability to search for these files. These systems can be used by organizations to reduce duplication of media assets as

well as to control their security. *EnterMedia* and *Razuna* are two examples of DAMSs. They are open source and support the management of every aspect of media assets. Many features come with these systems, including import and export functionality, content categorization, image editing, metadata support, revision control and the ability to perform conversion of media files into different file types.

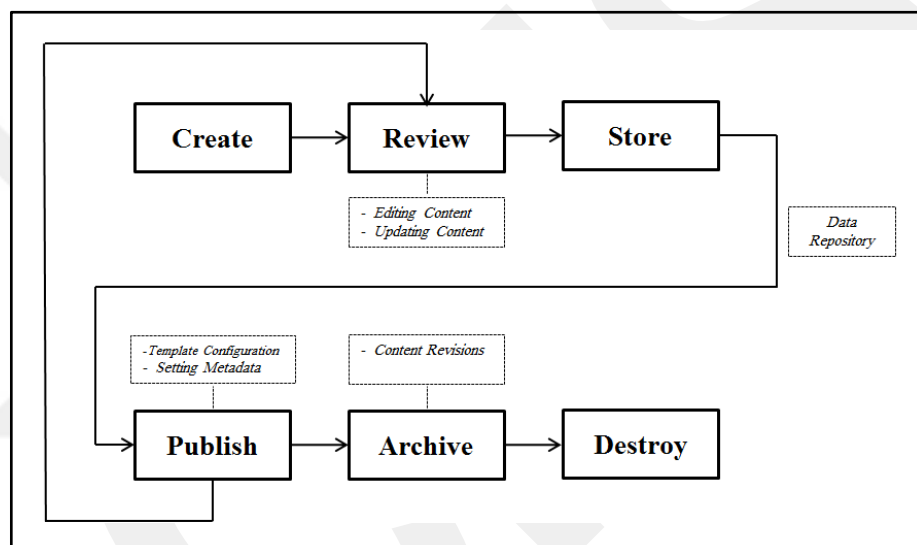
### 2.3 Main Parts of a Content Management System

The following parts are a foundation to build a website using a Content Management System:

1. **System interface:** Within the system dashboard, the system administrator can add content to a website, modify its theme, install/remove an extension and administer the entire website.
2. **Themes:** A theme is the layout of the website and its visual appearance. Website design and the appearance can be customized according to clients' and firms' logos and their preferred colors. There are advanced premium themes for most CMSs that can add even more features.
3. **Content:** When a website has a theme, the administrator can add content such as new web pages, more media and any content that the administrator would wish to add.
4. **Extensions:** An extension is an available plugin or module found on the official repositories for each system. Extensions are a piece of PHP code developed by third-party developers to affect and extend the functionality of a system either on the backend or on the front end (website). This means they either support the functionality of which only the administrator can take advantage (e.g., Google Analytics and Search Engine Optimization) or they can add new features to the frontend of which visitors can take advantage (e.g., multilingual site support, widgets and registration forms).

## 2.4 Content Management Systems Anatomy

Content management can be defined as digital content administration during the content lifecycle. The content management process covers all tasks and strategies that must be considered throughout the content lifecycle. The core of content management is based on the content lifecycle and the content repository. Content management involves “tagging of the content with Metadata in order to make content easier to find” [15, p. 11]. The digital content lifecycle comprises six main stages covering stages from the creation process to the destruction process [16], as shown in Figure 3.



**Figure 3** Digital content lifecycle

Different sources of created content require a review process after the first stage. The review stage determines whether content is acceptable in addition to the process involving further processes such as future content updates. Original content needs to be stored in a repository prior to the publication stage, which involves further processes such as template configuration, setting metadata and keywords. The archive stage occurs automatically after the given data satisfies the requirements of content revision. At some stage, the lifecycle involves permanent content retirement (destruction) from the repository. A single lifecycle is associated with each single document such that each document lifecycle identifies the current state of a document through the CMS [15].

A CMS involves *three phases* in which the aforementioned *content lifecycle* passes through the system. The first phase is the *Collection* phase, which involves content creation. The second is the *Management* phase, during which website content is stored into a type of complex database such as a “MySQL” database. The last phase is the *Publication* phase where information is published on a web page [17].

#### **2.4.1 Collection Phase**

During this phase, the necessary instruments, such as content editors, are used to create content and human resources are responsible for obtaining content to be managed in the second phase. In particular, during this phase, content creation and constitution prior to publication occur according to the following processes [17]:

- **Content creation:** A CMS supports an easy-to-use authoring environment such that end users can use it as a Microsoft Word processor to help non-technical users to create new pages, posts, and articles. The key that makes a CMS successful is the authoring tool. For example, WYSIWYG (“What You See Is What You Get”) editors and the web-based authoring environment simplify website implementation and allows website updating to be performed remotely. Moreover, this process involves structural management of the site such that a CMS allows users to know how web pages are linked. Some CMSs offer a drag-and-drop feature to perform website restructuring without damaging any of the links between web pages.
- **Content conversion:** This process involves filtering the content created during content creation phase whereupon it is translated into a specific markup language, i.e., HTML.
- **Content aggregation:** This process separates created content into components in order to be assigned by keywords or tags and be inserted into the Meta data system [17] so as to achieve content profiling and indexing. In the aggregation process, website content is collected according to a common topic that involves one or more related keyword or tags to facilitate content access.

## 2.4.2 Management Phase

During this phase, content is stored into a data repository and filtering lists can be used by administrators and end users to find and organize the stored content. The management system comprises the administration, repository and workflow functions as follows:

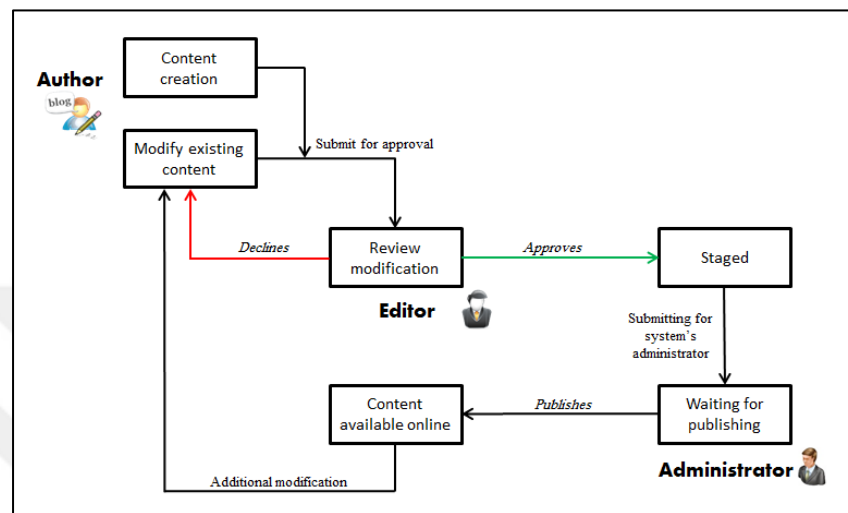
- **Central repository:** A repository is a database that saves all created website content along with other supporting details and a range of useful features offered by the central repository. This ensures that the system's end users can access and change only the section for which they are responsible in addition to keeping track of content versions of web pages such as when any changes occur and by whom.
- **User roles and workflow:** This process comprises to the automation of system processes including the management of administration tasks and the interactions of user roles. The workflow process is the automation of organizational processes depending on computer technologies [18, p. 21]. Workflow management involves control, coordination and communication of all related activities to support a content path beginning from content creation and ending at the publication phase. Thus, workflow is a series of stages that content may assume. Transitions are managed and triggered by human interaction according to their permissions [9] such that the system's users approve the stage transition in order to progress the content and have it approved by system users with higher level permissions and responsibilities. For example, a website team involves three roles, namely the Administrator, Editor and Author. These roles are supported by most CMSs to have the website team manage and review content approval prior to the publication process, and depending on the size of the team, the system may involve people separately assigned to the aforementioned roles. The following scenario explains a general concept of workflow tasks in most CMSs according to the roles assigned<sup>1</sup>:

- 1) An Author adds or modifies content such as a web page and saves the changes.

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<sup>1</sup> Understanding Workflow, the University of Kansas, available on: <http://cms.ku.edu/understanding-workflow>

- 2) The Editor receives an email from the system notifying him that a web page was created or modified by an author and is ready for view. The Editor cleans and reviews it and then decides whether to submit it for publication.
- 3) The revised content is approved by the system administrator for final publication. Figure 4 shows the tasks in the workflow in most CMSs.



**Figure 4** Workflow tasks in most CMSs

This kind of workflow task ensures that when content is not approved by a user role, the created content must be returned to the previous stage. Automatic actions are also involved during stage transitions. For example, the system sends an email to notify users of pending actions that they are to consider [9].

### 2.4.3 Publishing Phase

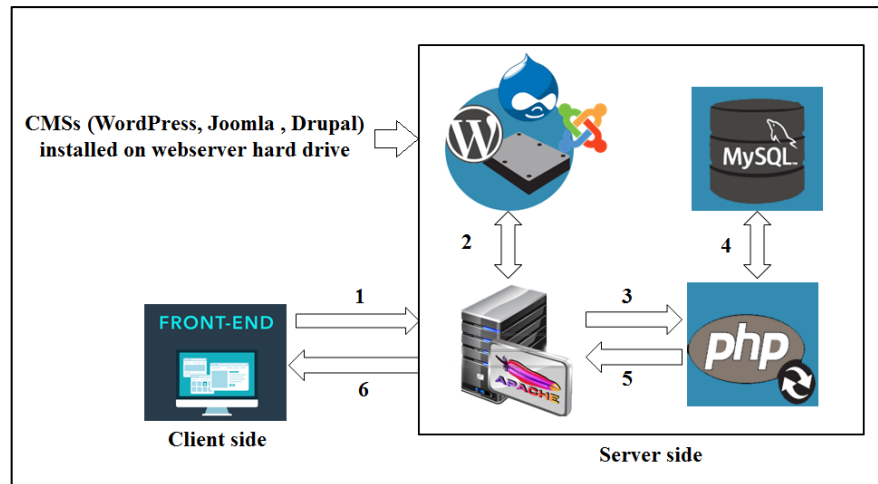
During this phase, the system extracts revised content from the MySQL database and produces the final publication on the website after administration approval. The page layout and appearance of the website can be applied automatically by powerful publishing engines that most CMSs have such that the system allows graphic designers or developers to modify the appearance that will be applied by the system. A publication output represents the unified information “Content” that has a purpose, publisher and audience [17]. At the core of the publication phase are templates and these templates link a CMS with the final publication release and handle the static and dynamic parts of the final publication to help content creators to concentrate on

writing and editing the content by depending on the system which takes care of the complete appearance of the website. In addition, during this phase, the system enforces presentation of the website and builds site navigation by reading the repository structure, and as a result, impact of the website is enhanced. The final output involves HTML post scripts that are to be rendered on the client's browser.

## **2.5 Content Management Systems Technical Overview**

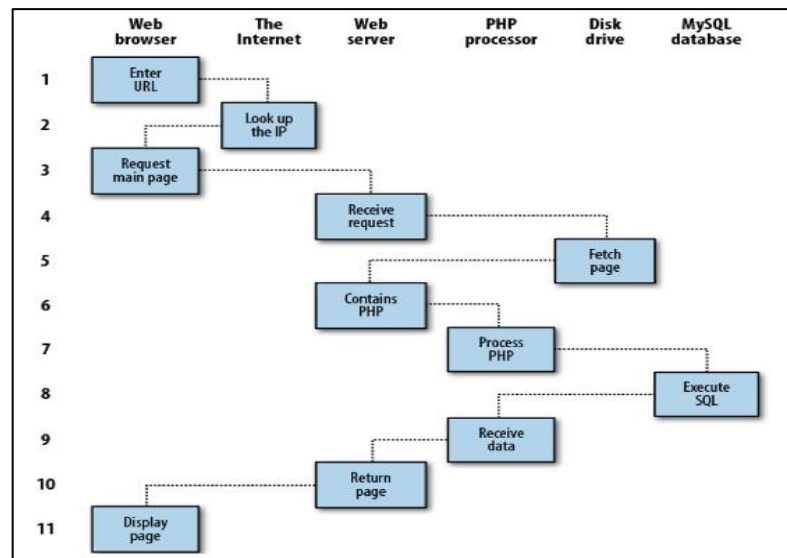
A webhost is required to install Content Management Systems for their services. A webhost supports and maintains the web servers on which CMSs are installed and deployed such that a CMS can be installed on the webserver's hard drive under a specific Domain Name System (DNS). Basically, CMSs have a frontend (which is what people see when they surf a website) and a backend "administration layer" where the configurations of the website are performed [19]. An account with a password is required to log in to the administration layer, which allows alteration of the entire website design, extensions installation, and publication of content. In addition, a system's administrator can set access permissions for each user to control their abilities related to viewing and modifying website content. A rich text editor, such as a WYSIWYG editor, is usually used in most CMSs to format content as HTML markup, and then the system renders the text using CSS sheets to personalize the output. WordPress, Joomla, and Drupal are PHP and MySQL based platforms. The PHP processor module is an open source server-side scripting language dedicated to web development. MySQL is a relational Database Management System in which content of the website is stored and from which it is retrieved.

The request/respond procedure occurs for dynamic web pages created with a CMS when a website visitor sends an HTTP request for a website. Figure 5 shows a client side/server side interaction:



**Figure 5** Client side/server side interactions

The client's request is transmitted to the web server. The web server (e.g., Apache server which is most commonly used) retrieves website files from the hard drive such that if the website is WordPress, Joomla or Drupal based, the Apache server attaches all CMS files that were installed when the website was built and sends these files to the PHP processor module. This module uses the Server Application Program Interface (SAPI) which is responsible for interpretation and execution of PHP for the Apache server. Some PHP code includes MySQL statements such that the PHP interpreter passes to the MySQL database to retrieve data [20]. The retrieved data is the actual content of the website. Theming files with PHP code produces necessary the HTML that a browser needs to read and control the website layout and structure. Moreover, the remaining PHP files create the backend of the installed CMS application. Later, the PHP module sends the request back to the web server and the server sends the requested data to the browser in the form of a website to display the web page content (Figure 6).



**Figure 6** Dynamic client/server request and response procedure [20, Fig. 1-2]

## 2.6 Problems of Classical Approaches to Web Content Updating

There are many controversial arguments in the modern business environment about the differences between traditional HTML software and CMSs in implementing a website. Traditional software such as *Microsoft FrontPage* and *Dreamweaver* would manage a static website and produce HTML, PHP and CSS code by abstracting code using a Graphical User Interface (GUI) such that a web designer can learn the software interface instead of learning how to write the code. Nevertheless, there can be few benefits by taking these traditional approaches and by spending great amounts of money, especially when multiple pages need to be updated periodically as updating content and site appearance with new functionalities are more expensive and time-consuming. Moreover, it is difficult on a website built by such software. Web development using HTML markup usually requires a large amount of coding as well as great effort for simple tasks such as content alignment. For instance, in classical approaches, web developers designed and maintained databases (e.g., Oracle) and they connected these databases to websites through JDBC for transactions. These processes were difficult and consumed many human resources. Moreover, when simultaneous updating is performed by more than one user with access rights to the website backend, the problem of tracing “who modified what” and “what the latest version of a web page is” becomes a serious problem. As a result, for many organizations, it became quite troublesome to continue maintaining

their websites when their contracts with website development agencies were about to end. On the other hand, CMSs support and produce dynamic websites. For instance, web page content can be updated easily by novice users, and new features and new looks can be installed and applied. These capabilities can save time and money. Below are the main drawbacks with traditional systems in comparison to CMSs:

- 1) **Web page creation:** With traditional HTML software, a new web page can be created as a copy of an existing one. Updating sitemaps and navigation links must be done manually, while with a CMS, the page can be created based on a predefined default and navigation links updated automatically [1].
- 2) **Publishing time:** With traditional HTML software, the new content is published only when a responsible webmaster has the time to perform this operation, and this may last several days. While with a CMS, an immediate publishing operation can be achieved once necessary approval has been given. However, many features and capabilities are supported by CMSs as explained in part 2.7.
- 3) **Costs:** With traditional HTML software, all of the content is mixed with the code, and for regular website maintenance, all of the code needs to be modified followed by the entire website needing to be re-hosted after each update operation. All these tasks require additional costs because professionals need to be hired even with these trivial simple updates of website content.

## 2.7 Benefits and Features of Content Management Systems

Content Management Systems that are considered powerful *dynamic* software help to manage and keep track of everything related to content on a website. The word dynamic means that a CMS can be extended by adding new features and functions when project requirements change [3]. These systems support tools that can be used easily to add or edit content displayed on web pages by anyone with basic computer literacy skills and without any technical knowledge of how to write complex computer programming code.

For any business, it is very important to know when to decide on using one of these open source systems. A CMS helps businesses to save money and time and it

simplifies web design operation. Additionally, a CMS can maintain and support content being created and used many times [3]. Furthermore, a CMS can help to change visual appearance, layout and structure quickly such that websites pages depend on separating content from presentation and whenever any change is required, the system can provide functions to apply any required updates in a fully processed fashion unlike hard coded static HTML sites [6]. These features make CMSs preferred by:

- Businesses preferring to change and modify content more easily and quickly; and
- Designers who can find help for interactive use from a large number of online contributors.

CMSs features and characteristics differ from each other and vary widely. Most CMSs perform the following:

- Web-based publishing
- Format and workflow management
- Content taxonomy
- Content management
- Access control and users' permissions
- Multilingual site support
- Search and retrieval

## **2.8 Content Management Systems Market Share**

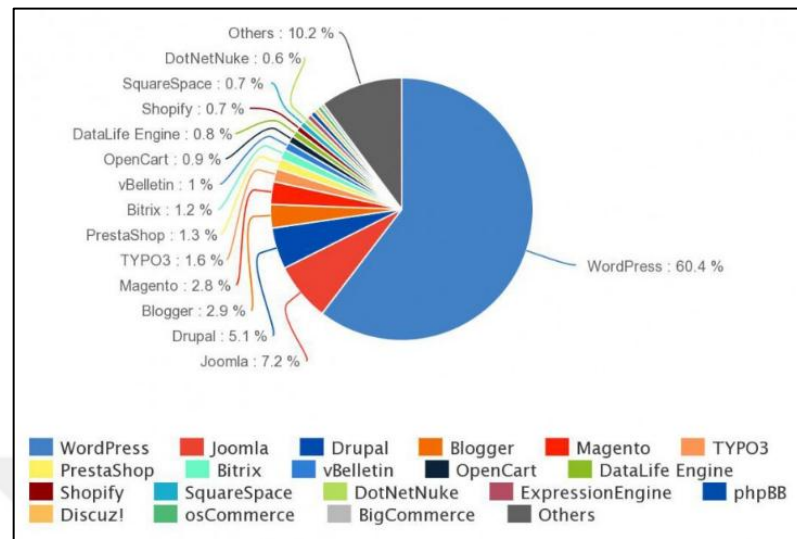
Market share is a percentage of a business's or a system's total profits that are earned by a specific company during a specific time period. Three famous Content Management Systems, WordPress, Joomla and Drupal, have been selected for this study according to their market share<sup>2</sup> as of 2017.

According to Word Wide Web Technology surveys (W3Tech), WordPress has the largest market share over its competitors with approximately 58% of total CMS market share. Joomla occupies the second place in market share with approximately

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<sup>2</sup> The CMSs platform market, retrieved from <http://creativeengineeringstudio.com/blog/cms-platforms-by-market-share/>

7%, followed by Drupal ranking third with 4.7% market share. Figure 7 shows the market share for the most widely used CMSs.



**Figure 7** CMS platforms by market share

The valuable features and capabilities behind each system affect market share percentage. For instance, the top three popular systems support extensibility that is preferred by a wide range of CMS users. In addition, the ability of allowing non-technical users to manage simple to complex websites is the most attractive feature for clients. Figure 8 shows usage percentage of sites according to World Wide Web Technology surveys.<sup>3</sup>

Most popular content management systems				
© W3Techs.com	usage	change since 1 April 2017	market share	change since 1 April 2017
1. <a href="#">WordPress</a>	27.9%	+0.2%	58.9%	+0.1%
2. <a href="#">Joomla</a>	3.3%		7.0%	
3. <a href="#">Drupal</a>	2.2%		4.7%	
4. <a href="#">Magento</a>	1.2%		2.5%	-0.1%
5. <a href="#">Blogger</a>	1.1%		2.3%	

percentages of sites

**Figure 8** Usage percentages of sites

<sup>3</sup> The most popular and the fastest growing CMSs as of 1 April 2017, retrieved from <https://w3techs.com>

## **2.9 Content Management Systems Used in the Study**

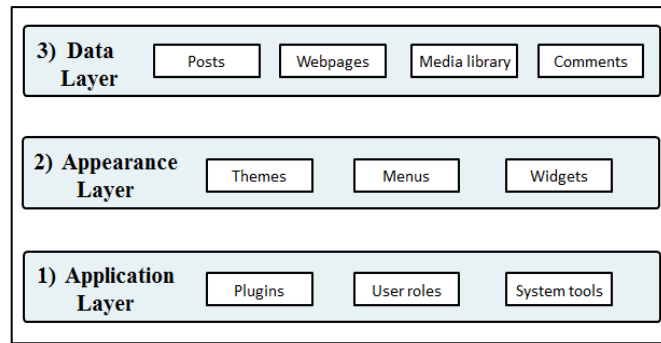
Open source Content Management Systems, such as WordPress, Joomla and Drupal, have gained their popularity due to many important factors. For instance, most of these open source packages perform workflow processes, basically beginning with authors creating content which eventually progresses to approval by the system administrator as well as organizing content for further modification or review [21].

### **2.9.1 WordPress Content Management System**

WordPress is an open source Content Management System licensed under General Public License (GPL) written and based on PHP and the MySQL database. The system has a friendly administration dashboard that is an all-in-one place to manage and organize every aspect of a website and provide elements of editorial control and workflow management. The system's posts usually include media files, texts or a mix of both that the system publishes in a dynamic manner. Many strong core features are provided by WordPress. For instance, a user can edit and manage content by using a word processor type interface and the system has a very flexible template with which the system administrator can arrange and customize widgets and easily change the appearance of a website by switching between installed themes. Furthermore, the system can be customized according to any new project requirements by integrating with contributed extensions to handle every need of a website, e.g., Google Analytics and multilingual site support. Most importantly, the system supports many usability features, including setting friendly URLs, version control, content scheduling and content categorization.

#### **WordPress architecture**

There are three basic layers in the system architecture through which content passes, as shown in Figure 9.



**Figure 9** WordPress CMS layers

- 1. Application layer:** This layer provides application management. It comprises the extensions manager in which includes all installed contributed third-party plugins and user roles that determine user authority.
- 2. Appearance Layer:** This layer helps the administrator to manage and customize the appearance of the website (i.e., the theme) as well as distribute and modify website layout by changing widget positions. Furthermore, this layer provides menu management that organizes the links between website pages.
- 3. Data layer:** This layer is the top layer with content management features. WordPress is a post-centered platform, which means the majority of the content is created and published in a post form [22]. The data layer allows users to create two basic kinds of content, namely posts and web pages. In addition, the layer provides the ability to organize and manage comments and media library content.

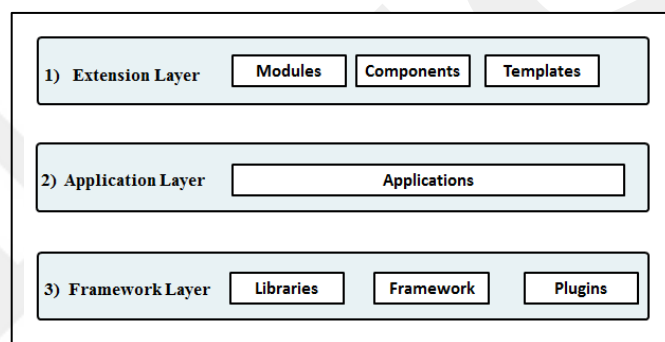
### 2.9.2 Joomla Content Management System

Joomla is an open source Content Management System released under General Public License (GPL) written and based on PHP and the MySQL database. The popularity of Joomla is due to the system's ease of use and acceptable learning curve. Second, the system is extensible by third-party extensions supported by a rich community of enthusiastic users and developers [5]. The system is designed to be modular so that system functionality can be extended. The Joomla core package performs many important functions; e.g., content syndication, page caching, revision control and page/menu management. The basic types of pages supported by Joomla

include articles which represent content, sections and categories. Categories are responsible for organizing articles wherein articles in Joomla are organized under one category and one section may include one or more categories. The system architecture has been designed to keep track of all website content in the MySQL database to support dynamic functionality.

## Joomla Architecture

The internal architecture of the system is broken into three basic layers, as shown in Figure 10.



**Figure 10** Joomla CMS layers

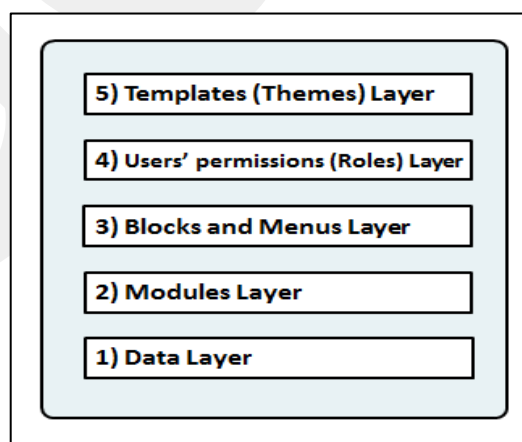
- 1. Extension layer:** This layer is the topmost layer comprising modules, components and templates. The components are developed as a custom independent application to empower the Joomla core and services. The templates function to control the entire look and appearance of the user interface and system layout.
- 2. Application layer:** This layer is the middle layer that extends the system framework with several important applications included in the system. Some of these applications exist to install system packages on the web server, and other applications deal with the backend and frontend of the system.
- 3. Framework layer:** This layer is the core of Joomla. It contains the default plugins that are responsible for oriented functions and libraries comprising a set of built-in services and installed extensions.

### 2.9.3 Drupal Content Management System

Drupal is an open source Content Management System licensed under General Public License (GPL) written and based on PHP and the MySQL database. The system has an advanced and customizable administration interface in which the administrator has the ability to add or remove items from the interface. Drupal provides a platform to implement different types of projects, e.g., forums and blogging platforms. The system provides its users with the ability to update content in a very flexible and reliable manner; for example, it can allow authentic users to submit website content and display the final output to website visitors by applying selectable criteria, such as by category or by date. Moreover, the system by default has the ability to perform a hierarchal taxonomy to classify and label content with keywords to facilitate content access. Drupal can be used to design and implement simple or complex websites. Similar to WordPress and Joomla, the system core features were designed to be extended by contributed extensions, modules and themes, a large number of which are available on the official Drupal repository. In addition, the system performs a number of important features such as assigning a hierarchy of permissions and content syndications via RSS feeds.

#### Drupal Architecture

Drupal's system architecture consists of five layers through which information passes, as shown in Figure 11.



**Figure 11** Drupal CMS layers

- 1. Data layer:** This layer is the pool of the data (nodes) which collects all the content prior to the publication process. Two types of content are supported by default, namely the article and the basic page.
- 2. Modules layer:** This layer includes modules that are functional extensions which are either shipped with the Drupal core or third party extensions to be installed into the system by the administrator.
- 3. Blocks and Menus layer:** Blocks are responsible for displaying the output of an existing module in which it shows regions of the website template, otherwise known as the layout of the website. Menus are web page navigators (relative URLs) that manage the links for all pages created by the system.
- 4. Users' permissions layer:** This layer contains the users' privileges to determine what users can do. In Drupal, users are assigned to the roles to give them assigned permissions.
- 5. Template layer:** This layer is for the appearance of the system frontend (theme or skin) to display generated content in the appropriate regions (blocks).

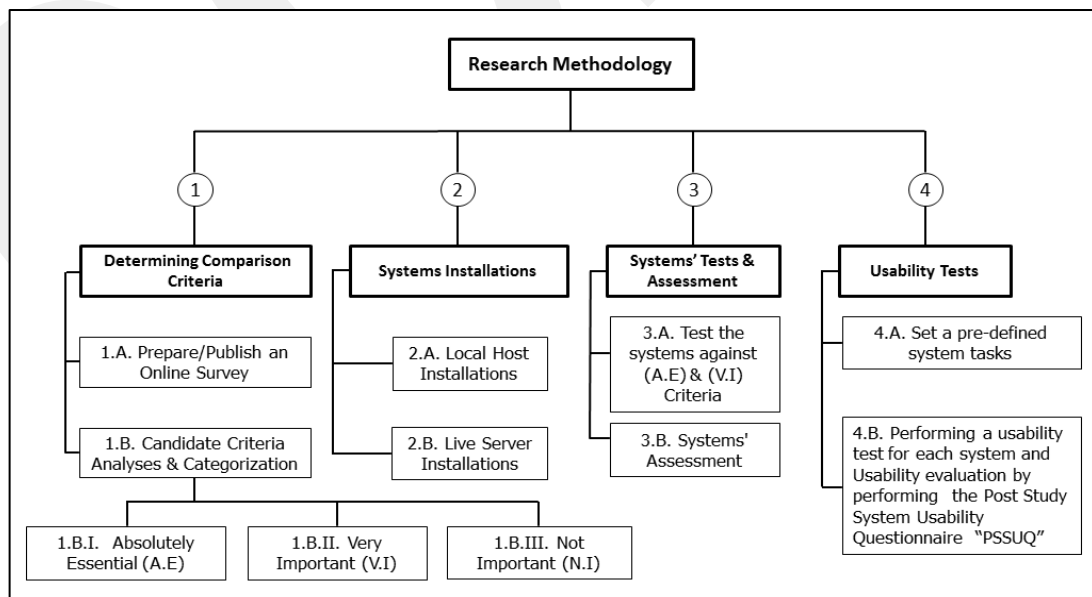
## CHAPTER 3

### METHODOLOGY

In this chapter, we present the methodology used in the research. The chapter highlights the research methodology that includes four steps to compare Content Management Systems.

#### 3.1 Research Methodology Steps

Our methodology is divided into four steps, as shown in Figure 12. The first step explains how to develop the necessary comparison criteria to compare the systems according to the opinions of IT experts by using an online Google Form survey. We have explained how to analyze the collected data and data categorization. The second step clarifies the systems installations on a local host and on a live server. The third step comprises testing the systems according to the criteria determined in the first step in addition to grading each system for assessment. The last step involves a usability test methodology to test each system using a research instrument called a Post Study System Usability Questionnaire (PSSUQ).



**Figure 12** Research methodology steps used in the study

### **3.1.1 Determining Comparison Criteria**

In our research, we developed a comparison criteria set for Content Management Systems in order to select the criteria that will be considered in this study. First, we prepared and published an online survey to determine the comparison criteria. Online surveys provide a mechanism to reach people who share a specific interest such that a researcher can take advantage of virtual communities [23]. Our survey comprises a set of 76 candidate criteria selected from previous studies [1], [5], [6], and [26] such that we supported the criteria according to the CMS capabilities explained in [1] relating to automated templates, access control, ease of content creation, and the ability to extend using third-party extensions. We considered the recommendations as set out in [26] to compare CMSs, as well as some of the criteria in [5], [6]. Moreover, we added new criteria to evaluate the systems according to the complexity of installation in addition to the criteria that support new technologies such as Search Engine Optimization, mobile support, social media support and tracking statistics support. Our criteria are organized under nine categories covering the following important aspects:

1. Installation Complexity
2. Usability
3. Technical requirements
4. Platform support
5. Security
6. Ease of extension and customization
7. Collaboration and interactivity
8. Performance and functionality
9. Other criteria related to system statistics

We used Google Form to prepare the survey because of the powerful capabilities it provides for researchers. For example, it supports tracking results and accumulates responses in a spreadsheet and it allows the exporting of collected data to statistical files. Although all three of the CMSs compared in this study have survey capabilities, we selected Google Form in order not to be biased toward one of the three systems so that we can perform a fair comparison. The target participants for the survey were

IT experts and specialists in order to garner their opinions about the importance of the candidate criteria. We asked them to rate each criterion according to its importance. The following scale was used to rate each criterion in the survey:

- Not Important at All
- Of Little Importance
- Of Average Importance
- Very Important
- Absolutely Essential

Most importantly, a purposeful sampling methodology was used for the selection process of the participants. Purposeful sampling is a technique used widely in studies for identification and selection of necessary information related to research aims. Purposeful sampling involves identifying a group of individuals representing candidate participants who have specific knowledge or experience consistent with research interests, and these participants should be willing to participate in the study questionnaire [24]. To illustrate, there are two methods on which purposeful sampling is based. The first is the qualitative method that focuses on saturation such that it depends on continuous sampling to obtain a comprehensive understanding until new information can no longer be acquired. The second method is the quantitative method, which focuses on generalization, i.e., this method concentrates on gained knowledge that is representative of the people from which the sample was extracted [25]. Each of the aforementioned methods has different standards to determine the number of research participants. The quantitative method requires a large sample of participants, (numbering as much as 20 to 30 participants), and each one of them participates once to express his opinion about items included in the study questionnaire according to his own experience. This strategy satisfies heterogeneity, which refers to diversity [25], i.e., a group of participants from many different backgrounds is considered to guarantee the quality of the heterogeneity.

In our study, we have selected a criterion sampling strategy because this strategy can be used to decrease the range of variation related to the opinions of different participants in order to concentrate on the similarities. This strategy performs quantitative measures such as calculating the mean of each item in the research survey. According to the recommendations in [25], we considered the qualifications

of the participants in terms of specific experience in information technologies to address our candidate criteria and maximize efficiency and validity of the research aims. In conclusion, our strategy objective emphasized the similarity of opinion of IT experts and we identified the comparison criteria based on the online questionnaire that included items that were compatible with the research questions. Table 1 below shows the demographics for 31 participants who shared their opinions in our published survey:

**Table 1** Demographics of participants

Gender		Expertise level (years in IT) sector	Number of Participants	Percentage
Males	Females			
27	4	1-3 years	0	0%
		4-6 years	4	12.9%
		7-9 years	10	32.3%
		10+ years	17	54.8%
		<b>Total</b>	31	100%

### Data Analysis and Criteria Categorization

Generally, data can be defined as collected information without human intervention such as “significance or context” collected into files as elementary units be handled and analyzed [17]. We analyzed the collected data that represented the views of experts after finding a sufficient number of participants based on the quantitative method. Our analyses involved criteria categorization according to importance. The collected data were organized and grouped as categorical groups. First, we assigned equivalent numerical values for each scale that was used to rate each criterion in the survey, as shown in Table 2:

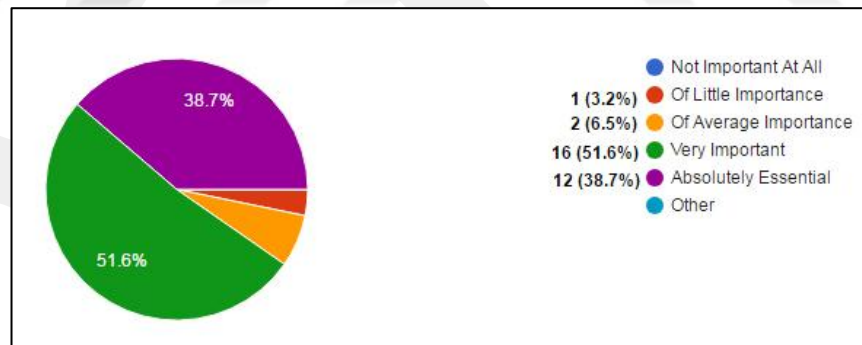
**Table 2** The importance scale equivalent values

Importance Scale	Equivalent Numerical value
Not Important At All	1
Of Little Importance	2
Of Average Importance	3
Very Important	4
Absolutely Essential	5

Second, we calculated the mean value for each criterion included in our survey, and we created three degrees of importance, namely the Absolutely Essential, Very Important, and Not Important, as follows:

- **Absolutely Essential (A.E.):**  
If the total average for a criterion is  $>4$ , this criterion will be considered in the study as an Absolutely Essential criterion.
- **Very Important (V.I.):**  
If the total average for a criterion is  $>3$  and  $\leq 4$ , this criterion will be considered in the study as a Very Important criterion.
- **Not Important (N.I.):**  
If the total average for a criterion is  $\leq 3$ , this criterion will not be considered in the study, and all criteria in this degree will be dropped.

For example, Authorized Access Control is a criterion considered in our study as an Absolutely Essential criterion because its mean value fulfills the condition of the Absolutely Essential degree. Figure 13 below shows statistics for the aforementioned criterion by 31 participants:



**Figure 13** Statistics for the Authorized Access Control criterion

Table 3 shows individual statistics that represent participants' opinions for the Authorized Access Control criterion collected from 31 specialists:

**Table 3** Accumulated statistics for the Authorized Access Control criterion

<b>Participants number</b>	<b>Participants' opinion</b>	<b>Equivalent Numerical Value</b>
1	Absolutely Essential	5
2	Absolutely Essential	5
3	Of Little Importance	2
4	Very Important	4
5	Very Important	4
6	Very Important	4
7	Absolutely Essential	5
8	Absolutely Essential	5
9	Absolutely Essential	5
10	Absolutely Essential	5
11	Absolutely Essential	5
12	Very Important	4
13	Very Important	4
14	Very Important	4
15	Absolutely Essential	5
16	Very Important	4
17	Absolutely Essential	5
18	Very Important	4
19	Very Important	4
20	Very Important	4
21	Very Important	4
22	Very Important	4
23	Very Important	4
24	Absolutely Essential	5
25	Very Important	4
26	Absolutely Essential	5
27	Absolutely Essential	5
28	Absolutely Essential	5
29	Very Important	4
30	Of Average Importance	3
31	Very Important	4
Average		4.32
Result		Absolutely Essential

In the same manner, we calculated the averages for all criteria. Appendix A shows tables containing candidate criteria categorization according to their importance

based on the survey results. Criteria for the Not Important degree were not considered in this study.

### **3.1.2 Systems Installations**

When a business hires a web developer or an agency to install a Content Management System and build a website, the ease of installation is not likely to be considered [26], while ease of installation is considered a concern for novice users who are not familiar with the technical aspects of the software. Since we have system installation criteria included in this study, there is a need to review and explain system installation in this chapter, on both a local host and on a live server in order to discover which CMS has less installation complexity as a part of our methodology.

#### **3.1.2.1 Local Host Installation of CMSs**

Content Management Systems require a database to be installed on a local server. Local host installation is explained because it shows the technical details about how to create a MySQL database using the “phpMyAdmin” tool, as well as showing some necessary installation screens that need to be configured during the installation process.

##### **Local Host Installation Steps:**

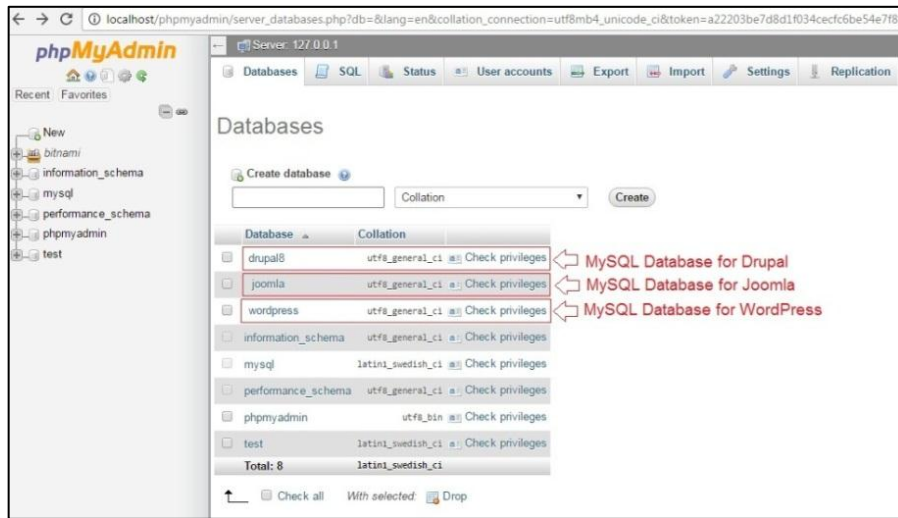
**Step1:** The first step is to create a local server using “XAMP,” which is an executable file compatible with many operating systems.<sup>4</sup> This package creates a file directory named “htdocs”, and the package installs phpMyAdmin, which is an open source graphical user interface tool (GUI) that is used to create and manage databases required for each system.

**Step2:** The second step is to create a MySQL database using the phpMyAdmin tool. A user needs to access (localhost/Phpmyadmin) through the browser to create and manage the MySQL database. A user can create a database by giving it a name and assigning a user account with full privileges to that database. The database name, password and database user name must be kept for later installation processes.

---

<sup>4</sup> XAMP for Many Operating Systems, <https://www.apachefriends.org/download.html>

Figure 14 shows three databases created for each system prior to installing and each database is assigned to a user account with full privileges.



**Figure 14** MySQL database creation using the PhpMyAdmin tool

### WordPress Local Host Installation Steps

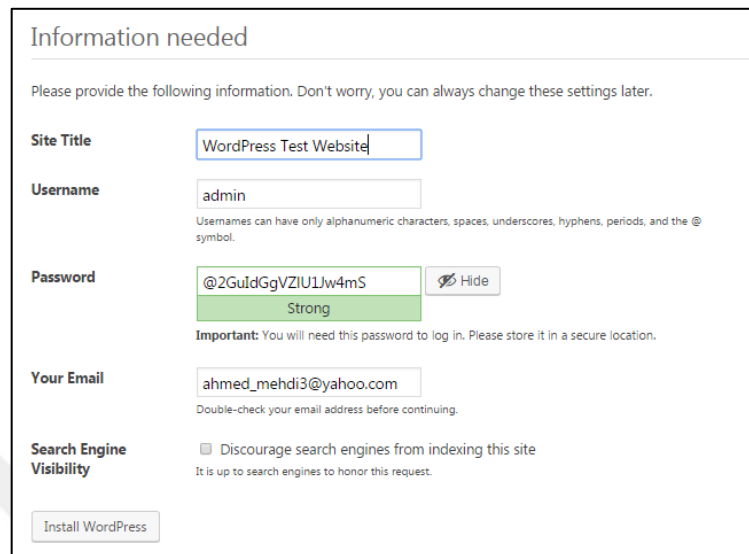
- 1- Downloading the software package available on the official website followed by the user extracting the package inside the (c:\xampp\htdocs) directory.
- 2- The user accesses (localhost/wordpress) through the browser to start the installation process. After selecting the language in the first window, the installation process asks for the database name, user account assigned for this database and its password created previously with the phpMyAdmin tool, as shown in Figure 15.

Below you should enter your database connection details. If you're not sure about these, contact your host.

<b>Database Name</b>	<input type="text" value="wordpress"/>	The name of the database you want to use with WordPress.
<b>Username</b>	<input type="text" value="username"/>	Your database username.
<b>Password</b>	<input type="text" value="password"/>	Your database password.
<b>Database Host</b>	<input type="text" value="localhost"/>	You should be able to get this info from your web host, if localhost doesn't work.
<b>Table Prefix</b>	<input type="text" value="wp_"/>	If you want to run multiple WordPress installations in a single database, change this.

**Figure 15** WordPress database connection

Afterwards, the user inputs website information such as Site Title and creates the administration account, as shown in Figure 16.



The screenshot shows the 'Information needed' form for WordPress installation. It includes fields for Site Title (WordPress Test Website), Username (admin), Password (@2GuIdGgVZIU1Jw4mS, Strong), and Your Email (ahmed\_mehdi3@yahoo.com). There is also a checkbox for Search Engine Visibility and an 'Install WordPress' button.

**Figure 16** WordPress installation/required information

After the installation process finishes, the system installation process shows a success message 20 seconds later. A user can log into the system by accessing (*localhost/wordpress/wp-login.php*) through the browser.

### **Joomla Local Host Installation Steps:**

- 1- The software package available for download on the official website. The user extracts the package inside the (c:\xampp\htdocs) directory.
- 2- A user needs to access the following link through the browser to start the installation process: (*localhost/joomla/installation/index.php*). Joomla installation consists of three phases: the configuration, database and overview phase. During the configuration phase, the user selects the language and sets the site name with a description in addition to creating the administrator account, similar to the WordPress installation. The database phase allows the connection of the database to the system such that a user uses the database name, password and the user name that was assigned to this database created previously with phpMyAdmin. Figure 17 shows the database connection phase:

**Database Configuration** ← Previous   Next →

Database Type \*  This is probably "MySQL".

Host Name \*  This is usually "localhost".

Username \*  Either something as "root" or a username given by the host.

Password  For site security using a password for the database account is mandatory.

Database Name \*  Some hosts allow only a certain DB name per site. Use table prefix in this case for distinct Joomla! sites.

**Figure 17** Joomla database connection phase

During the Overview phase, the main configuration of the site, such as the administrator’s email and user name, appears and a pre-installation check is performed. The Joomla installation process ensures that the required items, such as a version of PHP and database support, are available. The installation process of the software package takes approximately 43 seconds. Later, a user can log in to the system by accessing (*localhost/joomla/administrator*) through the browser.

**Drupal Local Host Installation steps:**

- 1- Download the software package available on the official website. Then a user extracts the package inside the (c:\xampp\htdocs) directory.
- 2- The user needs to access the following link through the browser to start the installation process: (*localhost/drupal/core/install.php*). Then, the user selects whether he wants a standard installation or a minimal installation profile. The first installs sample data with commonly used features, especially for beginners, as shown in Figure 18.

**Drupal** 8.2.1

Choose language

**Choose profile**

Verify requirements

Set up database

Install site

Configure site

**Select an installation profile**

- Standard  
Install with commonly used features pre-configured.
- Minimal  
Build a custom site without pre-configured functionality. Suitable for advanced users.

**Save and continue**

**Figure 18** Drupal installation profile selection

3- The next step is the Database Connection phase, which requires the database name, user name and database password created previously with phpMyAdmin as explained for the two previous systems. The installation process of the software package takes approximately 40 seconds. Later, a user can log in to the system through the browser by accessing (*Localhost/drupal*).

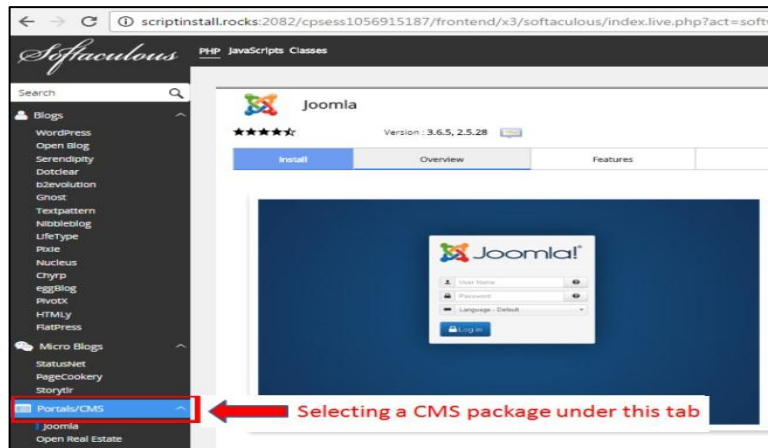
### 3.1.2.2 CMS Live Server Installations

Most hosting servers provide a Graphical User Interface (GUI) that contains a web hosting control panel, called “cPanel,” designed to facilitate the hosting process of the website. This interface, which is a Linux-based tool, offers installation wizards to support server administrators using a web browser. Web hosts that use this control panel support the MySQL database manager as well as other popular packages of PHP applications including the latest versions of Content Management Systems. Users can select the required software package for the system and install it on the host server on which the domain name resides. For a live server installation, we used the script installer “Installation Wizard” to install the three CMSs with the following Uniform Resource Locators (URLs):

- ( <http://aword.epizy.com> ) dedicated for WordPress CMS version 4.6
- ( <http://ahmedjoomla.epizy.com> ) dedicated for Joomla CMS version 3.6
- ( <http://ahmeddrupal.epizy.com> ) dedicated for Drupal CMS version 8.2

The Installation processes for the three CMSs on a live server are roughly similar, so we will explain the steps for one system, (Joomla for this case) to support the required illustration. Below are the steps to perform a Joomla live server installation process:

- 1. Database Creation:** This step is similar to the steps explained for the local host installation. We used the MySQL database manager supported by the web server control panel to create the database. The database name must be kept for the following steps.
- 2. Package Selection:** This step requires running through the installation wizard available on the web host “cPanel” to select the required CMS application under the “CMS/Portals” tab, as shown in Figure 19.



**Figure 19** A CMS package selection

- 3. Software Pre-installation:** This step performs software setup configuration. A user must provide some necessary information, as shown in Figure 20. The requested information includes:
- CMS required version
  - Required protocol (http:// or https)
  - Domain Name System (DNS)
  - Website name and description
  - Administration account information

 A screenshot of the Joomla! software setup form. The form is titled 'Joomla' and shows the version '3.6.5, 2.5.28' and release date '13-12-2016'. The 'Install' tab is selected. The form is divided into two sections: 'Software Setup' and 'Site Settings'.
   
 Under 'Software Setup':
 

- 'Choose the version you want to install': A dropdown menu with '3.6.5' selected.
- 'Choose Protocol': A dropdown menu with 'http://' selected.
- 'Choose Domain': A dropdown menu with 'ahmedjoomla.epizy.com' selected.
- 'In Directory': An empty text input field.

 Under 'Site Settings':
 

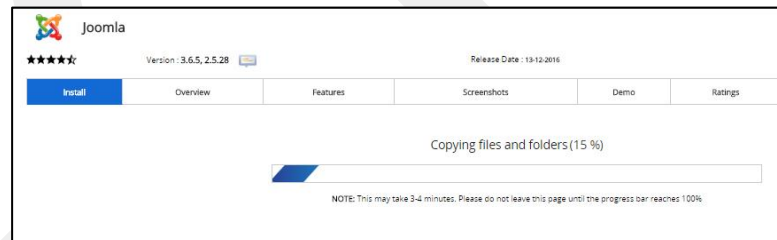
- 'Site Name': A text input field with 'Joomla Test Website' entered.
- 'Site Description': A text input field with 'Usability Test' entered.

**Figure 20** CMS software setup/site settings

Figure 21 shows administrator account creation, language selection, database name and backup configuration.

**Figure 21** A CMS software setup/administrator’s account creation

4. **Starting Installation:** This process involves copying all CMS files and folders into the website directory, as shown in Figure 22.



**Figure 22** A CMS software setup/copying files process

The table below shows recorded times for each system individually.

**Table 4** Live server installation recorded times

	<b>CMS Application</b>	<b>Installation Recorded time</b>
1	WordPress	10 sec.
2	Joomla	17 sec.
3	Drupal	35 sec.

**5. Finalizing Installation:** During this step, a message appears for users stating that the installation process was successfully completed.

### **3.1.3 Systems Test and Assessment**

This section discusses testing the systems against Absolutely Essential and Very Important criteria determined in the first step of our methodology. The test will be conducted against systems installed on the aforementioned URLs. The test aims to perform a functional analysis for each system, i.e., how a system performs a specific criterion such as depending on a core feature “Built-in,” or whether the system needs to be extended with a third-party-extension “Plug-ins.” Later, each system will be evaluated according to how a system performs the criteria. Assessment and grading of the systems will be carried out based on criteria which represent the systems’ components, which can be recognized as “Built-in or an Extension.” Chapters 4 and 5 are dedicated to performing System tests and assessments with detailed clarification.

### **3.1.4 Performing a Usability Test for Content Management Systems**

Usability can be defined as how easy it is for users to learn a system, and how pleasant it is to use. Alternatively, usability can be defined as the key for making a computer system easy to learn and use [27]. A usability test helps to assess users’ ability to use and interact with the systems’ dashboards. Generally, a usability test for a system falls under the notion and discipline of Human Computer Interaction (HCI), which represents how computer technologies impact human activities [28] as well as focusing on operating technology that is as easy and simple as possible for users. Our usability test will include a set of pre-defined tasks that participants should perform through the administrative interface for the Content Management Systems used in the study.

The main goal behind a usability test is to discover areas on system interfaces that end users may find difficult to use while implementing a set of proposed tasks. Thus, many small to medium businesses or non-profit organizations can afford to assign an appropriate person to maintain a website because we are assuming that our typical clients are interested in upgrading their own websites. This may be due to budget

limitations on hiring a web developer or an outside agent to perform frequent website updates. Instead, they can depend on the novice employees in their own firms.

### **Usability Test Methodology**

The method that will be used to implement a usability test depends on the tasks scenario in which a group of users participated to complete a set of pre-defined tasks on pre-installed systems according to the following steps:

- 1- Selecting participants that will be asked to perform specific tasks, according to previous studies [29] which recommend targeting participants that had heard about CMSs and none of whom had received formal training in these systems. Furthermore, the test considers more than five participants to be ideal in order to avoid inaccurate data collection [30].
- 2- Setting predefined system tasks to be implemented by the aforementioned participants during each session. Most importantly, and as a part of our usability test methodology, a pilot test was conducted to check whether these tasks are supported for the backend of the three systems. The proposed tasks that the participants should perform are as follows:
  1. Login into the administrator interface using the account name and password supported during the test session.
  2. Create a new user account with the account name and password supported during the test session.
  3. Assign a user role (WordPress), User groups (Joomla), permission (Drupal) for the created user account. Assign the following roles:
    - For WordPress/Joomla assign an “Editor” role.
    - For Drupal assign an “Authenticated user” role.
  4. Navigate through the system and open the default Content Editor Panel.
  5. Add the following content by creating a new post:
    - *“A usability test is the most efficient tool to discover usability issues that may face a systems’ end users, i.e., the test helps us to discover areas on the systems’ User interfaces where testers may have difficulties implementing a set of proposed tasks.”*
    - Use the following path to insert an image file into the above content:

*D:\PNGs\CMSUsage.jpg*

6. Add some Meta tags for the created content and select at least three Meta tags from the following keywords:
  - *Content Management Systems, Usability Test, Web Technologies, Dynamic Websites.*
7. Save and publish the created post.
8. Navigate to the frontend to see the published post.
9. Install an extension (Plugin for WordPress) and a (Module for Joomla /Drupal). Use the following links to reach official repositories for each system:
  - *WordPress: <https://wordpress.org/plugins/>*
  - *Joomla: <https://extensions.joomla.org/>*
  - *Drupal: [https://www.drupal.org/project/project\\_module](https://www.drupal.org/project/project_module)*

Use the search mechanism on the official website to find and install *one* of the following extensions for each system from the table below.

During the usability test, test users will be given a specific extension/plugin name.

**Table 5** Content Management Systems extensions

<b>For WordPress</b>	<b>For Joomla</b>	<b>For Drupal</b>
<i>Google Language Translator Plugin</i>	<i>GTranslate Module</i>	<i>GTranslate Module</i>
<i>Social Media Widget Plugin</i>	<i>Awesome Social Links Sidebar Module</i>	<i>Share This Module</i>
<i>Updraft Plus back up Plugin</i>	<i>Akeeba Plugin</i>	<i>Backup and migrate Module</i>

10. Delete the installed extension in the ninth task from the system.
11. Modify the (“Site icon” for WordPress) and the (“Logo” for Drupal/Joomla). Use the following paths for the image files:
  - *D:\PNGs\Blue Wordpress.png*
  - *D:\PNGs\ Joomla logo.png*
  - *D:\PNGs\Drupal.png*
12. Change the color of the current installed theme to blue
13. Logout from the administrator interface.

During each session, usability testing checklists are prepared for summarizing users' experience to ascertain whether users have succeeded or failed to implement the pre-defined tasks in order to calculate the systems' success rate and to record the time elapsed for each task and for each session for each system. The table below represents an example of the usability checklists.

**Table 6** An example of Usability test checklists

<b>Content Management System Name:</b>			
<b>Participant Number:01</b>	<b>Gender:</b>	<b>Disabilities:</b>	<b>Date:</b> <i>xx/xx/2017</i>
Task No.	Task Completion (Success/Fail)	Time Elapsed (Minute/Second)	Notes
Task1			
• • •			
Task13			
<b>Session Total Time</b>			

- 3- Usability *evaluation* by performing the Post Study System Usability Questionnaire.<sup>5</sup> This questionnaire is a research tool based on 19 Likert type items for the purpose of assessing users' perceived satisfaction with computer systems developed at IBM and identified by a panel of IBM Human Computer Interaction HCI experts [31]. The questionnaire attempts to address the main systems characteristics such as quick completion of work, ease of learning and high quality documentation, and it can be considered an adaptive instrument that can be used to evaluate user satisfaction while interacting with the system interface [32]. This questionnaire is selected for our study because it does not require a license fee and it works well for studies that test software [8]. Appendix B shows the Post Study System Usability Questionnaire items.

After participants have completed the predefined tasks on a system, the questionnaire must be completed by the participants in order to indicate how

<sup>5</sup> What is "PSSUQ", <http://www.conetrees.com/2010/12/ux-glossary/post-study-system-usability-questionnaire-pssuq>

strongly they agree or disagree with the included items by circling a number on a scale from 1 to 7. The Figure below is an example of one item:

1. Overall, I am satisfied with how easy it is to use this system.								
STRONGLY AGREE	1	2	3	4	5	6	7	STRONGLY DISAGREE
COMMENTS:								

**Figure 23** An item included in PSSUQ questionnaire

- 4- Calculating *the Mean value* for each task and the total mean for that CMS after completing the questionnaire by all participants. Later, the same usability test will be repeated for other systems in order to evaluate usability for each CMS such that the smallest mean value for any system indicates that the system offers usability and has an easy learning curve.

## CHAPTER 4

### IMPLEMENTATION AND TESTING

In this chapter, we provide a testing report that clarifies testing the systems against Absolutely Essential and Very Important criteria determined by experts' opinions. The tests have been performed against systems installed on the servers discussed in Chapter 3. We aimed to perform a functional analysis for each system, i.e., whether a criterion is available or a system performs a specific criterion depending on a core feature ("Built-in"), or the system needs to be extended with a third-party extension ("Plug-in") in order to evaluate each system later in Chapter 5.

#### 4.1 Section One: Systems Installation Criteria

This section pertains to the criteria that evaluate a system according to installation complexity.

- 1. Ease of Installation:** While performing the installations of all three-systems as explained in Chapter 3, WordPress showed that, of the three systems under consideration in this study, it had the easiest and fastest installation process. The Joomla installation process was relatively easy in comparison to WordPress and Drupal since the installation process comprised three phases with many technical details including a pre-installation check. The Drupal installation showed more advanced options than the other two systems, which may cause some confusion for non-technical users, especially when the installation process requires the user to select between a standard installation profile and a minimal installation profile.
- 2. Installation Time:** The times required for the complete installation processes were recorded. Table 7 presents the recorded times.

**Table 7** Content Management Systems installation time

<b>CMS Platform</b>	<b>Local host</b>	<b>Live server</b>
WordPress	20 Sec.	10 Sec.
Joomla	43 Sec.	17 Sec.
Drupal	40 Sec.	35 Sec.

- 3. Technical Expertise:** The installation processes for the three systems do not require any technical knowledge. The most difficult part for novice users is how to create a MySQL database and assign a user account to that database to be used later during the systems' installation.

#### **4.2 Section Two: Usability Criteria**

One of the main goals related to this study is to discover usability issues with Administrative Interface of the systems while testing candidate criteria. This section involves criteria that evaluate the systems from a perspective of ease of use as follows:

- 1. Interface Intuitiveness:** WordPress offers more intuitiveness while testing most of our technical criteria because of the drag-and-drop support and because of the simple terminologies. Joomla is similar to WordPress with few differences in terminology. Drupal has a more advanced user interface with more difficult terminologies.
- 2. Friendly URLs:** This is the ability of a system to support a clear and readable Uniform Resource Locator, either for humans or for search engines to deliver to users a brief understanding about a page or post. In WordPress, this criterion is performed as a built-in feature. The system supports permalinks settings which allow the administrator to set permanent URLs of a website's individual pages. There are many structures under the permalinks settings help to have website URLs include useful information such as the dates and titles of posts. The best setting to select is the "Post Name option" which generates URLs that are more readable. Joomla performs this criterion as a built-in feature. A website administrator can navigate to global configuration settings to modify the Search Engine Optimization (SEO) settings panel to enable optimized URLs. In Drupal, this criterion performed as a built-in feature. By default, when creating an article

or page, a user or the administrator can set URL aliases; for example, to create an “About Us” page, the administrator can specify an alternative path that can be accessed. It is possible to add “/about us” to that web page and save the configuration. Moreover, the administrator can perform the same process by navigating to the configuration panel and modify URL aliases under search and metadata to add aliases for content or for a page path. Screenshots can be seen in Appendices (D-1, E-1 and F-1).

- 3. Image Responsiveness:** This is the system’s ability to allow users to resize uploaded images for faster view. WordPress performs this criterion as a built-in feature. The system allows administrators to resize the physical dimensions and file sizes of uploaded images directly without using image processing software. While testing this feature, we uploaded an image with original image dimensions of (1229 wide × 691 high), and a 438 kB file size, and by using configuration supported by WordPress, we set a new scale of (600 wide × 337 high) and a new file size by reducing it to 35 kB. In Joomla, this criterion is not supported, so external software such as Photoshop or an online tool is required to modify images. Drupal can perform this criterion as a built-in feature. By default, the media section involves three image styles, large (480×480), Medium (220×220) and thumbnail (100×100). The administrator can add a new image style by selecting the resize effect and by adding new dimensions to resize the uploaded image when selecting the new image style. Screenshots can be seen in Appendices (D-2 and F-2).
- 4. Undo/Redo Functionality:** This criterion is the ability of the system to allow users to retreat when making mistakes in cases of complex and huge articles. WordPress, Joomla, and Drupal support this criterion as a built-in feature with default editors packaged with each system. Screenshots can be seen in Appendices (D-3, E-2 and F-3).
- 5. Spell Checking:** This criterion allows the automatic checking of plain texts against the digital dictionary to increase content accuracy such that running spell checker guarantees that the number of typing and spelling errors in the content is significantly reduced.

WordPress performs this feature using a plugin called TinyMCE Spellcheck. After installing and activating the plugin, a new button “Proofread writing” appears in the default editor. Joomla performs this feature using a plugin called the ARK editor, after installing and activating the plugin, Joomla will have another editor that includes a spell-checking ability. In Drupal, the default editor called CKEditor does not include spell checking ability, even when searching for available extensions on the official website. Screenshots can be seen in Appendices (D-4 and E-3).

**6. Multilingual Site support:** The Main benefit of having a multilingual website for a business is that a multilingual website is social and mobile. It helps to increase intimacy with online customers because it is the psychology of clients such that they always desire personalization, and if they think that the website cares about their preferences, they are more likely to do business with it. WordPress, Joomla, and Drupal perform this feature by using an extension called “Google Language Translator” which uses Google’s power to translate the entire structure of the website and its content into different languages using a drop-down menu. An administrator must assign a position to have the installed extension appear at the front end in the three systems, which is called a widget or block. Screenshots are shown in Appendices (D-5, E-4, and F-4).

**7. Content Editor:** This is a system application that allows users to create formatted content using special editors such as WYSIWYG editors without technical knowledge of writing HTML code. These kinds of editors have two panels, namely a visual panel and a text panel in order to separate the content from the code such that the visual panel shows only the content created by a user while text panel shows the HTML code. WordPress has a built-in extensible WYSIWYG editor; additional plugins are required to extend its functionality, including spell checkers. Joomla performs this feature using a plugin called *Ark Editor* as the default editor bundled with Joomla is limited in its functionality; therefore, a website administrator needs to download this plugin to extend the functionality of the system. After installing this plugin, the administrator and other authenticated users can switch to the new editor. Drupal performs this criterion as a built-in feature with the default editor called *CK Editor*, which supports two text formats,

namely basic HTML with limited functionality and full HTML with extra functionality. Screenshots can be found in Appendices (D-6, E-5 and F-5).

- 8. Content Scheduling:** This is a system feature that allows users to schedule content automatically for future publications. The main advantage for businesses is to achieve content dispersion by spreading website content through the entire month to keep site visitors engaged at a high level. WordPress performs this criterion as a built-in feature; the administrator can modify and publish panel settings when making a post or a new page. Joomla performs this criterion as a built-in feature; the administrator can set up a “Start and Finish” publishing date for future articles publications. Drupal needs an extension called Scheduler module, and an administrator should configure this module after enabling it by navigating to the structure panel and then to the content type to select one of the content types, such as articles to integrate the new module. After that, when adding an article to the system, a new option appears for setting a future publishing date. Screenshots are found in Appendices (D-7, E-6 and F-6).
- 9. Content Versioning:** This system feature automatically allows the saving of backup copies of content after each update such that it allows comparing revisions and the reversion to previous versions. This process is a part of the systems *workflow*, as explained in Chapter 2. WordPress performs this criterion as a built-in feature such that the system saves revisions automatically in a history revisions panel after each update. Joomla also performs this criterion as a built-in feature. The administrator can select any version of an article from the “Item Version History Panel” from versions in creating an article window. Drupal has built-in complete version control with a reverting ability. Screenshots can be seen in Appendices (D-8, E-7 and F-7).
- 10. Trashed content support:** This system feature allows the recovery of trashed content that has been removed from a website. It makes deleting a post or a webpage accidentally from the system extremely difficult. WordPress performs this criterion as a built-in feature and a user can use the trash button above the editor toolbar such that a user can restore or delete any trashed content permanently. Joomla performs this criterion as a built-in feature, and a website administrator can navigate to the control panel to find all trashed articles from

the recently added articles dashboard. Trashed articles can be recognized from the recycle bin symbol which indicates the ability to restore them if necessary. In Drupal, this feature is not supported. Screenshots can be seen in Appendices (D-9 and E-8).

**11. Compressed Files Upload:** This system ability allows the system administrator to upload compressed media files (ZIP extensions) into the system media library to grant website visitors the ability to download these files. The ZIP file is a data compression file format used to compress a file's original data size into a smaller size to save storage. WordPress performs this criterion as a built-in feature. A website administrator first needs to upload a ZIP file to the system and copy its URL, then he adds a hyperlink and pastes the copied ZIP file URL to a highlighted text. Joomla and Drupal do not support this feature. An error message appears when uploading a ZIP file. Screenshots can be seen in Appendices (D-10, E-9 and F-9).

**12. Themes/Template Wizard:** This system feature allows the modification of themes and templates, such as changing colors, logos and website appearance without dealing with CSS /HTML code. A theme is a graphical design layer that controls graphic elements, fonts, navigation styles, and page layouts [26]. WordPress and Drupal have a built-in wizard providing approximately the same functions for modifying website identity, e.g., changing logos, titles, colors and header images with a live theme preview. Joomla has this feature built into the system. By default, there are two styles (themes) installed, one for the system backend and one for the frontend. The administrator can modify settings for themes by clicking on extension menu and then navigating to the templates.

**13. Metadata/Tags support:** This criterion allows the profiling and indexing of website content. Metadata is data about content, including author name, date of posting, and the category in which a publisher or author organizes that content. Met tags are administrative information or keywords that refer to the content and describe it for visitors. WordPress, Joomla and Drupal perform this criterion as a built-in feature. These systems allow the adding of specific keywords (tags) about content that help to describe a business or a service such that whenever a visitor clicks on a keyword related to specific content, the system aggregates and

shows other related content with the same keyword. Screenshots can be seen in Appendices (D-11, E-10 and F-9).

**14. Remote Access:** By default, the three systems can be accessed remotely. This access grants administrators as well as registered users the ability to publish and manage the systems from a distant location without the need for File Transmission Protocol to perform required website updates.

**15. Learning Curve (L.C):** This criterion reflects users' progress in learning the systems, e.g., a gentle learning curve or steep learning curve. Our usability test results (see Chapter 5 Item 5.3) showed that WordPress offers a gentle learning curve because of its ease of use and friendly administration interface. Joomla, in terms of its learning curve, lies between WordPress and Drupal such that the system offers a moderate learning curve. Drupal is more technically advanced than the other two systems and offers a steep learning curve for new users. The main obstacle that users of Drupal encounter is when learning how to use the system interface.

#### **4.3 Section Three: Technical Requirements Criteria**

This section discusses the criteria pertaining to software and hardware required for CMSs.

- 1. Operating System:** The three Content Management Systems are compatible with Windows, iOS and Linux, so the platform is independent.
- 2. Web Server:** This criterion pertains to the program that processes clients' requests in order to access a webpage by using the Hyper Text Transmission Protocol. The server does some security checks on the client HTTP requests and brings that webpage to the client. Apache is the webserver software most widely used today. It is open source software which is secure, reliable and fast and it can be configured to satisfy the needs of different environments. Most CMS hosting providers use this server as webserver software. Our systems are compatible with the Apache server or any server that supports PHP and the MySQL database.

**Table 8** CMSs supported Webservers

<b>CMS platform</b>	<b>Supported Webservers</b>	<b>Recommended</b>
WordPress <sup>6</sup>	Apache	2.4+
	Nginx	1.8+
Joomla <sup>7</sup> , Drupal <sup>8</sup>	Apache	2.4+
	Nginx	1.8+

**3. Database Management System:** CMSs require having a database engine hosted on a hard drive to store and retrieve content. WordPress version 4.6 supports MySQL 5.6 or Creator, while Joomla version 3.6 and Drupal version 8.2 supports MySQL 5.5.

**4. Physical Hardware:** A CMS consumes many system resources such as RAM and CPU during records indexing, content creation and metadata generation. The table below shows information about the physical hardware required for these systems.

**Table 9** CMSs recommended Hardware

<b>Server CPU</b>	2 GHZ Dual core <sup>9</sup>
<b>RAM</b>	2 GB recommended
<b>Hard Drive</b>	120 GB

#### 4.4 Section Four: Platform Support Criteria

This section discusses the criteria to evaluate CMSs according to the online support perspective.

**1. Community Support:** This criterion involves the forums and documentation behind each CMS. These communities are significant because they help system users to receive proper consultation for solving issues and troubleshooting questions. There are large active communities behind WordPress, Joomla and Drupal. The following table includes URLs of the communities behind each system with total numbers of posts as of 28/04/2017:

<sup>6</sup> WordPress requirements, <https://wordpress.org/about/requirements>

<sup>7</sup> Joomla requirements, [https://docs.joomla.org/Technical\\_requirements](https://docs.joomla.org/Technical_requirements)

<sup>8</sup> Drupal webserver requirements, <https://www.drupal.org/docs/7/system-requirements/web-server>

<sup>9</sup> Drupal system requirements, <https://www.drupal.org/node/1505394>

**Table 10** CMSs online forums support

CMS platform	Community online URL	Total Posts
WordPress forum	<a href="https://wordpress.org/support/forums/">https://wordpress.org/support/forums/</a>	2,573,849
Joomla forum	<a href="https://forum.joomla.org">https://forum.joomla.org</a>	3,123,011
Drupal community	<a href="https://www.drupal.org/forum">https://www.drupal.org/forum</a>	1,284,234

- 2. Application Programming Interface:** APIs are a group of tools that help to make developing a software application easier. Doing this kind of development requires technical knowledge of coding. WordPress allows code editing directly from the administration area for advanced customization. Its API is divided into many sections, e.g., plugin API, theme API and dashboard API. All of these sections are the system's API, which are plugins or themes created.<sup>10</sup> In Joomla, the extension manager allows the administrator to edit master template files in the system. Drupal also is an extensible CMS, and there are many APIs that can help developers to extend the application.<sup>11</sup> Screenshots can be seen in Appendices (D-12 and E-11).
- 3. Manuals/User Guides:** This criterion behind a CMS plays significant role for system's users since it helps them to improve efficiency and productivity and decrease costly errors and procedural mistakes while working on the system. WordPress, Joomla and Drupal have many available online guides. The table below shows URLs for popular system manuals and user guides.

**Table 11** CMSs online manuals and users' guides

WordPress	<a href="https://easywpguide.com/wordpress-manual/">https://easywpguide.com/wordpress-manual/</a>
Joomla	<a href="https://docs.joomla.org">https://docs.joomla.org</a>
Drupal	<a href="https://www.drupal.org/docs/user_guide/en/index.html">https://www.drupal.org/docs/user_guide/en/index.html</a>

- 4. Third-Party support:** This criterion represents available developers that help to support necessary extensions such as plug-ins, themes and modules to extend system functionality. A CMS is a dynamic system [3] such that it can be extended with these extensions to add new features and functions as and when requirements change.

<sup>10</sup> WordPress APIs, [https://codex.wordpress.org/WordPress\\_APIs](https://codex.wordpress.org/WordPress_APIs)

<sup>11</sup> Drupal API reference, <https://api.drupal.org/api/drupal>

## 4.5 Section Five: Security Criteria

This section discusses the criteria that evaluate CMSs from a security perspective.

**1. Security Level:** Vulnerabilities and security issues cause the websites of CMSs to suffer three times more than non-CMS websites [33]. While testing security criteria included in this section, Joomla performed most of the criteria as a built-in feature, which makes Joomla a more secure system than other two systems for a number of reasons. First, the extensions are open source and usually less secure than the core features, thus presenting another opportunity for attackers [33]. Second, most CMS websites are hacked according to any extension that is more security critical such that vulnerability in any extension may expose the entire system to attackers [10]. During the test, WordPress supported most of the criteria using more extensions than Joomla, thereby causing this system to receive a second-place ranking. Drupal also supported most of the security criteria using extensions; however, some of the criteria could not be performed even when searching for available extensions. The security levels for each system were determined after testing the following security criteria included in this section. The three systems possess well-crafted essential security while performing security criteria such that Joomla performs at a high security level according to its core features, while WordPress and Drupal perform a moderate level.

**2. CAPTCHA support:** The word CAPTCHA is an acronym for Completely Automated Public Test to tell Computers and Humans Apart. This feature helps CMS websites to provide the required protection from abuse and spam. For example, it prevents spam emails or spam comments and ensures that a human is filling in forms, such as registration forms, and not computer software written to submit the form multiple times because humans have the ability to recognize CAPTCHA images. WordPress performs this criterion using a plugin called “WP-re CAPTCHA.” This plugin requires a public key and a private key supported by Google. The plugin makes a visitor check the “re CAPTCHA” box in order to register or submit a comment. Joomla performs this criterion as a built-in feature. The administrator can search for the “Captcha-reCaptcha” core plugin which requires site key and secret key supported by Google. This feature can be used with a new account registration module on the frontend. Drupal needs an

extension called the CAPTCHA module. The administrator can navigate to the configuration panel to modify its settings. The module involves two challenges, these being math and image recognition, which can be integrated into a user registration form. Screenshots can be seen in Appendices (D-13, E-12 and F-10).

**3. Secure Sockets Layer Certificate support:** SSL is a technology for data encryption that supports encrypted connections between a visitor's web browser and a web server in order to allow private information. A standard website URL without SSL is displayed as (http://). On the other hand, a secured website with an SSL certificate can be recognized as (https://). WordPress performs this feature using a plugin called "Really simple SSL" to make the system compatible with the SSL certificate. It requires an SSL certificate to be installed on the webserver to make all the secure connections with the webserver. Joomla performs this criterion as a built-in feature. The system allows the activation of a secure connection for a specific webpage. There is an option under the metadata panel which belongs to each webpage which can enable a secure connection (On or Off) and it requires an SSL certificate installed on the webserver. Drupal does not have built-in configuration to operate SSL. Even until now, there has been no module available for the system. This feature requires webserver configuration by technical users<sup>12</sup> to enable the certificate. Hosting providers can help to set up these certificates for a fee. Screenshots can be seen in Appendices (D-14 and E-13).

**4. Log History:** This is a system's ability to keep track of users and their activities on multi-author websites. Activities recorded may include log in, log out, posting comments and creating new content activities, with the possibility to show visitors' IP addresses. WordPress performs this criterion as a built-in feature. The system provides an administration dashboard giving a summary about recent activities about published posts, recent comments, user names, and their IP addresses. Joomla performs this criterion as a built-in feature. The administrator has the ability to see logged in users, recently added articles and the identities of those who published them. This information is found in the main control panel. Drupal performs this criterion as a built-in feature using a core login module

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<sup>12</sup> Enabling HTTP secure (HTTPS), <https://www.drupal.org/https-information>

which helps to record system events, user events, content events and contact events onto the Drupal database. The administrator can navigate to the reports panel and click on recent log messages. Screenshots can be seen in Appendices (D-15, E-14 and F-11).

**5. Authorized Access Control:** This is the ability of the system that enables the control of access rights and permissions that each user has to a particular system object such as a file directory, to specific content or to an individual file. CMSs support different levels of user roles to assign access rights to control users' activities such as what users can do. This feature helps to organize workflow tasks, e.g., content creation, content update, and content publishing. WordPress performs this criterion as a built-in feature and the system supports five user roles that can be assigned for a registered user. These roles are Administrator, Editor, Author, Contributor, and Subscriber roles. The Administrator role has full privileges over other user roles. Joomla has a built-in Access Control List (ACL) that allows the creation of new user groups and assigning user rights to it. Its mechanism means certain groups have specific access level features related to creating, editing and publishing content. Each user group has its own different levels of access and a new user for a group directly inherits the rights of that user group. The main access levels under a user group are:

1. *Manager:* including administrators' roles.
2. *Registered:* including three roles: *author*, *editor* and *publisher* for submitting, editing and publishing content.
3. *Super users:* including users with full access privileges; this type of role can be edited by another super user account.

Drupal performs this criterion as a built-in feature. The system offers the ability to create new roles and control what people can access and what they can do. By default, the system has three types of users:

1. *Administrator:* this role has full privileges over the system.
2. *Authenticated:* this role is for logged in users, which by default has limited permissions, such as posting comments, viewing comments, viewing published content and searching for content.
3. *Anonymous:* this role is for non-logged in users.

Drupal gives the administrator the ability to create a new role such as an Editor role, and then this new role can be assigned to a set of permissions according to the administrator's needs. Screenshots can be seen in Appendices (D-16, E-15 and F-12).

- 6. Email Verification:** This is the system's ability to verify users' valid emails. An email is a tool that supports communication with individual website customers. Email verification is an important factor for maintaining trusted business because when this feature is not supported, there is the possibility of fraud operations by using email. WordPress and Joomla support this criterion as a built-in feature. The systems perform email verification when a new user attempts to submit an email to register an account to the website such that these systems send a message to that email to complete registration of the newly created account by default. This feature helps to guarantee that the email is valid and belongs to that user. Screenshots in Appendices (D-17 and E-16) show an email message received by a user after registering to the WordPress and Joomla websites. Drupal also performs this criterion as a built-in feature. The system supports an option available with a new user registration form that makes the system require email verification. A new registered user pends for administrator approval, and when the administrator activates the new account, the system sends an email to the new user account email. A screenshot can be seen in Appendix (F-13).
- 7. Systems Update:** Updating the system regularly improves system security in addition to extending system functionality. When a CMS behind a website is out of date, there will be security vulnerability because a CMS source code is available for anyone to study; however, this also means that hackers have the ability to analyze and find weaknesses. WordPress, Joomla and Drupal support frequent updates according to planned versions, and by default, the three systems show a notification message on the administrator dashboard when a new update becomes available.
- 8. Backup and Restore:** This feature helps to keep a safe copy of physical files and databases on a save site for preservation. A CMS must be able to restore the website's database and files in case of a server shutdown, as well as for the troubleshooting of extensions, equipment failure and other catastrophes such as

malicious hacking or user error. In WordPress, this feature is performed by using a plugin called “Updraft Plus back up”. The plugin settings allow the administrator to back up a copy of database and website files. The administrator has the ability to set backup times such as on a daily or weekly basis. Joomla performs this criterion by using an extension called “Akeeba,” which is the most widely used open source backup plugin. After installing the plugin, a new menu item appearing under the components menu leads to the plugin settings. The plugin produces a backup copy to be downloaded onto the computer for later retrieval. Drupal performs this feature with an extension called “Backup and migrate” module. A new option appears under the configuration menu after installing the module. The module settings allow backing up the database and other website files into the computer such that the module supports scheduled backups. Screenshots can be seen in Appendices (D-18, E-17, and F-14).

#### **4.6 Section Six: Ease of Extension and Customization Criteria**

This section discusses the criteria to evaluate CMSs according to their core features and available extensions, as in the following:

- 1. Contact Forms:** This is the system’s ability to allow a website to have a “Contact Form” to be completed by visitors when there is a need to send the website owner an email as well as when a website owner needs to accumulate information about website customers. There are many reasons behind supporting a contact form for a website with a CMS, such as to have website customers and visitors to provide specific details including contact telephone numbers. In addition, contact forms are considered to be more mobile friendly and are convenient for customers because they decrease the burden of opening email accounts. WordPress performs this criterion by using a plugin called “Fast secure contact form.” The plugin provides the administrator with the ability to add an email address into the “Email To” text box so that the website can receive customers’ and visitors’ emails. Moreover, the plugin allows for the use of a CAPTCHA feature by configuring the security settings. In Joomla, a basic single contact form can be created by using the core contact form component. The contact form in Joomla requires a category first to categories contacts for a website; later the administrator is

required to create a new contact by clicking on “New option” under Contact Manager to support the basic information. For example:

- The name of the person that users are going to contact and the email of the contacted person and some other information.
- A linked user to connect the Contact Form into an existing user account, such as a super user.

Drupal performs this criterion as a built-in feature by using a core “Contact”, module. The configuring of this module requires an email address that will receive users’ messages. The administrator needs to assign a menu item for the contact form to appear on the front end. By default, the form has two fields, which are the subject and the message. Screenshots can be seen in Appendices (D-19, E-18, and F-15).

**2. Search Engine Optimization (SEO):** This feature refers to a number of SEO standards that website administrators should take in order to achieve higher page rankings with search engine results; in other words, SEO helps to increase website traffic. For example, the website Home Title (Site Meta description) can be made less than 57 characters and the website Home Description (Site Meta keywords) made no more than 160 characters as an SEO standard. WordPress performs this criterion using a plugin called “All in one SEO pack,” which allows the administrator to meet SEO standards when setting the home title, description and keywords relevant to the blog niche. Joomla performs this criterion as a built-in feature as it allows the insertion of a Home Title (Site Meta description) and a website home description (Site Meta keywords). The Meta description is an optional text used to describe the page in the HTML output which is displayed in search engine results. Drupal requires a module called “SEO Checklist,” which divides SEO tasks into functional requirements such as title, content and paths. A new option appears under the configuration menu, which is the SEO checklist. The module performs SEO in a form of sequence tasks. Additionally, the module leads the administrator to all necessary modules that help to satisfy SEO standards. Screenshots can be seen in Appendices (D-20, E-19, and F-16).

- 3. Help File:** A CMS must have an integrated help file with the system to explain the abilities of the system. WordPress comes with a built-in help file. It provides a brief explanation and leads users to the online documentation for further help. Joomla performs this criterion as a built-in feature, and with each panel inside the system, there is help documentation that explains the current window with a brief description and with quick tips. Drupal also has a built-in help file which provides relatively adequate overviews for the system's installed modules using help reference pages which are a starting point for online documentation. (Screenshots can be found in Appendices (D-21, E-20, and F-17).)
- 4. Media Management:** This system ability allows users to import, manage and organize all aspects of media files and organize them into the media library to be used later. WordPress has a built-in media manager that allows users to organize media files and perform fast searches inside the media library using the media filter and the date filter. Joomla is similar to WordPress such that the system has a built-in content media manager that includes the necessary tools for uploading and deleting media files as well as creating directories for media files inside the media library. It supports thumbnail views and detailed views to allow users to discover file sizes and dimensions. Drupal needs an extension called the "Media entity" module in order for the system to have a media library. This module requires creating a view to make the media tab appear. The administrator can use filter lists to search for a media file according to the file name or publishing status. Screenshots can be seen in Appendices (D-22, E-21, and F-18).
- 5. Content Management:** This is the ability of the system that allows the management of website content, e.g., content creation, content update, content publication, content destruction, and filtering website content using available filter lists. WordPress performs this criterion as a built-in feature. A user can create posts, webpages, and scheduling content for future publication. In addition, the system allows users to choose whether the content is secured with a password or public. WordPress supports two types of content, either a post or a web page. The content manager allows the administrator to filter posts according to their category as well as the editing or trashing of listed posts. Joomla performs this criterion as a built-in feature, wherein the system allows the administrator to create, edit and

publish articles. The system allows the selection of a category for an article and assigns a permission to that article to make it either private for registered users or public. Additionally, the administrator can use filter lists to search for articles according to status, language or by category. Drupal performs this criterion as a built-in feature in which the system supports two kinds of content, namely articles and basic page. Articles are information that is updated regularly such as blog posts, and the basic page used for static content which is rarely changed such as creating “About us” page. Moreover, the system allows the creation of custom content types specifically for website administrators to help them to create content according to their requirements. The content manager lists all types of content inside the website and gives the administrator the ability to filter content using filtering lists. Screenshots can be seen in Appendices (D-23, E-22, and F-19).

- 6. Users’ Management:** This criterion is a system feature that allows the registration and management of user accounts. A CMS must allow the administrator to edit user accounts, including operations such as creating, deleting, activating and blocking accounts as well as changing names and assigning user roles. WordPress performs this criterion as a built-in feature. The system allows all aforementioned operations including each user being allowed to edit his profile. A very important feature offered by the system is when the administrator deletes a user account; the administrator is able to assign all the posts of the deleted account to another user account. The user manager lists all user accounts and their roles and posts. Joomla performs this criterion as a built-in feature. A user manager determines to which permission group a user account belongs. The user manager shows the accounts of activated users as well as their emails, registration dates and IDs. Drupal also performs this criterion as a built-in feature. The system allows the creation and management of user accounts as well as the configuration of user roles. The “People” page is the manager of users in the system. The page allows the adding of new accounts, new roles and the setting of permissions. All registered user accounts are listed with statuses as either “Activated” or “Blocked” and the roles to which they are assigned. The administrator can use filtering lists to search for a user account according to status or role. Screenshots can be seen in Appendices (D-24, E-23, and F-20).

**7. Inline Editing support:** This feature is the system’s ability to edit content directly from the front end to provide more flexibility and customization for users. WordPress does not have this feature while Joomla and Drupal support this criterion as a core feature. The system allows registered accounts to edit any content directly from the front end such that the system’s Content Editor appears directly on the frontend side when authenticated users use the “Quick Editing” option (at the front end). Screenshots can be seen in Appendices (E-24 and F-21).

**8. Charts and Graphs support:** This criterion refers to the ability of the system to allow the creation of graphs and bar charts to represent statistical data for publication on websites. For example, a bar chart may visualize comparisons between the values of the most common categories and groups with horizontal and vertical axes to represent quantities or numerical scales. WordPress performs this feature using a plugin called “WordPress charts and graphs lite”. The plugin requires a file in CSV format including lines of data recorded in order to embed charts into the posts. Moreover, the plugin adds a visualizer library containing different types of charts. The system has even succeeded to in drawing a bar chart that represents populations for a number of cities. Joomla performs this feature using a plugin called “Aimy Charts.”<sup>13</sup> This extension requires:

- Opening and closing tags through the Joomla Editor.
- Data record fields such as an  $x$ -axis to represent block names, entity names, and a  $y$ -axis to represent the numeric values. Data fields are separated by “;”. In addition, there is hexadecimal notation for color.

As an example, we supported the above requirements as an article using Joomla Editor and the system succeeded in drawing a chart that represents a comparison of students’ success averages. Drupal does not support this feature. Screenshots can be seen in Appendices (D-25 and E-25).

**9. Editor Configuration:** This is the ability of the system to allow the website administrator to configure the system editor by adding or removing function buttons; e.g., undo, redo, copy and paste. With this feature, the administrator has more control over authenticated user roles, such as the author role to limit their

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<sup>13</sup> Joomla charts, <http://www.aimy-extensions.com/joomla/charts.html>

editor functionality when creating articles and posts. WordPress and Joomla do not support this criterion. System administrators do not have the ability to limit the functionality of the editors for registered users. Drupal performs this feature as a built-in feature. The editor includes two text formats, which are basic HTML and full HTML. The administrator can customize the basic HTML text format by determining its functions and assigning this format to Editors or to the Publishers' roles. Furthermore, the administrator can configure the second format with full functions such as adding copy, paste, alignment and all other necessary formatting tools, and then assigning this format to the administrator's role. A screenshot can be seen in Appendix (F-22).

**10. Mobile Friendly:** This is the ability of the system to support mobile responsive websites. A regular website must be a resizable to be displayed on different devices such that every part of the website's frontend must be viewable. Many reasons make this criterion significant. First, it is a customer need as desktop and laptop usage has decreased in the wake of increased smartphone use. Second, Google has started delisting websites that are not mobile friendly as they prefer not to display these unresponsive websites as a legitimate search result. Generally, dynamic websites that are created with CMSs support mobile responsiveness. WordPress, Joomla and Drupal support this criterion as a built-in feature using the default themes in each system. As evidence to attest to this, the domains of websites are tested using a mobile friendly test supported by Google.<sup>14</sup> This test fetches every webpage inside each website to check for responsiveness. The results for the three systems were positive. Screenshots for the test can be seen in Appendices (D-26, E-26, and F-23).

**11. Mobile Administration:** This feature is related to the previous criterion (Mobile friendly). The difference is that this criterion evaluates the system back end's (the Administration layer) responsiveness, i.e., it is a system feature that allows administrators to manage the system from a smart phone or a tablet. WordPress, Joomla and Drupal support this criterion as a built-in feature. System administrators can log in to the administration layer using different devices to

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<sup>14</sup> Google mobile friendly test, available on <https://search.google.com/search-console/mobile-friendly>

manage the systems. The three systems support default responsive backend themes.

#### **4.7 Section Seven: Collaboration and Interactivity Criteria**

This section presents criteria that evaluate CMSs according to user collaboration, social media and Web 2.0 features, as follows:

- 1. Facebook Integration:** This is the ability of the system to integrate with the Facebook platform. Integrating social media such as Facebook with a website to be used as a marketing tool can help businesses to grow their brands and profits. WordPress can integrate with the Facebook platform and other social media using an extension called the “Social Media widget” plugin. The administrator needs to support a URL for a specific Facebook page in the Social Media Networking field inside the plugin settings. The result is a new widget appearing on the frontend that transfers users to that page on Facebook. Joomla can integrate with the Facebook platform using an extension called the “Awesome social links” module. This extension has many features, and after installing and enabling the module, the administrator can integrate a Facebook account by providing the required URLs. The result will be a slider that appears on the frontend. Drupal also performs this criterion using an extension called the “Share this” module. The administrator needs to activate the module via the configuration menu and configure the module settings to integrate the Facebook platform. Screenshots can be seen in Appendices (D-27, E-27, and F-24).
- 2. YouTube Integration:** This criterion pertains to the ability of the system to integrate with the YouTube platform. The YouTube platform helps businesses’ websites to increase traffic by embedding advertising videos about products, brands and services. WordPress, Joomla and Drupal can integrate with YouTube videos directly by inserting the embedded code for a specific video into the source code using a “WYSIWYG” editor or the “CK Editor” of the systems without any third-party-extension. As a result, the post or webpage displays that YouTube video directly on the frontend. Screenshots can be seen in Appendices (D-28, E-28, and F-25).

**3. Real Simple Syndication Feeds:** This is the ability of the system to share website content and make it available via an RSS feed to notify website visitors about the latest posts. This feature helps the administrator to distribute a list of headlines about new content with website interests. It allows visitors to be informed by receiving the latest posts and articles from the website in which they are interested when they subscribe to the website's RSS feed. WordPress performs this criterion as a built-in feature and the system generates an RSS feed automatically. In order to extract this feed and make it readable by an RSS reader, Google Feed Burner was used to extract the feed address of the WordPress website. Feed Burner is a web feed management provider used to extract RSS feeds generated by a website.<sup>15</sup> Later, the extracted feed can be displayed on the frontend by entering the feed URL into the "Social Media widget" so that visitors may subscribe. Joomla performs this feature using a built-in module called "Syndications feeds." The module creates a syndication feed for the page in which the module is activated. Moreover, the same feed burner was used to extract the feed and share it with website visitors by designing new web pages or by entering the feed URL into a new menu item to make it available on the frontend. Drupal performs this feature as a built-in feature with which the system generates an RSS feed automatically. Moreover, the same feed burner was used to extract the feed URL. Later, the administrator can design an individual page or block that includes the extracted feed to make it available for visitors who wish to subscribe. Screenshots can be seen in Appendices (D-29, E-29, and F-26).

**4. Web Push Notifications support:** This is a system feature that allows website administrators to push notifications, such as text messages, to website visitors. This feature is considered an additional marketing tool that helps to increase business and sales by increasing traffic to a website. WordPress performs this feature using an extension called the "Push notification for WordPress" plugin. The plugin supports Chrome, Firefox and Safari browsers and gives the system a notification library. After installing the plugin, the administrator can navigate to a new option under the system setting called "PushAssist" to send notifications. The plugin succeeds in making WordPress site viewing an invitation message for site

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<sup>15</sup> Feed burner, <https://google.oit.ncsu.edu/consumer/google-feedburner/>

visitors and it asks them to accept future notifications when new posts and articles are published (Figure 24).



**Figure 24** WordPress push notification invitation

When website visitors accept the above message, a new notification will be received even when visitors are not browsing the website. Joomla can push notifications to visitors using an extension called the “PushCrew” plugin. The administrator needs to register an account on the PushCrew.com<sup>16</sup> website. This website provides integration code that the administrator has to place into the home page HTML code via the Joomla editor. After installing the plugin, the Joomla site views an invitation message for site visitors and asks them to accept future notifications, similarly to the WordPress website. The administrator can log in to a registered account with “PushCrew.com” and push a notification from the interface supported by this website by completing the required fields such as title and message. Furthermore, the administrator can set scheduling for a notification when required. Drupal version 8.2 does not support this feature, but there are many modules available at the official extension center on Drupal.org, including the “Roost” module, which allows pushing notifications. All of the current available modules are compatible with older versions of the system. Screenshots can be seen in Appendices (D-30 and E-30).

- 5. Posting Comments support:** This is the system’s ability to allow users to submit opinions and post comments about website content. WordPress performs this criterion as a built-in feature. The system allows the administrator to configure comment settings through a discussion window; e.g., the administrator can allow only logged users to post comments. Joomla needs an extension, called the “Disqus comments” plugin, to perform this feature. This plugin is considered a

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<sup>16</sup> Joomla Push Notification registering accounts, <https://pushcrew.com/>

tool for web discussions and it helps to make comments more interactive such that it allows registered users to post comments on articles. Drupal allows user comments using a built-in module called “Comment.” This module can be activated for a specific content type usually by adding a comment field. By default, only authenticated users have the ability to post or view comments in Drupal; e.g., for users with “Skip comment approval permission,” their comments are published directly, while anonymous users’ comments are collected in an unapproved comments queue until given administrator approval. Screenshots can be seen in Appendices (D-31, E-31, and F-27).

#### **4.8 Section Eight: Performance and Functionality Criteria**

This section involves criteria that evaluate CMSs from caching functionality and other performance factors as follows:

- 1. Page Caching:** This feature allows the caching of website pages in order to pass database queries when requesting cached pages. Page caching improves website page load time, which is a critical factor that can affect customer experience with websites. WordPress page caching can be performed by using an extension called the “WP Super Cache” plugin. After installing the plugin, the system administrator can enable “Caching On” through the plugin settings. Joomla supports page caching by using a built-in “System-Page Cache” feature. The caching system offers users a stored view of website pages such that these pages no longer need to be pulled from the database every time a user views the page. The plugin is turned off by default and once enabled, it allows cached copies of any redundant pages, such as when the next request of the cached pages are displayed by passing database queries. Similarly, to Joomla, Drupal performs this criterion with a built-in module called “Internal Page Cache.” By default, the module is enabled and no configuration is required. Screenshots are attached in Appendices (D-32, E-32, and F-28).
- 2. Dynamic Page Caching:** This system feature allows the caching of pages for users logged into the website by storing pages the first time when requested and then reusing them later. WordPress and Joomla do not support this feature, while Drupal performs this feature for logged-in users by using a built-in “Dynamic

Page Cache” module. The module improves performance by speeding up website pages such that it handles dynamic content, such as posts and blogs, and makes later requests served by those cached pages. The module is enabled by default and it does not require any configuration by the system administrator. A screenshot for the module is attached in Appendix (F-29).

- 3. Import and Export Content:** This criterion refers to the system’s ability allowing the transfer of content from one website to another site on the same system. WordPress performs this criterion as a built-in feature. The system has two options available, namely “import” and “export,” which allow the administrator to import posts and categories as XML files. Joomla requires an extension called the “J2XML” plugin to perform this function. After installing and enabling the plugin, a new option “Button” appears in the Content Manager called “Export,” which allows the administrator to export Joomla articles as an XML file. In addition, the plugin allows importing XML files through the Control Panel by browsing the required file. Drupal does not have the ability to import and export content individually as does Joomla or WordPress; however, in order to migrate an entire website under the same environment, the administrator can use the “Backup and migrate” module explained previously. Screenshots attached in Appendices (D-33 and E-33).
- 4. Content Check-Out:** This system feature prevents two users from simultaneously editing the same content file in order to prevent the loss of data when saving. WordPress and Drupal do not support this feature. Joomla supports this criterion as a built-in feature. The system shows a padlock symbol next to some articles; this occurs when a user is editing an article because the system changes the status to “Check-Out” status, which means the file is locked and only the user who has opened it can make changes. This prevents two registered users from simultaneous editing. The administrator has the ability to remove the padlock symbols by clicking on “Global Check-in” from the System Menu to recall all “Check-Out” statuses. A screenshot can be seen in Appendix (E-34).
- 5. Tracking Statistics:** This system ability allows websites created by CMSs to be integrated with an analytic tool to track all traffic and every visitor coming to the website. Generally, Google Analytics considered to be a valuable tracking tool

that monitors the efficiency of businesses' online presence. It helps to measure online traffic in order to make any evaluations that are necessary to improve online campaigns. This tool supports statistics about the number of website visitors, number of sessions, as well as efficient reporting tools.<sup>17</sup> To integrate the systems with this tool, systems administrators are required to register an account with Google Analytics and feed the websites' Domains Names during the account registration process to acquire a unique tracking ID number for each of the submitted domains. WordPress, Joomla and Drupal succeeded integrating with this tool during our tests. WordPress uses an extension called the "Google analytics dashboard" plugin. The administrator needs to feed the tracking ID into the plugin settings. Later, the website becomes tracked by the Google analytics tool, and all statistical data can be viewed by logging into the Google Analytics account. Similarly, Joomla and Drupal systems are integrated with this tool using an extension called the "Google analytics" plugin. The websites became tracked after inserting the tracking ID supported by Google for the domain of each website. Moreover, the results can be viewed by logging into the Google account. Screenshots can be seen in Appendices (D-34, E-35, and F-30).

- 6. Maintenance Mode:** This criterion is a feature of the system that allows websites administrators to set a website status to Offline during an update or while making mass modifications, such as the administrator having an option to insert a clarifying message to be displayed at the frontend. WordPress performs this feature using an extension called the "WP Maintenance Mode" plugin. The plugin settings allow administrators to insert these kinds of messages. Joomla performs this criterion as a built-in feature; the administrator can enable an option called "Site offline" to view a custom message at the frontend. Similarly, to Joomla, Drupal performs this criterion as a built-in feature, wherein the system supports Maintenance Mode through the Configuration Panel. This mode is beneficial when modifying themes or making backups of websites. Screenshots are attached in Appendices (D-35, E-36, and F-31).

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<sup>17</sup> Google analytics Features, available on <https://www.google.com/analytics/analytics/features/>

#### 4.9 Section Nine: Other related Statistical Information

This section comprises the necessary criteria to clarify the popularity of a system.

- 1. CMSs' Market Share:** Businesses investors consider this criterion and they monitor its increase and decrease because this criterion can be a sign of competition among systems, which is an important factor in decision making for a system. According to World Wide Web Technology surveys, the market share for WordPress sees this system with a first-place ranking at 58%, followed by Joomla with 7.2% and finally Drupal with a 4.7% market share.
- 2. Software License:** WordPress, Joomla and Drupal are distributed under the General Public License (GPL), which refers to the software its source code being allowed to be copied, distributed and modified [2].
- 3. Original Cost:** As the three CMSs are open source, they are free to download from the official websites in their latest versions. Users may need to pay only for premium extensions according to their needs.
- 4. CMSs' Usage Statistics:** This criterion is the number of websites that use a specific CMS as of the current year of 2017. According to Builtwith.com,<sup>18</sup> which supports usage analytics for the Internet using technology tracking to discover technologies behind websites, we can find the approximate number of websites for each system. The following statistical data are accumulated by using a browser add-on called "BuiltWith," which detects CMSs behind websites. The findings show that WordPress is used by 18,308,117 websites, Joomla by 2,166,689 and Drupal by 701,774 websites. A screenshot can be seen in Appendix (D-36).
- 5. Total Number of the Official Extensions:** This criterion is the number of Available Official Extensions (plugins/modules) behind each CMS written and published by third-party developers as of the current year 2017. WordPress is supported by 49,634 extensions,<sup>19</sup> while Joomla is supported by 7,860.<sup>20</sup> Drupal is supported by 37,177 extensions.<sup>21</sup> These numbers grow continuously because of the active communities behind each CMS.

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<sup>18</sup> Websites Using Open Source Technologies, <https://trends.builtwith.com/cms/open-source>

<sup>19</sup> WordPress Plugins, <https://wordpress.org/plugins/>

<sup>20</sup> Joomla Extensions, <https://extensions.joomla.org/>

<sup>21</sup> Drupal Download & Extend, [https://www.drupal.org/project/project\\_module](https://www.drupal.org/project/project_module)

## CHAPTER 5

### RESULTS

In this chapter, the results of the assessment of the systems and their respective grading are presented based on the technical criteria which represent the systems' components that can be recognized as "built-in" or as an "extension." In addition, usability test results are presented at the end of this chapter.

#### 5.1 Testing Content Management Systems Results

Taken from comparing against the system criteria reported in Chapter 4, the tables below include summary results for each system. The criteria for the technical components of the systems will be evaluated as:

- 1- **Built-in:** If the system performs a criterion as a core feature.
- 2- **Extension:** If the system needs to be extended by a third-party extension such as a "*Plug-in*" or a "*Module*" to perform a criterion.
- 3- **Not supported:** If the system does not perform the criterion as 1 or 2 above.

In all of the following tables, "V.I." refers to the Very Important and "A.E." refers to the Absolutely Essential. The results of the Systems Installation criteria are presented in Table 12. Three criteria are included and all are the heuristic type. We can see that WordPress has the easiest and fastest installation process.

**Table 12** Systems installation criteria results

Section (1) Systems Installation Criteria					
	Criterion	Importance	WordPress	Joomla	Drupal
1	Ease of Installation	V.I.	Easy Installation	Relatively Easy	Relatively Easy
2	Installation Time	V.I.	Local host <b>20 Sec.</b> Live server <b>10 Sec.</b>	Local host <b>43 Sec.</b> Live server <b>17 Sec.</b>	Local host <b>40 Sec.</b> Live server <b>35 Sec.</b>
3	Technical Expertise	V.I.	Not required	Not required	Not required

The results of the Usability Section criteria are presented in Table 13. Fifteen criteria are included, two of which are heuristic: “Interface Intuitiveness” and “Learning Curve.” WordPress succeeded in performing all of the criteria in this section, either as core features or by using extensions.

**Table 13** Usability section criteria results

<b>Section (2) Usability Criteria</b>					
	<b>Criterion</b>	<b>Importance</b>	<b>WordPress</b>	<b>Joomla</b>	<b>Drupal</b>
1	Interface Intuitiveness	V.I.	Friendly User Interface	Moderate User Interface	Advanced User Interface
2	Friendly URLs <sup>22</sup>	V.I.	Built-in	Built-in	Built-in
3	Image Responsiveness	V.I.	Built-in	Not supported	Built-in
4	Undo/Redo Functionality	A.E.	Built-in	Built-in	Built-in
5	Spell Checking	V.I.	Extension	Extension	Extension
6	Multilingual Site support	V.I.	Extension	Extension	Extension
7	Content Editor	V.I.	Built-in	Extension	Built-in
8	Content Scheduling	V.I.	Built-in	Built-in	Extension
9	Content Versioning	V.I.	Built-in	Built-in	Built-in
10	Trashed Content support	V.I.	Built-in	Built-in	Not supported
11	Compressed File Upload	V.I.	Built-in	Not supported	Not supported
12	Themes / Template wizard	V.I.	Built-in	Built-in	Built-in
13	Metadata / Tags support	V.I.	Built-in	Built-in	Built-in
14	Remote Access	V.I.	Built-in	Built-in	Built-in
15	Learning Curve L.C.	V.I.	Gentle L.C.	Moderate L.C.	Steep L.C.

<sup>22</sup> URLs: Uniform Resource Locators

Table 14 presents the Technical requirements criteria. Four criteria are included representing the recommended hardware and software. All of the criteria in this section are the heuristic type.

**Table 14** Technical requirements criteria results

<b>Section (3) Technical Requirements Criteria</b>					
	<b>Criterion</b>	<b>Importance</b>	<b>WordPress</b>	<b>Joomla</b>	<b>Drupal</b>
1	Operating System	V.I.	Windows, IOS ,Linux	Windows, IOS ,Linux	Windows, IOS ,Linux
2	Web Server	V.I.	Apache, Nginex	Apache, Nginex	Apache, Nginex
3	Database Management System	V.I.	MySQL 5.6	MySQL 3.6	MySQL 5.5
4	Physical Hardware CPU, RAM, Hard Drive	V.I.	2GHZ Dual core CPU, 2GB RAM, 120 GB H.D		

The results of the Platform Support criteria are presented in Table 15. Four criteria are included that represent online support. The table shows that all the systems are supported by an available community and all the criteria in this table are the heuristic type.

**Table 15** Platform support criteria results

<b>Section (4) Platform Support Criteria</b>					
	<b>Criterion</b>	<b>Importance</b>	<b>WordPress</b>	<b>Joomla</b>	<b>Drupal</b>
1	Community support	V.I.	Available	Available	Available
2	Application Programming Interface	V.I.	Available	Available	Available
3	Manuals/User Guides	V.I.	Available	Available	Available
4	Third-Party support	V.I.	Available	Available	Available

Table 16 shows Security criteria results. Eight criteria are included, one of which is a heuristic type, which is “Security Level.” Joomla supports most of the criteria as “Built-in” features.

**Table 16** Security criteria results

<b>Section (5) Security Criteria</b>					
	<b>Criterion</b>	<b>Importance</b>	<b>WordPress</b>	<b>Joomla</b>	<b>Drupal</b>
1	Security Level	A.E.	Moderate	High	Moderate
2	CAPTCHA <sup>23</sup> support	V.I.	Extension	Built-in	Extension
3	Secure Sockets Layer Certificate support	V.I.	Extension	Built-in	Not supported
4	Log History	V.I.	Built-in	Built-in	Built-in
5	Authorized Access Control	A.E.	Built-in	Built-in	Built-in
6	Email Verification	V.I.	Built-in	Built-in	Built-in
7	System Update	A.E.	Built-in	Built-in	Built-in
8	Backup and Restore	A.E.	Extension	Extension	Extension

The Ease of Extension and Customization criteria results are presented in Table 17. The total number of criteria is eleven, all of which are technical criteria of the necessary features that must be supported by a CMS. WordPress needed to be customized with more extensions to perform the included criteria.

**Table 17** Ease of extension and customization criteria results

<b>Section (6) Ease of Extension and Customization Criteria</b>					
	<b>Criterion</b>	<b>Importance</b>	<b>WordPress</b>	<b>Joomla</b>	<b>Drupal</b>
1	Contact Forms	V.I.	Extension	Built-in	Built-in
2	Search Engine Optimization	V.I.	Extension	Built-in	Extension
3	Help File	V.I.	Built-in	Built-in	Built-in
4	Media Management	V.I.	Built-in	Built-in	Extension
5	Content Management	A.E.	Built-in	Built-in	Built-in
6	Users' Management	A.E.	Built-in	Built-in	Built-in
7	Inline Editing support	V.I.	Not supported	Built-in	Built-in
8	Charts and Graphs support	V.I.	Extension	Extension	Not supported
9	Editor Configuration	V.I.	Not supported	Not supported	Built-in
10	Mobile Friendly	A.E.	Built-in	Built-in	Built-in
11	Mobile Administration	V.I.	Built-in	Built-in	Built-in

<sup>23</sup> CAPTCHA: Completely Automated Public Turing test to tell Computers and Humans Apart

Table 18 presents results of the Collaboration and Interactivity criteria section. Five criteria are included, all of which are technical criteria. The table shows that all of the systems support the included criteria except for Drupal, which did not support the fourth criterion.

**Table 18** Collaboration and interactivity criteria results

<b>Section (7) Collaboration and interactivity Criteria</b>					
	<b>Criterion</b>	<b>Importance</b>	<b>WordPress</b>	<b>Joomla</b>	<b>Drupal</b>
1	Facebook Integration	V.I.	Extension	Extension	Extension
2	YouTube Integration	V.I.	Built-in	Built-in	Built-in
3	Real Simple Syndication Feeds	V.I.	Built-in	Built-in	Built-in
4	Web Push Notifications support	V.I.	Extension	Extension	Not supported
5	Posting Comments Support	V.I.	Built-in	Extension	Built-in

Table 19 presents the Performance and Functionality criteria results. Six criteria are included, all of which are technical criteria. Joomla and Drupal succeeded in supporting most of the criteria as a core or by using available extensions.

**Table 19** Performance and functionality criteria results

<b>Section (8) Performance and Functionality Criteria</b>					
	<b>Criterion</b>	<b>Importance</b>	<b>WordPress</b>	<b>Joomla</b>	<b>Drupal</b>
1	Page Caching	V.I.	Extension	Built-in	Built-in
2	Dynamic Page Caching	V.I.	Not supported	Not supported	Built-in
3	Import and Export Content	V.I.	Built-in	Extension	Extension
4	Content Check-Out	A.E.	Not supported	Built-in	Not supported
5	Tracking Statistics	V.I.	Extension	Extension	Extension
6	Maintenance Mode	V.I.	Extension	Built-in	Built-in

The final section, which represents the related statistical information, is presented in Table 20. Five criteria are included, all of which are the heuristic type, showing that WordPress holds the highest statistical values.

**Table 20** Related statistical information

<b>Section (9) Other related Statistical Information</b>					
	<b>Criterion</b>	<b>Importance</b>	<b>WordPress</b>	<b>Joomla</b>	<b>Drupal</b>
1	CMS's Market Share	V.I.	58%	7.2%	4.7%
2	Software License	V.I.	Open source (GPL)	Open source (GPL)	Open source (GPL)
3	Original Cost	A.E.	Free	Free	Free
4	CMSs' Usage Statistics	V.I.	18,308,117	2,166,689	701,774
5	Total Number of the Official Extensions	V.I.	49,634	7,860	37,177

## 5.2 Content Management Systems Assessment and Evaluation

There are two kinds of criteria supported with Tables 12, 13, 14, 15, 16, 17, 18, 19 and 20 in Item 5.1, which are heuristic and technical criteria. The first kind represents the required information that helps decision makers directly understand what a criterion means; e.g., Systems Installation, Technical Requirements, Platform Support and the Statistical criteria. The second kind of criterion is the components of the systems that can be recognized as being "Built-in" or as an "Extension." The technical criteria are evaluated by assigning equivalent grades, as shown in the Table 21:

**Table 21** The equivalent grades of the Technical criteria

<b>Technical Criteria (Systems' Components)</b>	<b>Equivalent Grade</b>	<b>Importance Grades</b>	
Built-in	4 Grades	Absolutely Essential (A.E.)	2 Grades
Extension	2 Grades	Very Important (V.I.)	1 Grade
Not Supported	0		

To illustrate, our methodology to grade the technical criteria that represent the systems' components is done by making a summation of "Equivalent Grades" with "Importance Grades" in order to make each system an aggregate grade for assessment according to the following rules:

1. If a criterion is a Built-in feature and its importance is Absolutely Essential, then its total grade will be equal to six (6) grades.
2. If a criterion is a Built-in feature and its importance is Very Important, then its total grade will be equal to five (5) grades.
3. If a criterion is an Extension and its importance is Absolutely Essential, then its total grade will be equal to four (4) grades.
4. If a criterion is an Extension and its importance is Very Important, then its total grade will be equal to three (3) grades.
5. If a criterion is not supported by a system, then its total grades will be 0.

The above rules have been applied and the results calculated in Tables 22, 23, 24, 25, and 26. Finally, we assessed the systems according to their Total Systems Grades (out of 100) and their averages.

Table 22 below shows Usability Section criteria evaluation. WordPress obtained the highest Total Systems Grades (94 out of 100), while Joomla and Drupal obtained the same Total Systems Grades (76 out of 100).

**Table 22** Usability Section criteria evaluation

	Criterion	Degree of Importance		WordPress 4.6		Joomla 3.6		Drupal 8.2	
		Abbreviation	Importance Grade	Criterion	Grade	Criterion	Grade	Criterion	Grade
1	Friendly URLs	A.E.	2	Built-in	6	Built-in	6	Built-in	6
2	Image Responsiveness	V.I.	1	Built-in	5	Not supported	0	Built-in	5
3	Undo / Redo Functionality	A.E.	2	Built-in	6	Built-in	6	Built-in	6
4	Spell Checking	V.I.	1	Extension	3	Extension	3	Extension	3
5	Multilingual Site support	A.E.	2	Extension	4	Extension	4	Extension	4
6	Content Editor	A.E.	2	Built-in	6	Extension	4	Built-in	6
7	Content Scheduling	V.I.	1	Built-in	5	Built-in	5	Extension	3
8	Content Versioning	V.I.	1	Built-in	5	Built-in	5	Built-in	5
9	Trashed Content support	V.I.	1	Built-in	5	Built-in	5	Not supported	0
10	Compressed File Upload	V.I.	1	Built-in	5	Not supported	0	Not supported	0
11	Themes/Template Wizard	V.I.	1	Built-in	5	Built-in	5	Built-in	5
12	Metadata / Tags support	V.I.	1	Built-in	5	Built-in	5	Built-in	5
13	Remote Access	V.I.	1	Built-in	5	Built-in	5	Built-in	5
<b>Total Systems Grades (Out of 69)</b>					<b>65</b>		<b>53</b>		<b>53</b>
<b>Total Systems Grades (Out of 100)</b>					<b>94</b>		<b>76</b>		<b>76</b>
<b>Averages</b>					<b>5</b>		<b>4.07</b>		<b>4.07</b>

Table 23 below shows Security Section criteria evaluation. Joomla obtained the highest Total Systems Grades among the systems (94 out of 100), followed by WordPress with Total Systems Grades (84 out of 100).

**Table 23** Security Section criteria evaluation

	Criterion	Degree of Importance		WordPress 4.6		Joomla 3.6		Drupal 8.2	
		Abbreviation	Importance Grade	Criterion	Grade	Criterion	Grade	Criterion	Grade
1	CAPTCHA support	V.I.	1	Extension	3	Built-in	5	Extension	3
2	Secure Sockets Layer Certificate support SSL	V.I.	1	Extension	3	Built-in	5	Not supported	0
3	Log History	V.I.	1	Built-in	5	Built-in	5	Built-in	5
4	Authorized Access Control	A.E.	2	Built-in	6	Built-in	6	Built-in	6
5	Email Verification	V.I.	1	Built-in	5	Built-in	5	Built-in	5
6	System Update	A.E.	2	Built-in	6	Built-in	6	Built-in	6
7	Backup and Restore	A.E.	2	Extension	4	Extension	4	Extension	4
<b>Total Systems Grades (Out of 38)</b>					<b>32</b>		<b>36</b>		<b>29</b>
<b>Total Systems Grades (Out of 100)</b>					<b>84</b>		<b>94</b>		<b>76</b>
<b>Averages</b>					<b>4.57</b>		<b>5.14</b>		<b>4.14</b>

Table 24 below shows Ease of Extension and Customization criteria evaluation. Joomla obtained the highest Total Systems Grades with (88 out of 100), followed by Drupal with (85 out of 100).

**Table 24** Ease of Extension and Customization Section criteria evaluation

	Criterion	Degree of Importance		WordPress 4.6		Joomla 3.6		Drupal 8.2	
		Abbreviation	Importance Grade	Criterion	Grade	Criterion	Grade	Criterion	Grade
1	Contact Forms	V.I.	1	Extension	3	Built-in	5	Built-in	5
2	Search Engine Optimization	V.I.	1	Extension	3	Built-in	5	Extension	3
3	Help File	V.I.	1	Built-in	5	Built-in	5	Built-in	5
4	Media Management	V.I.	1	Built-in	5	Built-in	5	Extension	3
5	Content Management	A.E.	2	Built-in	6	Built-in	6	Built-in	6
6	Users' Management	A.E.	2	Built-in	6	Built-in	6	Built-in	6
7	Inline Editing support	V.I.	1	Not supported	0	Built-in	5	Built-in	5
8	Charts and Graphs support	V.I.	1	Extension	3	Extension	3	Not supported	0
9	Editor Configuration	V.I.	1	Not supported	0	Not supported	0	Built-in	5
10	Mobile Friendly	A.E.	2	Built-in	6	Built-in	6	Built-in	6
11	Mobile Administration	V.I.	1	Built-in	5	Built-in	5	Built-in	5
<b>Total Systems Grades (Out of 58)</b>					<b>42</b>		<b>51</b>		<b>49</b>
<b>Total Systems Grades (Out of 100)</b>					<b>72</b>		<b>88</b>		<b>85</b>
<b>Averages</b>					<b>3.81</b>		<b>4.63</b>		<b>4.45</b>

Table 25 below shows Collaboration and Interactivity criteria evaluation. WordPress obtained the highest Total Systems Grades with (84 out of 100) followed by Joomla with Total Systems Grades (76 out of 100).

**Table 25** Collaboration and Interactivity Section criteria evaluation

	Criterion	Degree of Importance		WordPress 4.6		Joomla 3.6		Drupal 8.2	
		Abbreviation	Importance Grade	Criterion	Grade	Criterion	Grade	Criterion	Grade
1	Facebook Integration	V.I.	1	Extension	3	Extension	3	Extension	3
2	YouTube Integration	V.I.	1	Built-in	5	Built-in	5	Built-in	5
3	Real Simple Syndication Feeds RSS	V.I.	1	Built-in	5	Built-in	5	Built-in	5
4	Web Push Notifications support	V.I.	1	Extension	3	Extension	3	Not supported	0
5	Posting Comments support	V.I.	1	Built-in	5	Extension	3	Built-in	5
<b>Total Systems Grades (Out of 25)</b>					<b>21</b>		<b>19</b>		<b>18</b>
<b>Total Systems Grades (Out of 100)</b>					<b>84</b>		<b>76</b>		<b>72</b>
<b>Averages</b>					<b>4.2</b>		<b>3.8</b>		<b>3.6</b>

Table 26 below shows Performance Section criteria evaluation. Joomla obtained the highest Total Systems Grades (71 out of 100) followed by Drupal with (68 out of 100). WordPress obtained the lowest grades as it does not support two of the included criteria.

**Table 26** Performance Section criteria evaluation

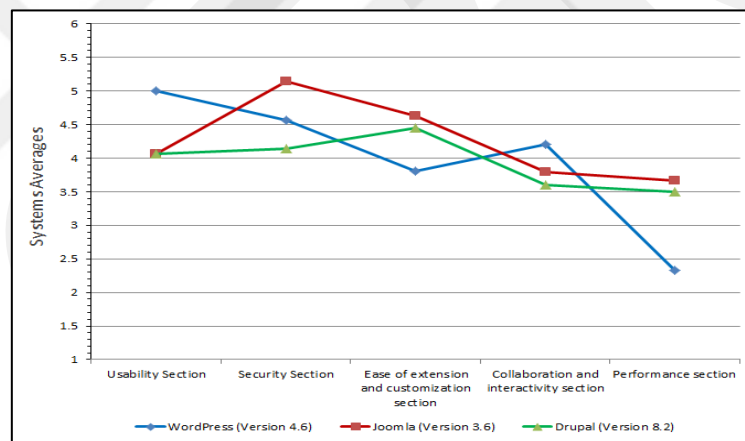
	Criterion	Degree of Importance		WordPress 4.6		Joomla 3.6		Drupal 8.2	
		Abbreviation	Importance Grade	Criterion	Grade	Criterion	Grade	Criterion	Grade
1	Page Caching	V.I.	1	Extension	3	Built-in	5	Built-in	5
2	Dynamic Page Caching	V.I.	1	Not supported	0	Not supported	0	Built-in	5
3	Import and Export Content	V.I.	1	Built-in	5	Extension	3	Extension	3
4	Content Check-Out	A.E.	2	Not supported	0	Built-in	6	Not supported	0
5	Tracking Statistics	V.I.	1	Extension	3	Extension	3	Extension	3
6	Maintenance Mode	V.I.	1	Extension	3	Built-in	5	Built-in	5
<b>Total Systems Grades (Out of 31)</b>					<b>14</b>		<b>22</b>		<b>21</b>
<b>Total Systems Grades (Out of 100)</b>					<b>45</b>		<b>71</b>		<b>68</b>
<b>Averages</b>					<b>2.33</b>		<b>3.66</b>		<b>3.5</b>

The total calculations that summarize Tables 22, 23, 24, 25 and 26 are presented in Table 27 below, which shows the final order of the systems. Joomla produced the highest Total Systems Grades with (181 out of 221 grades) and (82 out of 100), which gives this system a first-place ranking.

**Table 27** Systems total evaluation grades

CMS Platform	Order	System Total Grades	
		(Out of 221)	(Out of 100)
Joomla Version 3.6	1	181	82
WordPress Version 4.6	2	174	79
Drupal Version 8.2	3	170	77

Figure 25 shows the linear comparison among the systems based on technical criteria evaluation averages.



**Figure 25** Linear comparison among CMSs

The reasons for the above methodology to give four grades when a system performs a criterion as a core feature are that the performance of the system as well as its security will not be affected. In other words, when a system does not support a criterion as a built-in feature, the system’s administrator needs to find a suitable extension available online on official repositories which can satisfy project requirements. However, the most important point that website administrators should take into consideration is that these kinds of extensions, whether plugins or modules, will impact and affect the system’s and website’s performance because the

extensions require an additional number of HTTP requests and database queries. Furthermore, there are many security issues relating to faulty extensions. According to [10], there are possible risks when installing and using third-party extensions. These are fraught with many disadvantages and threats, as most extensions are open source and usually less secure than the core features. This offers more weaknesses that attackers can exploit as “most of the vulnerabilities related to these open source systems are due to poorly coded or malicious third-party extensions” [19, p. 46], and “there is no official process for vetting add-ons or themes for security issues beyond community ratings” [26, p. 30].

### 5.3 Usability Test Results

During our usability test sessions, we prepared usability testing checklists in order to document participant task completion and the time required to perform each task. In order to increase the test reliability, we considered six participants according to the usability test methodology, as explained in Chapter 3 (see part 3.1.4).

#### 5.3.1 Usability Participants Checklists

During our testing sessions, we recorded the elapsed time required to accomplish the predefined tasks for all the systems. All usability checklists are presented with Appendix C. We summarized the collected data of the usability checklists in Table 28 below, which represents total time averages for each system. The WordPress sessions took the lowest amount of time, averaging 35.88 minutes, which indicates the simplicity of its interface.

**Table 28** Total time averages of Usability checklists

Checklist No.	CMS Platform		
	WordPress	Joomla	Drupal
1	32.35	39.35	40.50
2	37.10	42.68	46.90
3	36.26	46.11	44.80
4	34.70	36.60	43.60
5	37.10	37.55	45.70
6	37.78	44.80	43.20
<b>Systems Total Time</b>	<b>215.29</b>	<b>247.09</b>	<b>264.70</b>
<b>Systems Total Averages</b>	<b>35.88</b>	<b>41.18</b>	<b>44.11</b>

In addition, we took some notes with the usability checklists in case a participant fails to perform a specific task in order to calculate the Success Rate later. We calculated the Success Rate for all the systems and for each task as follows:

$$\text{Success Rate percentage} = \frac{(\text{Succeeded Participants} \times 100)}{\text{Total Participants Number}}$$

The results are presented in Table 29 below. WordPress obtained the highest average as all of its participants succeeded to accomplish all the predefined tasks.

**Table 29** Systems Usability Success Rates

Task No.	WordPress			Joomla			Drupal		
	Participants Number		Success Rate	Participants Number		Success Rate	Participants Number		Success Rate
	Fail	Success		Fail	Success		Fail	Success	
1	0	6	100%	2	4	66%	0	6	100%
2	0	6	100%	0	6	100%	0	6	100%
3	0	6	100%	0	6	100%	0	6	100%
4	0	6	100%	0	6	100%	0	6	100%
5	0	6	100%	0	6	100%	0	6	100%
6	0	6	100%	0	6	100%	0	6	100%
7	0	6	100%	0	6	100%	0	6	100%
8	0	6	100%	2	4	66%	0	6	100%
9	0	6	100%	0	6	100%	0	6	100%
10	0	6	100%	0	6	100%	4	2	33%
11	0	6	100%	0	6	100%	0	6	100%
12	0	6	100%	0	6	100%	2	4	66%
13	0	6	100%	0	6	100%	0	6	100%
<b>Success Rate Averages</b>			<b>100%</b>			<b>95%</b>			<b>92%</b>

### 5.3.2 Post-Study Systems Usability Questionnaire (PSSUQ) Results

The following tables present the mean values for each task and the total mean for each Content Management System after completion of the questionnaire items by all participants. The PSSUQ Questions are shown in Appendix B. The questions in this questionnaire are of the Likert type where 1 represents the highest level of satisfaction and 7 represents the lowest, as explained in Chapter 3. In Tables 30, 31, and 32, “*P.N*” refers to the “Participant Number”.

## 1. WordPress PSSUQ Calculations:

**Table 30** WordPress PSSUQ calculations

(PSSUQ) Item Number	P.1	P.2	P.3	P.4	P.5	P.6	Mean
1	2	2	3	3	3	1	2.33
2	3	3	2	3	2	2	2.50
3	4	3	3	4	2	3	3.17
4	2	4	3	4	2	2	2.83
5	3	3	4	4	3	3	3.33
6	3	2	3	3	2	2	2.50
7	2	2	3	3	4	2	2.67
8	3	3	4	2	4	4	3.33
9	2	4	4	3	4	4	3.50
10	3	5	4	2	2	3	3.17
11	3	4	4	2	3	2	3.00
12	4	3	3	2	4	3	3.17
13	2	3	3	2	4	2	2.66
14	3	4	4	3	4	2	3.33
15	2	2	5	2	2	2	2.50
16	4	3	3	2	3	3	3.00
17	2	2	3	3	3	2	2.50
18	3	4	4	2	2	3	3.00
19	2	2	3	3	3	2	2.50
<b>Sum</b>							<b>54.99</b>
<b>Mean</b>							<b>2.89</b>

## 2. Joomla PSSUQ Calculations:

**Table 31** Joomla PSSUQ calculations

(PSSUQ) Item Number	P.1	P.2	P.3	P.4	P.5	P.6	Mean
1	3	6	3	4	4	5	4.16
2	4	5	4	4	5	3	4.16
3	2	5	3	4	3	4	3.50
4	4	5	3	6	3	4	4.16
5	3	5	5	6	4	2	4.16
6	2	4	4	5	3	6	4.00
7	3	5	3	6	5	6	4.66
8	3	3	3	6	4	5	4.00

**Table 31 (Cont.) Joomla PSSUQ calculations**

<b>(PSSUQ) Item Number</b>	<b>P.1</b>	<b>P.2</b>	<b>P.3</b>	<b>P.4</b>	<b>P.5</b>	<b>P.6</b>	<b>Mean</b>
9	6	2	5	6	6	7	5.33
10	2	2	4	6	2	6	3.66
11	3	3	3	6	3	6	4.00
12	2	5	3	7	3	6	4.33
13	4	3	3	6	4	5	4.16
14	3	2	3	6	6	3	3.83
15	3	2	3	6	6	6	4.33
16	4	5	3	6	5	4	4.50
17	3	6	4	6	3	6	4.66
18	3	5	3	6	3	5	4.16
19	2	6	3	6	3	5	4.16
<b>Sum</b>							<b>79.92</b>
<b>Mean</b>							<b>4.20</b>

**3. Drupal PSSUQ Calculations:****Table 32 Drupal PSSUQ calculations**

<b>(PSSUQ) Item Number</b>	<b>P.1</b>	<b>P.2</b>	<b>P.3</b>	<b>P.4</b>	<b>P.5</b>	<b>P.6</b>	<b>Mean</b>
1	5	5	6	4	4	4	4.66
2	5	6	4	4	4	6	4.83
3	4	6	5	3	6	4	4.66
4	5	6	6	4	7	6	5.66
5	4	5	5	5	6	5	5.00
6	6	7	6	5	5	5	5.66
7	5	4	5	4	6	7	5.16
8	3	2	7	3	6	6	4.50
9	6	6	6	6	7	7	6.33
10	4	4	5	3	5	4	4.16
11	5	4	5	2	6	3	4.16
12	4	6	6	5	6	6	5.50
13	4	4	6	4	5	5	4.66
14	5	5	5	4	5	4	4.66
15	3	6	6	4	5	4	4.66
16	6	4	5	4	4	6	4.83
17	5	5	5	5	4	7	5.16
18	5	6	6	3	6	6	5.33

**Table 32 (Cont.)** Drupal PSSUQ calculations

<b>(PSSUQ) Item Number</b>	<b>P.1</b>	<b>P.2</b>	<b>P.3</b>	<b>P.4</b>	<b>P.5</b>	<b>P.6</b>	<b>Mean</b>
19	4	5	6	5	5	5	5.00
<b>Sum</b>							<b>94.58</b>
<b>Mean</b>							<b>4.97</b>

Table 33 presents a comparison between the PSSUQ averages. WordPress is the most usable system because of the lowest mean value of 2.89 based on participants' opinion when they completed the questionnaire items. The lowest average indicates a higher degree of satisfaction.

**Table 33** The PSSUQ Means comparison

<b>CMS Platform</b>	<b>PSSUQ Means</b>
WordPress	2.89
Joomla	4.20
Drupal	4.97

## CHAPTER 6

### CONCLUSION

In our study, we presented the comparison results of the most widely used open source Content Management Systems, namely WordPress, Joomla, and Drupal. Our first research question was “*What are the criteria that are important for IT experts to compare open source Content Management Systems?*”. According to our analysis of the survey, the total number of criteria that were important according to the IT experts’ opinions was 61 out of 76 criteria under 9 categories that are mostly taken from the previous studies. The criteria that are found important for IT experts to compare open source CMSs are presented in Chapter 4, and all the candidate criteria that were submitted to the experts are presented in Appendix A.

The second research question was “*Among Joomla, Drupal, and WordPress, which CMS produces the highest evaluation score according to the criteria that are determined by the IT experts?*”. Answering this question requires looking at the individual evaluations results that support the answers to the following sub-questions:

First, “*Among Joomla, Drupal, and WordPress, which CMS offers more usability features?*”. Based on the evaluation of the Usability Section, WordPress succeeded to pass all criteria tests and performed most of this section’s criteria depending on its core features, the system gained the highest Total Systems Grades (94 out of 100) among the systems and average score of 5 (out of 6).

Second, “*Among Joomla, Drupal, and WordPress, which CMS provides more security elements as a built-in feature?*”. Based on the evaluation of the Security Section, Joomla provided most of the included elements depending on its core features shipped with the package. Joomla gained the highest Total Systems Grades among the systems with a score of (94 out of 100) and a security average score of 5.14 (out of 6). This ranks Joomla first among its competitors in this comparison.

Third, “*Among Joomla, Drupal, and WordPress, which CMS requires more customization with third party extensions?*”. Based on the Ease of Extension and Customization Section evaluation, WordPress needs to be customized with more extensions to support the included criteria; moreover, some of the criteria are not supported. Joomla and Drupal did not require to be customized with more third-party extensions in this comparison.

Fourth, “*Among Joomla, Drupal, and WordPress, which CMS supports more collaboration and interactivity features such as social media integration?*”. Based on the evaluation of Collaboration and Interactivity Section, WordPress ranked as the forerunner. WordPress gained the highest Total Systems Grades (84 out of 100) among the systems and average score of 4.2 by supporting all the criteria whether as core features or by using available extensions.

Fifth, “*Among Joomla, Drupal, and WordPress, which CMS offers and supports more performance features?*”. Based on the evaluation of Performance Section, the competition was confined between Joomla and Drupal. The two systems shared the same bundle in terms of Page Caching, Import and Export Content, Maintenance mode and Tracking statistics. However, Joomla outperformed Drupal by providing “Content Check-Out” functionality which prevents simultaneous editing of the same content.

In summary, for the answer to the second research question, Joomla obtained the *highest evaluation score* (82 out of 100) according to the criteria determined by the IT experts due to its core features (see Item 5.2, Table 27).

The final research question was “*Among Joomla, Drupal, and WordPress which CMS has the least installation complexity and the highest level of usability?*”. WordPress has the easiest and fastest installation process as compared to the other two systems because the installation process did not require too many technical details. In addition, of the three systems, WordPress is the easiest to use according to the usability test results. The results of the usability prepared checklists showed that WordPress participants scored a lower average time to perform the pre-defined usability tasks in 35 minutes and a 100-percent success rate. Furthermore, the Post-Study Systems Usability Questionnaire (PSSUQ) results showed that WordPress

scored a lower mean value of 2.89, which correlates with a higher degree of user satisfaction.

In conclusion, we can say that Joomla is a recommended CMS according to the core features. In terms of ease of use, Joomla lies between WordPress and Drupal. Joomla is a combination of the “flexibility” of Drupal and the intuitive “user friendliness” of WordPress, which allows the creation of high-quality websites by non-technical users.

By making a comparison of our results to [4], the authors installed older packages of the systems as well as installing three extensions for each system to test a number of parameters (e.g., Page Load Time). They concluded that WordPress is the best system for a live server according to its least values of page load time. In addition, the authors concluded that Joomla can reduce page load times and perform faster than the other two systems after enabling its caching features. At this point, our results are compatible with them because for future requirements, WordPress needs to be customized with more plugins that reduce site performance, and according to our conclusion, Joomla is bundled with many built-in features. When comparing our results with [6], the authors concluded that “Joomla offers the most flexible system requirements” as the system package is bundled with the necessary features by default and it offers the best management of assets while WordPress provides the least possible management features. Moreover, the systems share the same spot of security. The difference in our study is that we conclude Joomla has the highest security level based on our security criteria evaluation and the three systems share the same spot in terms of Content Management, Media Management, and Users’ Management. Our results are also compatible with [7] as the author concluded that Joomla is the best system as the system is compatible with W3C standards based on their analysis.

There are certain limitations that affect our findings, as follows:

1. There are a number of criteria that were *not supported* by installed versions of CMSs while testing because of incompatible or unavailable extensions.
2. Our study is limited to the survey tools and methodology applied as explained in Chapter 3.

3. The comparison is limited to 61 criteria under 9 categories.
4. The results are limited to 31 participants that include IT experts/specialists from both public and private institutions.
5. Organizational policies and legal issues were not taken into consideration while comparing CMSs.

For future work, and other than what we did,

1. A researcher can search for the final release of the extensions that *are not supported* by CMSs used in this study during the period of preparation of this research.
2. A researcher can use a semi-structured research approach to determine the new comparison criteria and there might be some other criteria that can be considered.
3. Considering more than 31 participants to determine the comparison criteria and more than 6 participants to evaluate the usability of the CMSs might provide more reliable results.
4. More management side work can be done, wherein researchers can consider policy and organizational issues when evaluating these CMSs.

In addition, performing a number of security tests against these CMSs such as XSS scripting and SQLi injections would be worth investigating in order to discover the security weaknesses of the systems as well as performing a number of usability tests by considering more advanced scenario tasks.

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## APPENDIX A

### Candidate Criteria Categorizations

The following tables involve candidate criteria analysis according to its importance based on the survey results.

**Table 1** Systems Installation criteria categorization

Section (1) Systems installation			Importance		
	Criterion	Average	Absolutely Essential (A.E.)	Very Important (V.I.)	Not Important (N.I.)
1	Ease of Installation	3.70		✓	
2	Installation Time	3.06		✓	
3	Technical Expertise	3.64		✓	

**Table 2** Usability criteria categorization

Section (2) Usability			Importance		
	Criterion	Average	Absolutely Essential (A.E.)	Very Important (V.I.)	Not Important (N.I.)
4	Interface Intuitiveness	3.70		✓	
5	Friendly URLs	3.87		✓	
6	Image Responsiveness	3.41		✓	
7	Undo/Redo Functionality	4.09	✓		
8	Spell Checking	3.58		✓	
9	Multilingual Site support	3.96		✓	
10	Content Editor	3.90		✓	
11	Content Scheduling	3.54		✓	
12	Content Versioning	3.61		✓	
13	Drag and Drop support	3			✓
14	Trashed Content support	3.54		✓	
15	Compressed Files Upload	3.54		✓	
16	Themes/Template Wizard	3.32		✓	
17	Metadata / Tags support	3.48		✓	
18	Remote Access	3.32		✓	
19	Learning Curve L.C	3.29		✓	

**Table 3** Technical requirements criteria categorization

Section (3) Technical requirements			Importance		
	Criterion	Average	Absolutely Essential (A.E.)	Very Important (V.I.)	Not Important (N.I.)
20	Operating System	3.96		✓	
21	Web Server	3.87		✓	
22	Database Management System support	3.96		✓	
23	Programming Language	2.90			✓
24	Physical Hardware (CPU, RAM and Hard Drive).	3.90		✓	

**Table 4** Platform support criteria categorization

Section (4) Platform support			Importance		
	Criterion	Average	Absolutely Essential (A.E.)	Very Important (V.I.)	Not Important (N.I.)
25	Community support	3.96		✓	
26	Application Programming Interface	3.41		✓	
27	Manuals/User Guides	3.93		✓	
28	Third-Party support	3.64		✓	

**Table 5** Security criteria categorization

Section (5) Security			Importance		
	Criterion	Average	Absolutely Essential (A.E.)	Very Important (V.I.)	Not Important (N.I.)
29	Security Level	4.29	✓		
30	CAPTCHA support	3.90		✓	
31	Secure Sockets Layer Certificate support	3.87		✓	
32	Log History	3.83		✓	
33	Authorized Access Control	4.32	✓		
34	Email Verification	3.70		✓	
35	System Update	4.06	✓		
36	Backup and Restore	4.70	✓		

**Table 6** Ease of extension and customization criteria categorization

<b>Section (6) Ease of extension and customization</b>			<b>Importance</b>		
	Criterion	Average	Absolutely Essential (A.E.)	Very Important (V.I.)	Not Important (N.I.)
37	Contact Forms	3.29		✓	
38	Short Message System support SMS	2.54			✓
39	Website Map	2.96			✓
40	Online Chat	2.54			✓
41	Image Gallery	2.90			✓
42	Flash support	2.83			✓
43	Search Engine Optimization SEO	3.80		✓	
44	Weather Forecasting	2.19			✓
45	Help File	3.58		✓	
46	Google Maps Integration	2.96			✓
47	Tour Module	2.90			✓
48	Media Management	3.74		✓	
49	Content Management	4.09	✓		
50	Users' Management	4.41	✓		
51	Inline Editing support	3.54		✓	
52	Charts and Graphs support	3.77		✓	
53	Editor Configuration	3.87		✓	
54	Mobile Friendly	4.38	✓		
55	Mobile Administration	3.51		✓	

**Table 7** Collaboration and interactivity criteria categorization

<b>Section (7) Collaboration and Interactivity</b>			<b>Importance</b>		
	Criterion	Average	Absolutely Essential (A.E.)	Very Important (V.I.)	Not Important (N.I.)
56	Facebook Integration	3.38		✓	
57	Twitter Integration	2.83			✓
58	YouTube Integration	3.70		✓	
59	Instagram Integration	2.83			✓
60	Polls	2.96			✓
61	Real Simple Syndication Feeds	3.41		✓	

**Table 7 (Cont.)** Collaboration and interactivity criteria categorization

<b>Section (7) Collaboration and Interactivity</b>			<b>Importance</b>		
	Criterion	Average	Absolutely Essential (A.E.)	Very Important (V.I.)	Not Important (N.I.)
62	Web Push Notifications support	3.06		✓	
63	Posting Comments Support	3.58		✓	
64	Forums	2.96			✓

**Table 8** Performance and functionality criteria categorization

<b>Section (8) Performance and functionality</b>			<b>Importance</b>		
	Criterion	Average	Absolutely Essential (A.E.)	Very Important (V.I.)	Not Important (N.I.)
65	Page Caching	3.64		✓	
66	Dynamic Page Caching	3.58		✓	
67	Import and Export Content	3.87		✓	
68	Content Check-Out	4	✓		
69	Tracking Statistics	3.83		✓	
70	Maintenance Mode	3.70		✓	

**Table 9** Other related Statistical Information criteria categorization

<b>Section (9) Other related Statistical Information</b>			<b>Importance</b>		
	Criterion	Average	Absolutely Essential (A.E.)	Very Important (V.I.)	Not Important (N.I.)
71	CMS's market share	3.32		✓	
72	Software license	3.83		✓	
73	Original cost	4.22	✓		
74	CMSs' Usage Statistics	3.03		✓	
75	Total Number of the Official Extensions	3.03		✓	
76	Total Number of the Official Themes	2.70			✓

## APPENDIX B

### Post Study System Usability Questionnaire Items

The Post-Study System Usability Questionnaire (PSSUQ) helps us to understand your personal reactions to the system you used such that we will understand which parts of the system you are particularly concerned about and the aspects that satisfy you. Please, try to think about all the tasks that you have achieved with the system while you answer these questions. Read each statement and indicate how strongly you agree or disagree with the statement by circling a number on the scale. Please write any comments if required. After you have completed this questionnaire, we will check your answers with you to ensure that we understand all of your responses. Study part: Usability Test for Content Management Systems namely WordPress, Joomla and Drupal.

Note: Item number 1 and number 2 illustrates the item format for everything. The remaining items show only the item text to conserve space.

1. Overall, I am satisfied with how easy it is to use this system.								
Strongly Agree	1	2	3	4	5	6	7	Strongly disagree
Comments								
2. It was simple to use this system								
Strongly Agree	1	2	3	4	5	6	7	Strongly disagree
Comments								

3. I could effectively complete the tasks and scenarios using this system
4. I was able to complete the tasks and scenarios quickly using this system
5. I was able to efficiently complete the tasks and scenarios using this system
6. I felt comfortable using this system
7. It was easy to learn to use this system
8. I believe I could become productive quickly using this system
9. The system gave error messages that clearly told me how to fix problems
10. Whenever I made a mistake using the system, I could recover easily and quickly
11. The information (such as System help, on-screen messages, and other documentation) provided with this system was clear
12. It was easy to find the information I needed
13. The information provided for the system was easy to understand
14. The information was effective in helping me complete the tasks and scenarios
15. The organization of information on the system screens was clear
16. The interface of this system was pleasant
17. I liked using the interface of this system
18. This system has all the functions and capabilities I expect it to have
19. Overall, I am satisfied with this system

## APPENDIX C

### Usability Participants' Checklists

#### C.1 WordPress Participants Checklists:

**Table 1** WordPress First Participant Checklist

<b>Participant Number:01</b>	Gender: Male	Disabilities:	Date: 26/04/2017
Task No.	Task Completion (Success/Fail)	Time Elapsed (Minute/Second)	Notes
Task1	Success	0.70	
Task2	Success	2.90	
Task3	Success	2.50	
Task4	Success	3.00	
Task5	Success	3.10	
Task6	Success	2.20	
Task7	Success	1.00	
Task8	Success	2.15	
Task9	Success	4.30	
Task10	Success	2.60	
Task11	Success	4.10	
Task12	Success	2.00	
Task13	Success	1.80	
<b>Session Total Time</b>		32.35	

**Table 2** WordPress Second Participant Checklist

<b>Participant Number:02</b>	Gender: Male	Disabilities:	Date: 26/04/2017
Task No.	Task Completion (Success/Fail)	Time Elapsed (Minute/Second)	Notes
Task1	Success	0.50	
Task2	Success	3.30	
Task3	Success	2.60	
Task4	Success	4.00	
Task5	Success	5.00	
Task6	Success	2.00	
Task7	Success	1.50	
Task8	Success	2.50	
Task9	Success	4.40	
Task10	Success	4.80	
Task11	Success	3.50	
Task12	Success	1.80	
Task13	Success	1.20	
<b>Session Total Time</b>		37.10	

**Table 3** WordPress Third Participant Checklist

<b>Participant Number:03</b>	Gender: Male	Disabilities:	Date: 26/04/2017
Task No.	Task Completion (Success/Fail)	Time Elapsed (Minute/Second)	Notes
Task1	Success	1.00	
Task2	Success	3.60	
Task3	Success	2.40	
Task4	Success	2.80	
Task5	Success	3.90	
Task6	Success	2.20	
Task7	Success	1.66	
Task8	Success	2.50	
Task9	Success	4.20	
Task10	Success	3.70	
Task11	Success	4.10	
Task12	Success	2.40	
Task13	Success	1.80	
<b>Session Total Time</b>		36.26	

**Table 4** WordPress Fourth Participant Checklist

<b>Participant Number:04</b>	Gender: Male	Disabilities:	Date: 26/04/2017
Task No.	Task Completion (Success/Fail)	Time Elapsed (Minute/Second)	Notes
Task1	Success	0.40	
Task2	Success	3.90	
Task3	Success	2.80	
Task4	Success	2.10	
Task5	Success	4.60	
Task6	Success	2.70	
Task7	Success	1.20	
Task8	Success	2.00	
Task9	Success	4.50	
Task10	Success	3.60	
Task11	Success	3.30	
Task12	Success	2.60	
Task13	Success	1.00	
<b>Session Total Time</b>		34.70	

**Table 5** WordPress Fifth Participant Checklist

<b>Participant Number:05</b>	Gender: Male	Disabilities:	Date: 27/04/2017
Task No.	Task Completion (Success/Fail)	Time Elapsed (Minute/Second)	Notes
Task1	Success	0.40	
Task2	Success	3.00	
Task3	Success	2.50	
Task4	Success	4.30	
Task5	Success	4.70	
Task6	Success	1.80	
Task7	Success	1.90	
Task8	Success	2.50	
Task9	Success	5.10	
Task10	Success	4.30	
Task11	Success	3.20	
Task12	Success	2.30	
Task13	Success	1.10	
<b>Session Total Time</b>		37.10	

**Table 6** WordPress Sixth Participant Checklist

<b>Participant Number:06</b>	Gender: Male	Disabilities: Vision impairment	Date: 27/04/2017
Task No.	Task Completion (Success/Fail)	Time Elapsed (Minute/Second)	Notes
Task1	Success	1.30	
Task2	Success	3.60	
Task3	Success	2.88	
Task4	Success	2.30	
Task5	Success	3.00	
Task6	Success	2.50	
Task7	Success	2.00	
Task8	Success	2.60	
Task9	Success	4.70	
Task10	Success	2.80	
Task11	Success	5.00	
Task12	Success	3.00	
Task13	Success	2.10	
<b>Session Total Time</b>		37.78	

## C.2 Joomla Participants Checklists:

**Table 7 Joomla First Participant Checklist**

<b>Participant Number:01</b>	Gender: Male	Disabilities:	Date: 27/04/2017
Task No.	Task Completion (Success/Fail)	Time Elapsed (Minute/Second)	Notes
Task1	Success	1.80	
Task2	Success	3.00	
Task3	Success	3.10	
Task4	Success	3.20	
Task5	Success	4.10	
Task6	Success	3.65	
Task7	Success	2.00	
Task8	Success	3.00	
Task9	Success	4.50	
Task10	Success	3.90	
Task11	Success	3.60	
Task12	Success	2.00	
Task13	Success	1.50	
<b>Session Total Time</b>		39.35	

**Table 8 Joomla Second Participant Checklist**

<b>Participant Number:02</b>	Gender: Male	Disabilities:	Date: 27/04/2017
Task No.	Task Completion (Success/Fail)	Time Elapsed (Minute/Second)	Notes
Task1	Fail		1-The system did not transfer the user to the administration interface using the login form.
Task2	Success	3.80	
Task3	Success	3.70	
Task4	Success	3.50	
Task5	Success	5.10	
Task6	Success	2.90	
Task7	Success	2.00	
Task8	Success	3.10	
Task9	Success	5.80	
Task10	Success	4.20	
Task11	Success	3.88	
Task12	Success	2.80	
Task13	Success	1.90	
<b>Session Total Time</b>		42.68	

**Table 9 Joomla Third Participant Checklist**

<b>Participant Number:03</b>	Gender: Male	Disabilities:	Date: 28/04/2017
Task No.	Task Completion (Success/Fail)	Time Elapsed (Minute/Second)	Notes
Task1	Success	2.50	
Task2	Success	3.45	
Task3	Success	4.00	
Task4	Success	3.10	
Task5	Success	1.00	
Task6	Success	6.40	
Task7	Success	3.00	
Task8	Success	3.66	
Task9	Success	4.50	
Task10	Success	6.00	
Task11	Success	4.10	
Task12	Success	2.70	
Task13	Success	1.70	
<b>Session Total Time</b>		46.11	

**Table 10 Joomla Fourth Participant Checklist**

<b>Participant Number:04</b>	Gender: Male	Disabilities:	Date: 28/04/2017
Task No.	Task Completion (Success/Fail)	Time Elapsed (Minute/Second)	Notes
Task1	Success	1.60	1-The participant did not succeed to see his published post because the system requires assigning a category for the created content.
Task2	Success	3.00	
Task3	Success	2.20	
Task4	Success	3.10	
Task5	Success	4.00	
Task6	Success	3.20	
Task7	Success	3.10	
Task8	Fail		
Task9	Success	3.80	
Task10	Success	3.20	
Task11	Success	3.00	
Task12	Success	3.60	
Task13	Success	2.80	
<b>Session Total Time</b>		36.60	

**Table 11 Joomla Fifth Participant Checklist**

<b>Participant Number:05</b>	<b>Gender:</b> Male	<b>Disabilities:</b>	<b>Date:</b> 28/04/2017
Task No.	Task Completion (Success/Fail)	Time Elapsed (Minute/Second)	Notes
Task1	Fail		1-The system did not transfer the user to the administration interface using the login form.  2-The participant did not succeed to see his published post because the system requires assigning a category for the created content.
Task2	Success	3.50	
Task3	Success	4.00	
Task4	Success	3.20	
Task5	Success	5.00	
Task6	Success	3.00	
Task7	Success	2.20	
Task8	Fail		
Task9	Success	4.50	
Task10	Success	3.80	
Task11	Success	3.35	
Task12	Success	3.00	
Task13	Success	2.00	
<b>Session Total Time</b>		37.55	

**Table 12 Joomla Sixth Participant Checklist**

<b>Participant Number:06</b>	<b>Gender:</b> Male	<b>Disabilities:</b> Vision impairment	<b>Date:</b> 28/04/2017
Task No.	Task Completion (Success/Fail)	Time Elapsed (Minute/Second)	Notes
Task1	Success	2.10	
Task2	Success	4.30	
Task3	Success	3.60	
Task4	Success	3.20	
Task5	Success	4.75	
Task6	Success	4.30	
Task7	Success	3.00	
Task8	Success	3.90	
Task9	Success	4.20	
Task10	Success	3.50	
Task11	Success	3.45	
Task12	Success	2.70	
Task13	Success	1.80	
<b>Session Total Time</b>		44.80	

### C.3 Drupal Participants Checklists:

**Table 13** Drupal First Participant Checklist

<b>Participant Number:01</b>	Gender: Male	Disabilities:	Date: 03/05/2017
Task No.	Task Completion (Success/Fail)	Time Elapsed (Minute/Second)	Notes
Task1	Success	1.00	1-The participant did not success to remove the installed extension because the uninstallation process requires enabling the new module first in order to perform uninstallation later.
Task2	Success	3.90	
Task3	Success	3.50	
Task4	Success	4.50	
Task5	Success	5.00	
Task6	Success	3.10	
Task7	Success	2.80	
Task8	Success	3.60	
Task9	Success	5.00	
Task10	Fail		
Task11	Success	3.70	
Task12	Success	2.50	
Task13	Success	1.90	
<b>Session Total Time</b>		40.50	

**Table 14** Drupal Second Participant Checklist

<b>Participant Number:02</b>	Gender: Male	Disabilities:	Date: 03/05/2017
Task No.	Task Completion (Success/Fail)	Time Elapsed (Minute/Second)	Notes
Task1	Success	1.50	
Task2	Success	3.50	
Task3	Success	3.80	
Task4	Success	3.20	
Task5	Success	5.30	
Task6	Success	3.30	
Task7	Success	2.90	
Task8	Success	4.00	
Task9	Success	4.90	
Task10	Success	5.10	
Task11	Success	4.20	
Task12	Success	3.10	
Task13	Success	2.10	
<b>Session Total Time</b>		46.90	

**Table 15** Drupal Third Participant Checklist

<b>Participant Number:03</b>	Gender: Male	Disabilities:	Date: 03/05/2017
Task No.	Task Completion (Success/Fail)	Time Elapsed (Minute/Second)	Notes
Task1	Success	1.50	1-The participant did not success to remove the installed extension because the uninstallation process requires enabling the new module first in order to perform uninstallation later.  2-The participant failed to find Color Scheme interface that helps to change the color of the installed Theme.
Task2	Success	4.80	
Task3	Success	4.10	
Task4	Success	3.80	
Task5	Success	4.80	
Task6	Success	5.90	
Task7	Success	3.00	
Task8	Success	4.20	
Task9	Success	5.80	
Task10	Fail		
Task11	Success	4.30	
Task12	Fail		
Task13	Success	2.60	
<b>Session Total Time</b>		44.80	

**Table 16** Drupal Fourth Participant Checklist

<b>Participant Number:04</b>	Gender: Male	Disabilities:	Date: 03/05/2017
Task No.	Task Completion (Success/Fail)	Time Elapsed (Minute/Second)	Notes
Task1	Success	1.10	1-The participant did not success to remove the installed extension because the uninstallation process requires enabling the new module first in order to perform uninstallation later.
Task2	Success	3.50	
Task3	Success	3.40	
Task4	Success	4.00	
Task5	Success	5.20	
Task6	Success	4.50	
Task7	Success	3.30	
Task8	Success	4.00	
Task9	Success	5.30	
Task10	Fail		
Task11	Success	4.10	
Task12	Success	2.50	
Task13	Success	2.70	
<b>Session Total Time</b>		43.60	

**Table 17** Drupal Fifth Participant Checklist

<b>Participant Number:05</b>	Gender: Male	Disabilities:	Date: 05/05/2017
Task No.	Task Completion (Success/Fail)	Time Elapsed (Minute/Second)	Notes
Task1	Success	1.00	
Task2	Success	3.90	
Task3	Success	3.70	
Task4	Success	4.20	
Task5	Success	4.80	
Task6	Success	3.50	
Task7	Success	3.00	
Task8	Success	3.80	
Task9	Success	5.10	
Task10	Success	4.20	
Task11	Success	4.20	
Task12	Success	3.20	
Task13	Success	1.10	
<b>Session Total Time</b>		45.70	

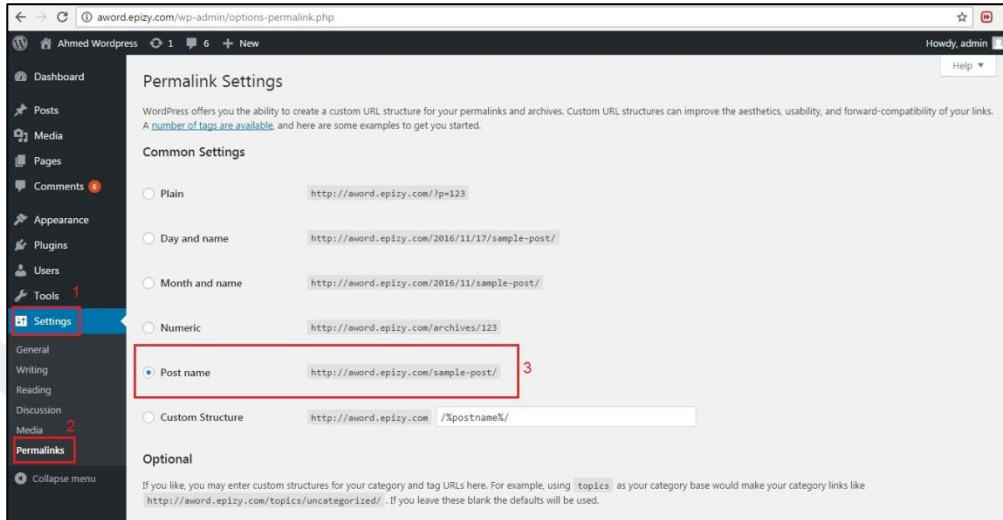
**Table 18** Drupal Sixth Participant Checklist

<b>Participant Number:06</b>	Gender: Male	Disabilities: Vision impairment	Date: 05/05/2017
Task No.	Task Completion (Success/Fail)	Time Elapsed (Minute/Second)	Notes
Task1	Success	2.10	1-The participant failed to uninstall the extension for the same aforementioned reason with Participants 1 and 5.  2-The participant failed to find Color Scheme interface that helps to change the color of the installed Theme.
Task2	Success	4.20	
Task3	Success	4.00	
Task4	Success	3.80	
Task5	Success	4.90	
Task6	Success	5.80	
Task7	Success	2.70	
Task8	Success	4.10	
Task9	Success	5.30	
Task10	Fail		
Task11	Success	4.00	
Task12	Fail		
Task13	Success	2.30	
<b>Session Total Time</b>		43.20	

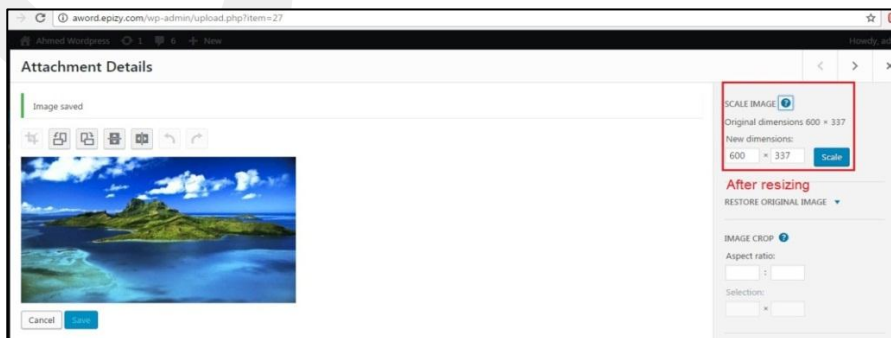
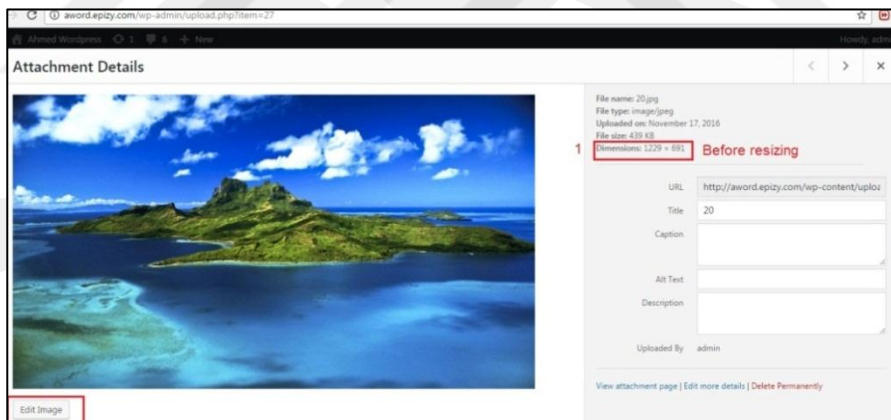
## APPENDIX D

### WordPress Content Management System Screenshots

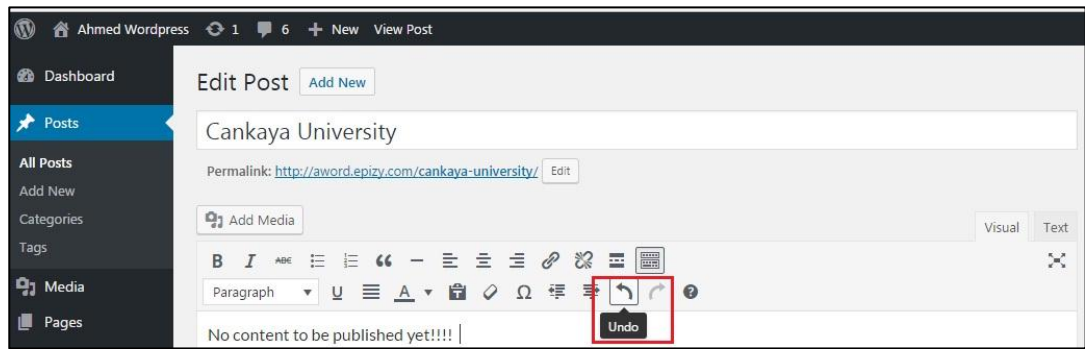
#### 1. Friendly URLs



#### 2. Image Responsiveness



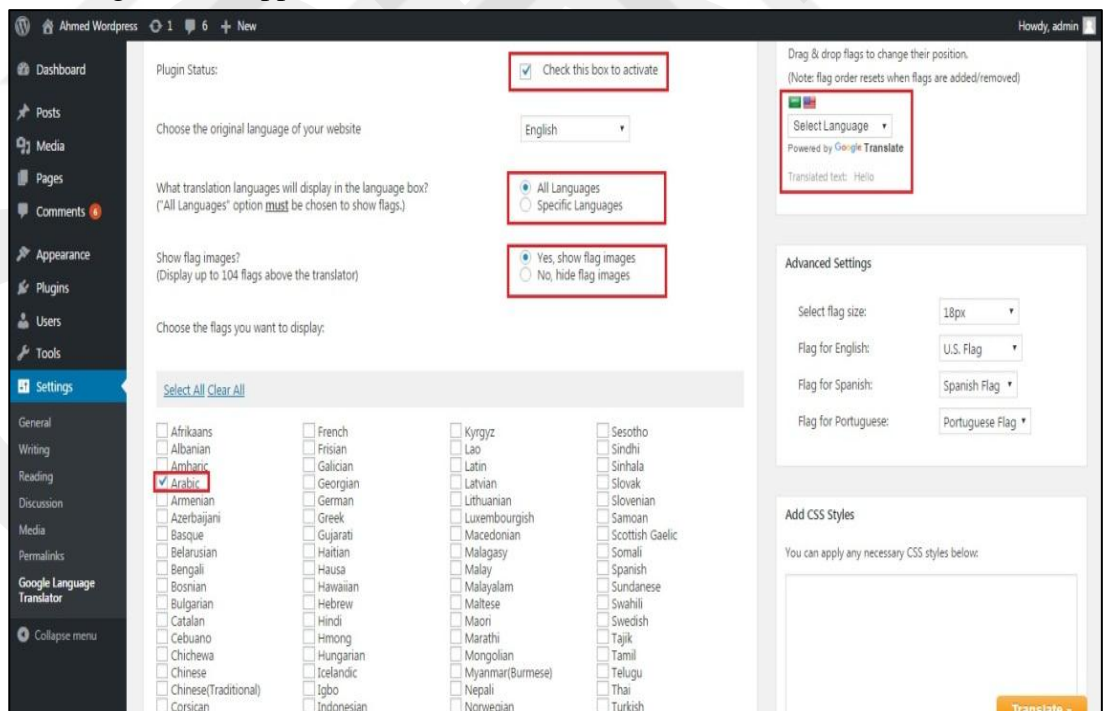
### 3. Undo/Redo Functionality



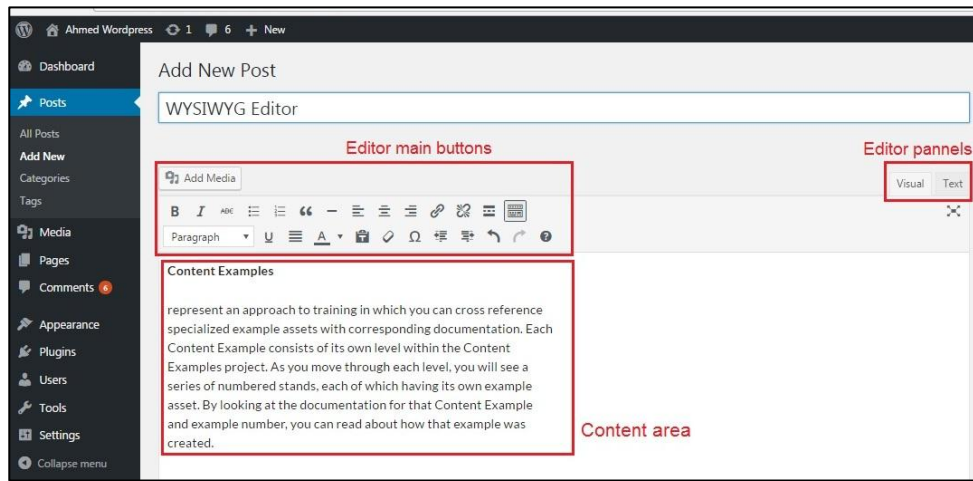
### 4. Spell Checking



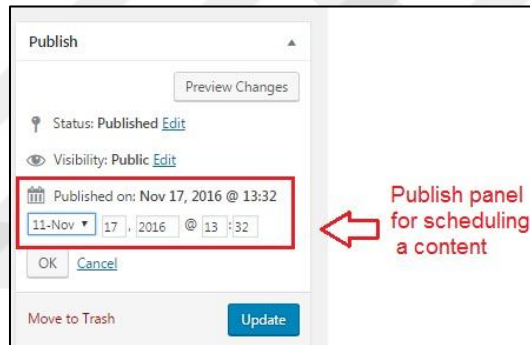
### 5. Multilingual Site support



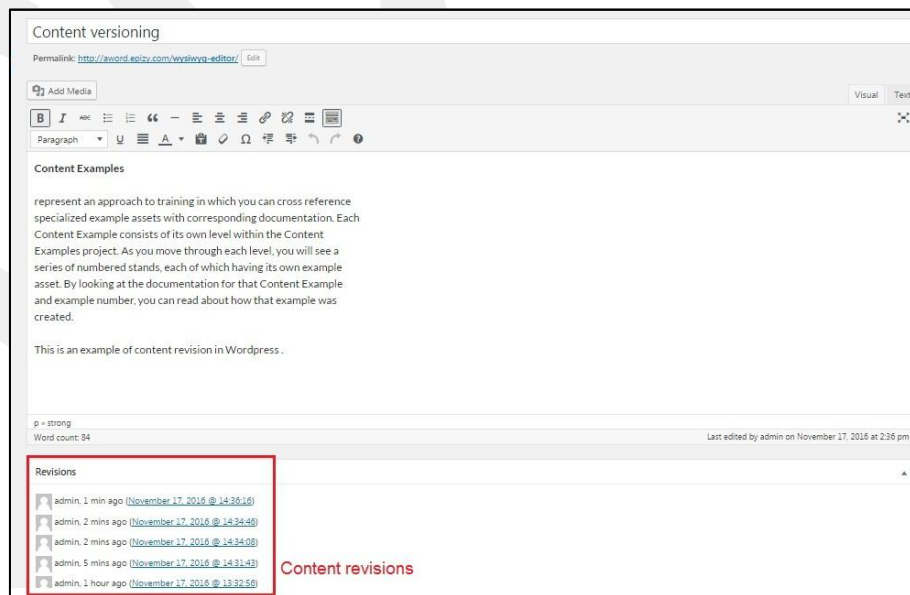
## 6. Content Editor



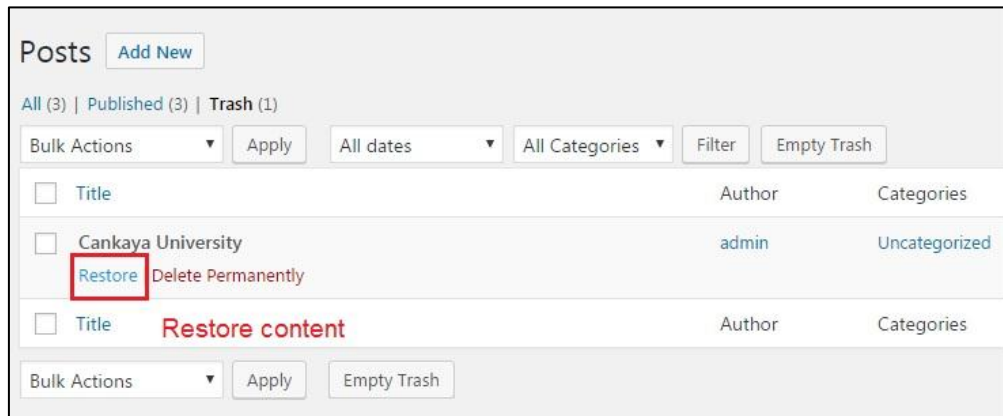
## 7. Content Scheduling



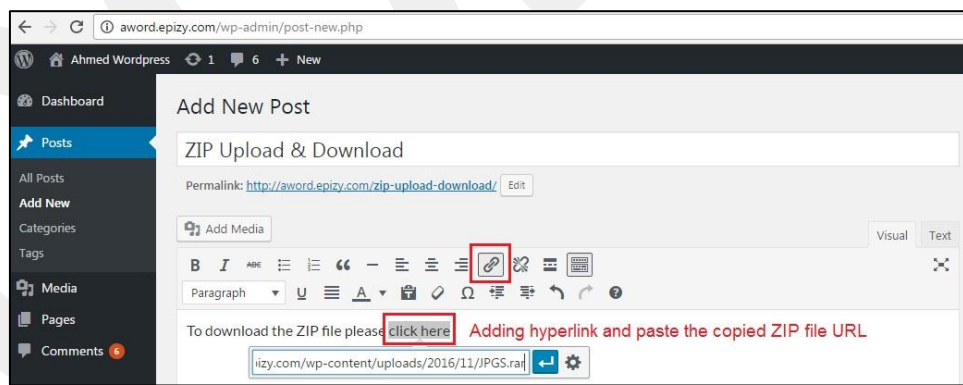
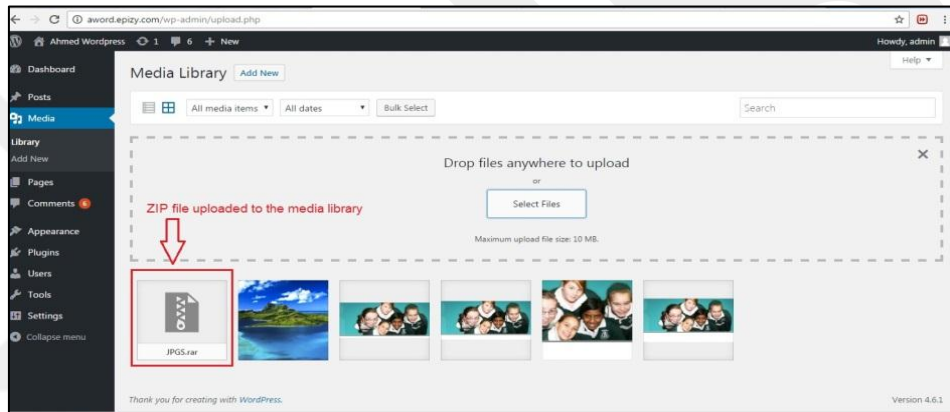
## 8. Content Versioning



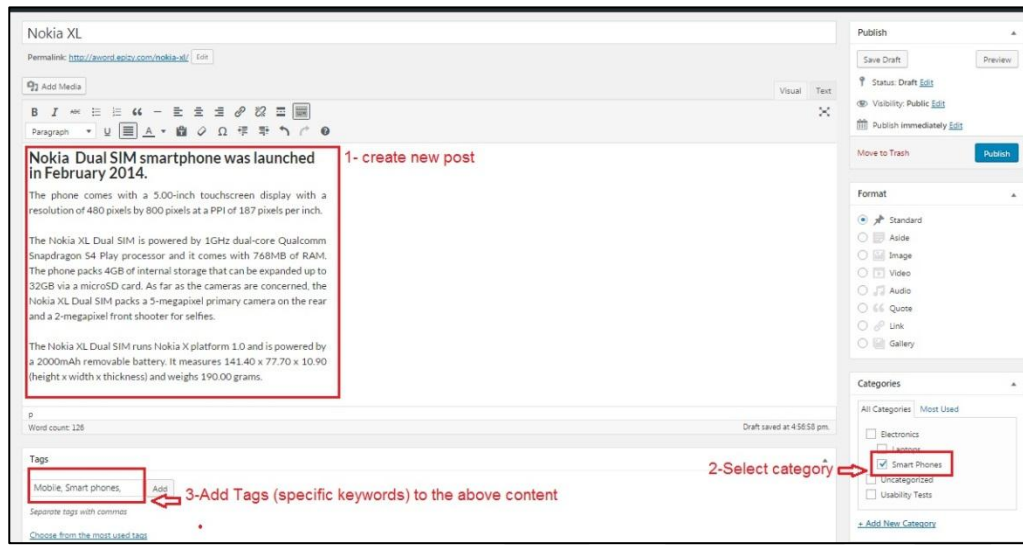
## 9. Trashed Content support:



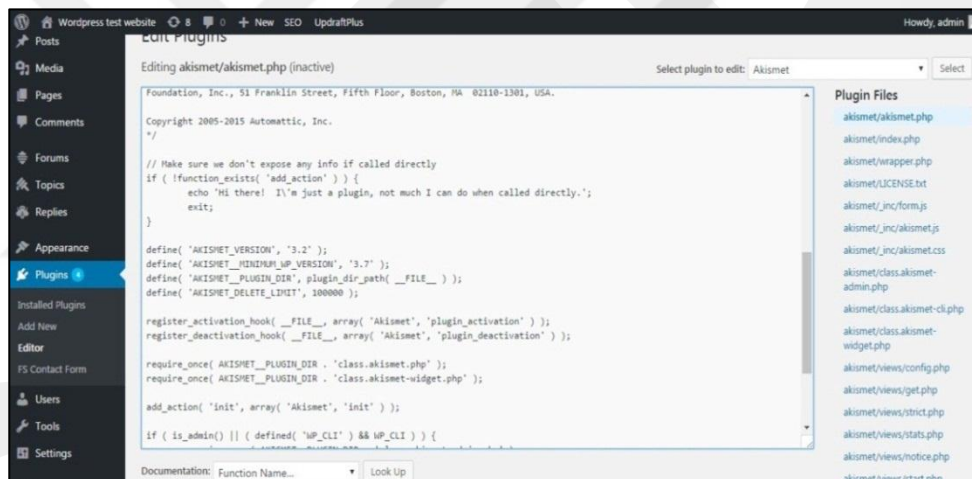
## 10. Compressed Files Upload



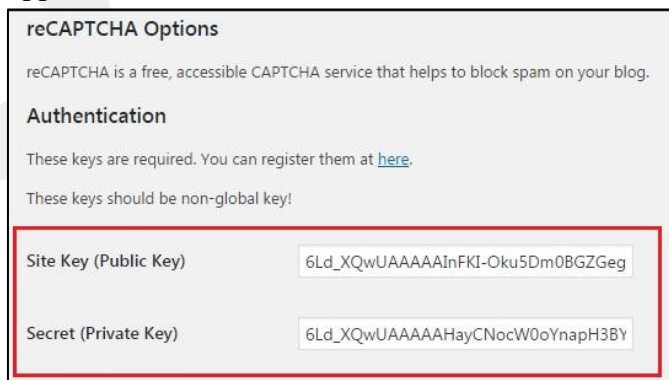
## 11. Metadata/Tags support

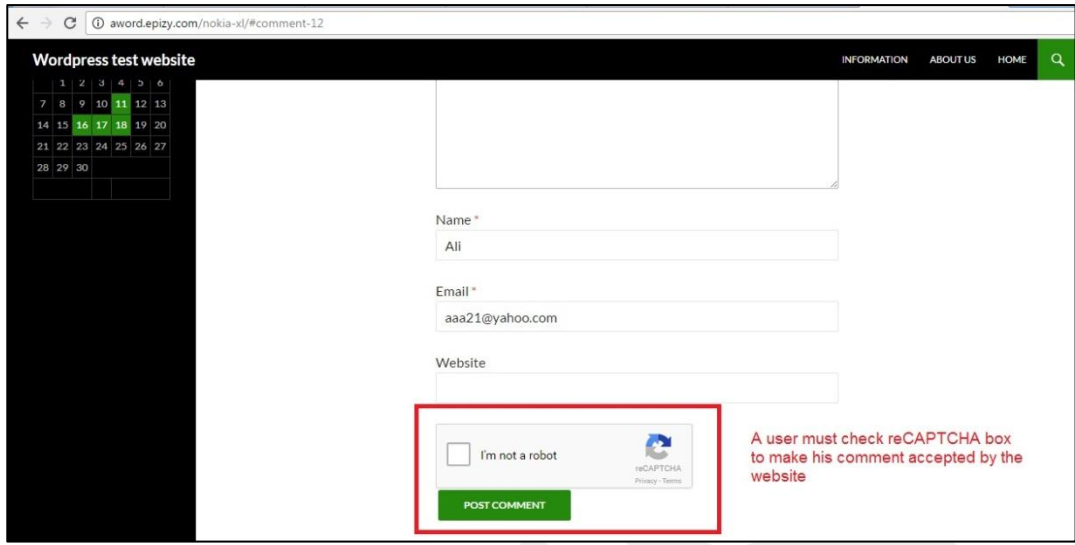


## 12. Application Programming Interface

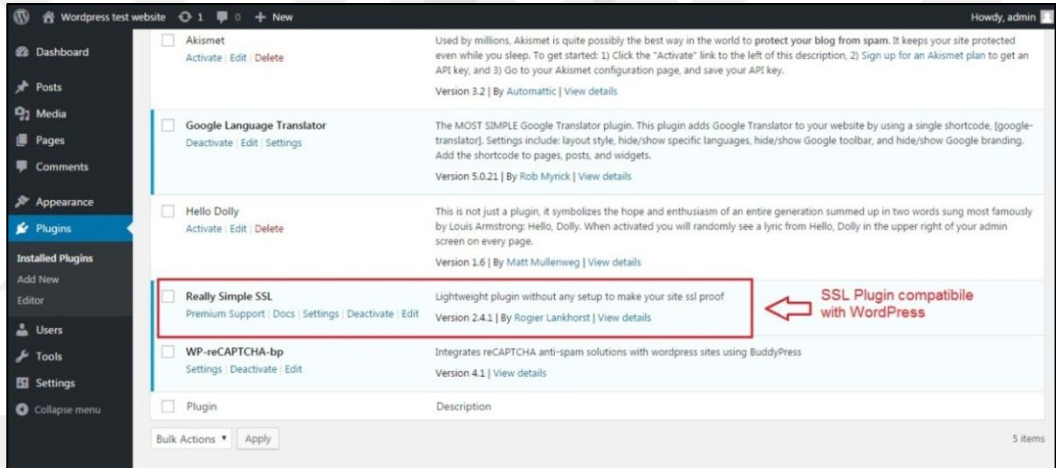


## 13. CAPTCHA Support

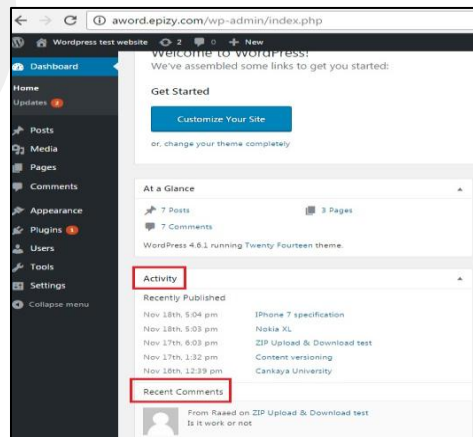


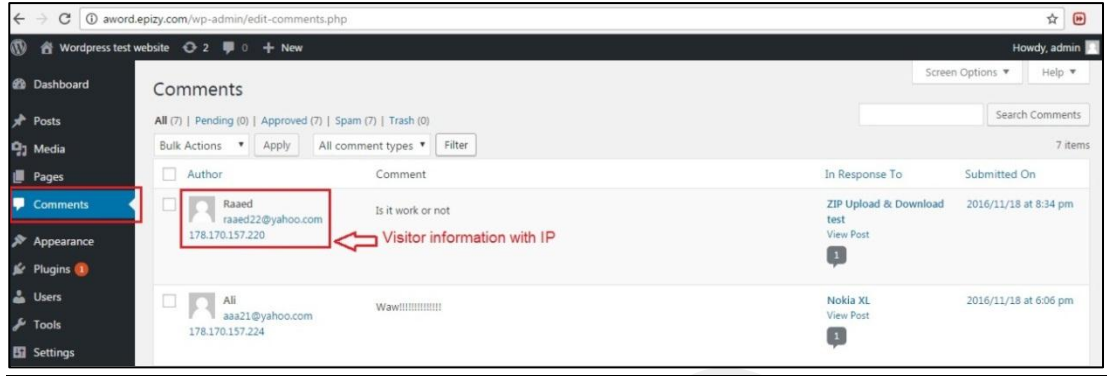


## 14. Secure Sockets Layer Certificate support

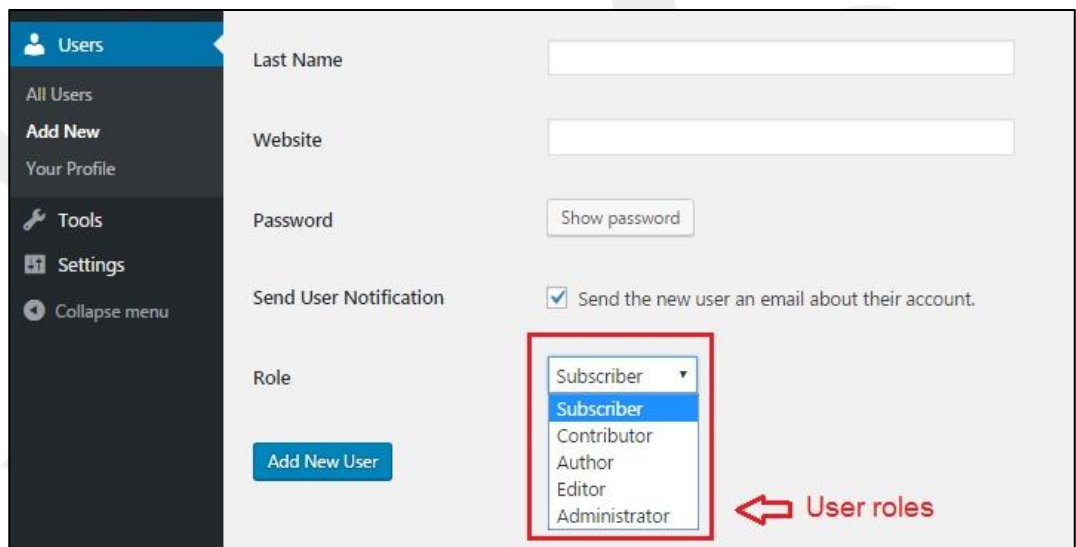


## 15. Log History

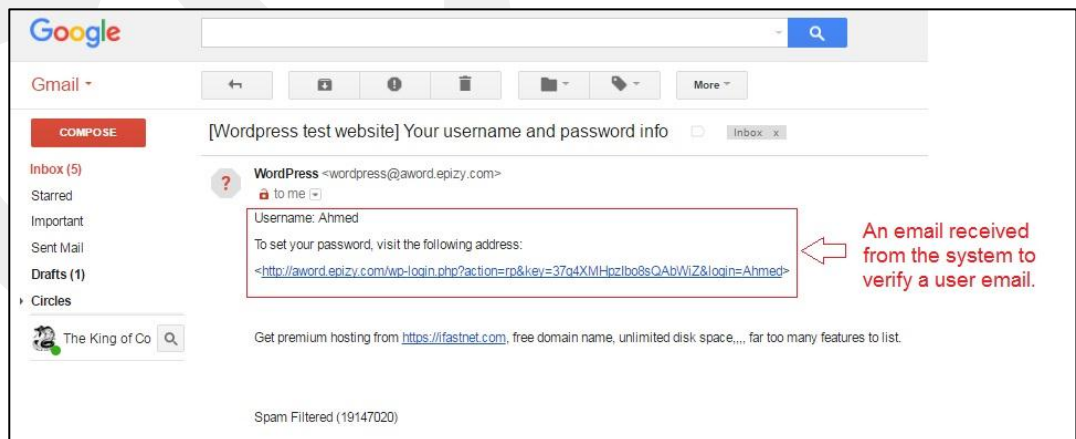




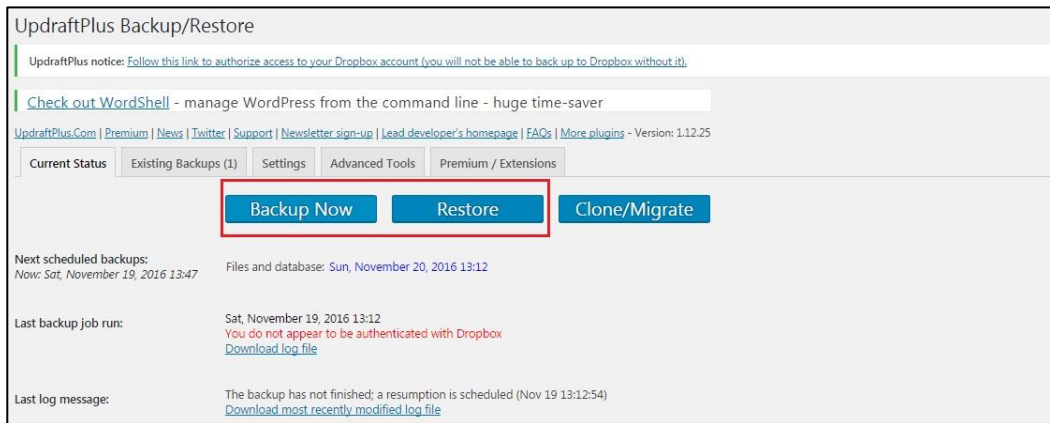
## 16. Authorized Access Control



## 17. Email Verification



## 18. Backup and Restore



UpdraftPlus Backup/Restore

UpdraftPlus notice: Follow this link to authorize access to your Dropbox account (you will not be able to back up to Dropbox without it).

[Check out WordShell](#) - manage WordPress from the command line - huge time-saver

[UpdraftPlus.Com](#) | [Premium](#) | [News](#) | [Twitter](#) | [Support](#) | [Newsletter sign-up](#) | [Lead developer's homepage](#) | [FAQs](#) | [More plugins](#) - Version: 1.12.25

Current Status | Existing Backups (1) | Settings | Advanced Tools | Premium / Extensions

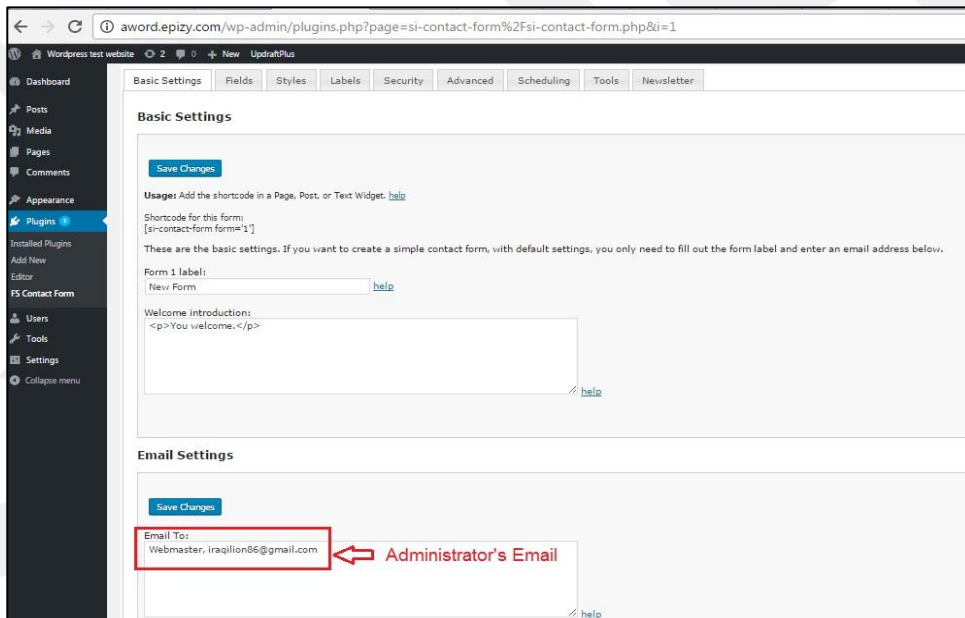
**Backup Now** | **Restore** | **Clone/Migrate**

Next scheduled backups: Files and database: Sun, November 20, 2016 13:12  
Now: Sat, November 19, 2016 13:47

Last backup job run: Sat, November 19, 2016 13:12  
You do not appear to be authenticated with Dropbox  
[Download log file](#)

Last log message: The backup has not finished; a resumption is scheduled (Nov 19 13:12:54)  
[Download most recently modified log file](#)

## 19. Contact Form:



WordPress test website - WordPress

Basic Settings | Fields | Styles | Labels | Security | Advanced | Scheduling | Tools | Newsletter

### Basic Settings

[Save Changes](#)

Usage: Add the shortcode in a Page, Post, or Text Widget: `[wp-contact-form form=1]`

Shortcode for this form: `[si-contact-form form=1]`

These are the basic settings. If you want to create a simple contact form, with default settings, you only need to fill out the form label and enter an email address below.

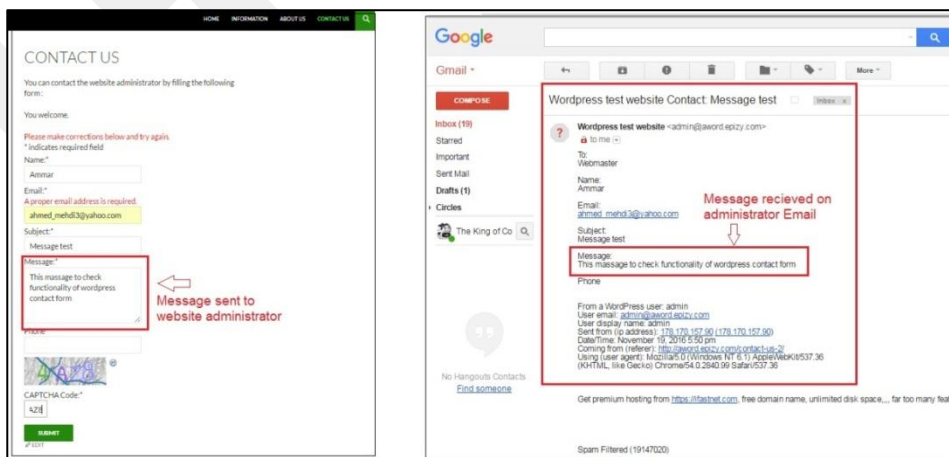
Form 1 label: New Form [help](#)

Welcome introduction: <p>You welcome.</p> [help](#)

### Email Settings

[Save Changes](#)

Email To: Webmaster, iraqilion86@gmail.com **← Administrator's Email**



**CONTACT US**

You can contact the website administrator by filling the following form:

You welcome.

Please make corrections below and try again.  
\* Indicates required field

Name: Anmar

Email: \* Anmar\_email\_address\_is\_required. anmar\_email\_address@yahoo.com

Subject: \* Message test

Message: \* This message to check functionality of wordpress contact form

Message sent to website administrator

Google

Gmail - Wordpress test website Contact: Message test

WordPress test website <admin@aword.epizy.com>

To: Webmaster

Name: Anmar

Email: anmar\_email@yahoo.com

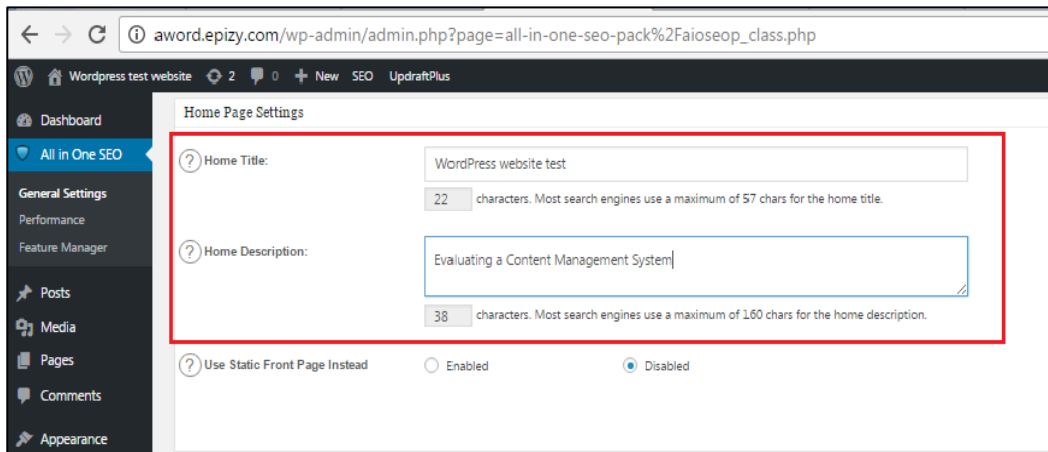
Subject: Message test

Message: This message to check functionality of wordpress contact form

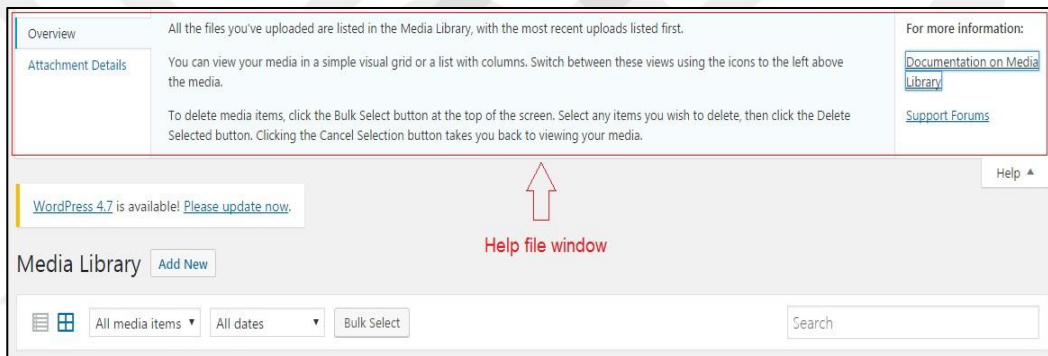
From a WordPress user: admin  
User email: admin@aword.epizy.com  
User display name: admin  
Sent from (ip address): 179.130.137.65  
Date/Time: November 19, 2016 13:50 pm  
Coming from (referrer): http://aword.epizy.com/wp-contact-form/  
Using (user agent): Mozilla/5.0 (Windows NT 6.1; AppleWebKit/537.36 (KHTML, like Gecko) Chrome/54.0.2840.99 Safari/537.36

Spam Filtered (19147020)

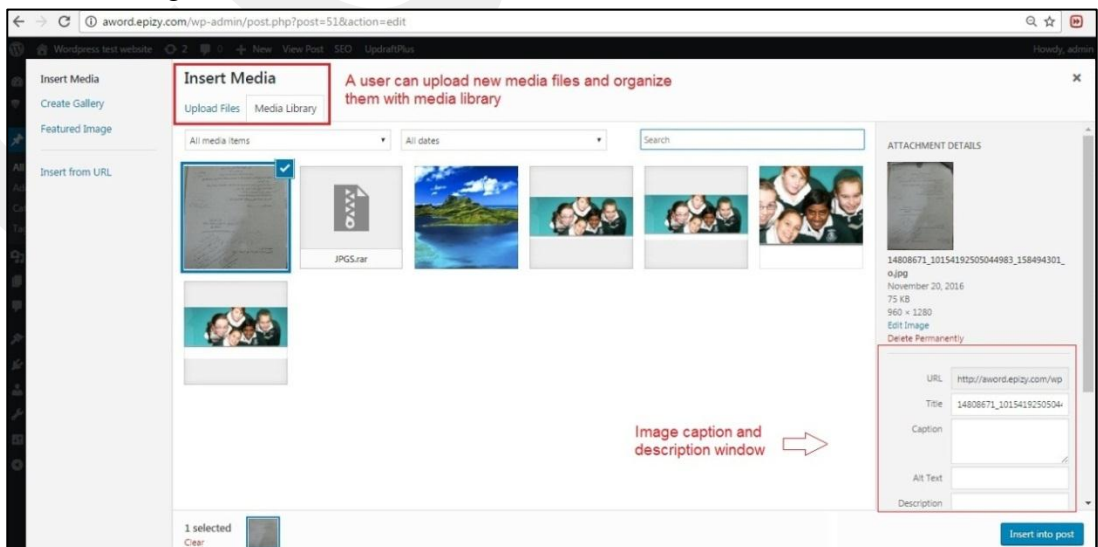
## 20. Search Engine Optimization SEO



## 21. Help File



## 22. Media Management



## 23. Content Management

The screenshot shows the WordPress 'Posts' management interface. The top navigation bar includes 'All in One SEO', 'Posts', and 'Add New'. The main content area displays a list of posts with columns for Title, Author, Categories, Tags, Date, Analytics, and SEO Title. A red box highlights the 'Filter' button and the 'All Categories' dropdown, with an arrow pointing to the text 'Filtering lists'. Another red box highlights the first row of the post list, with an arrow pointing to the text 'listed posts'.

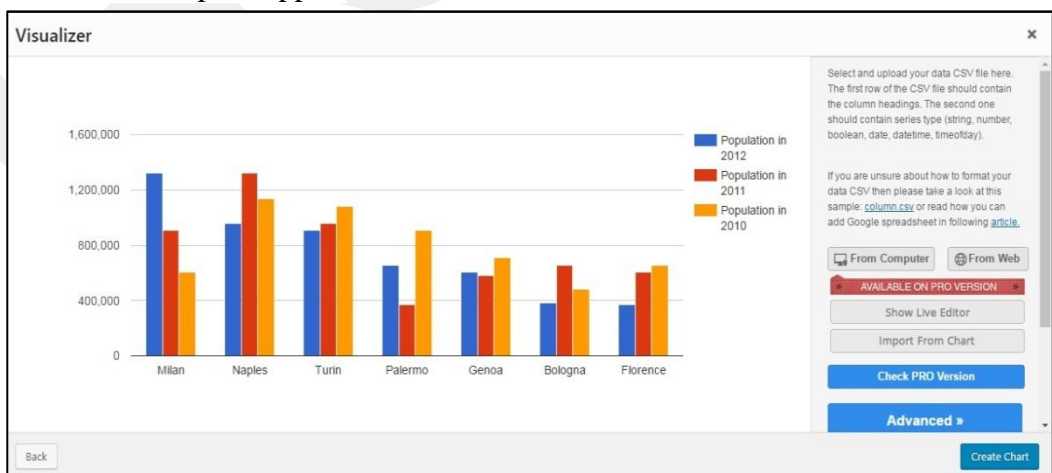
Title	Author	Categories	Tags	Date	Analytics	SEO Title
Embedding YouTube video test	admin	Uncategorized	—	Published 2016/12/04		No title
Samsung latest news	admin	Uncategorized	—	Published 2016/11/20		No title
Latest news about Iphone7	admin	Uncategorized	—	Published 2016/11/20		No title
Cities population	admin	Uncategorized	—	Published 2016/11/20		No title
IPhone 7 specification	admin	Smart Phones	Mobile, Smart phones, technology	Published 2016/11/18		No title
Nokia XL	admin	Smart Phones	Mobile, Smart phones	Published 2016/11/18		No title

## 24. Users' Management

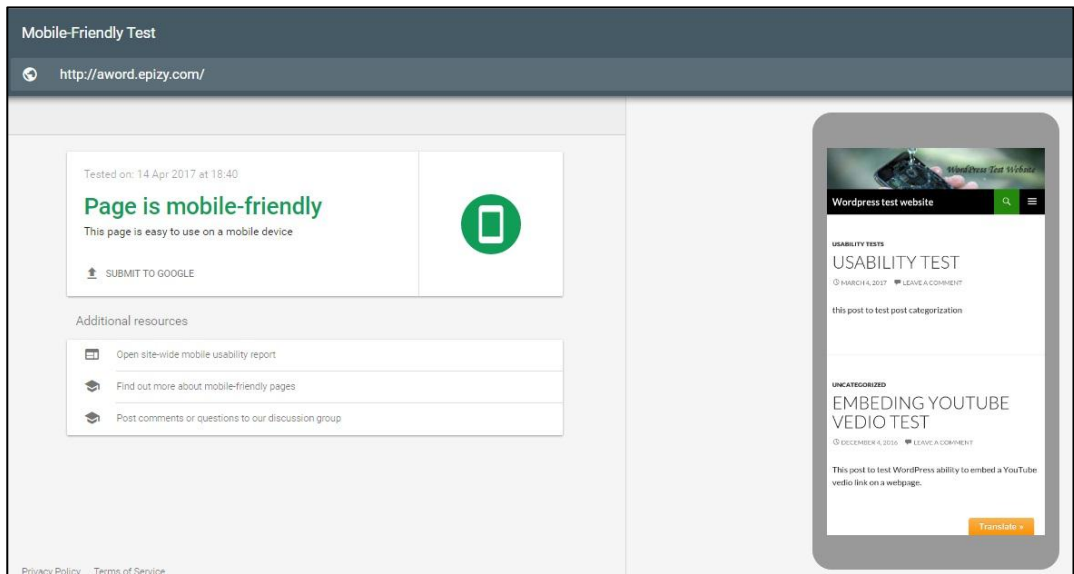
The screenshot shows the WordPress 'Users' management interface. The top navigation bar includes 'Users', 'Add New', 'Screen Options', and 'Help'. The main content area displays a list of users with columns for Username, Name, Email, Role, and Posts. The users listed are 'admin' (Administrator), 'Author' (Author), and 'Editor' (Editor).

Username	Name	Email	Role	Posts
admin		admin@avord.epicy.com	Administrator	8
Author		Author@gmail.com	Author	0
Editor		Editor@gmail.com	Editor	0

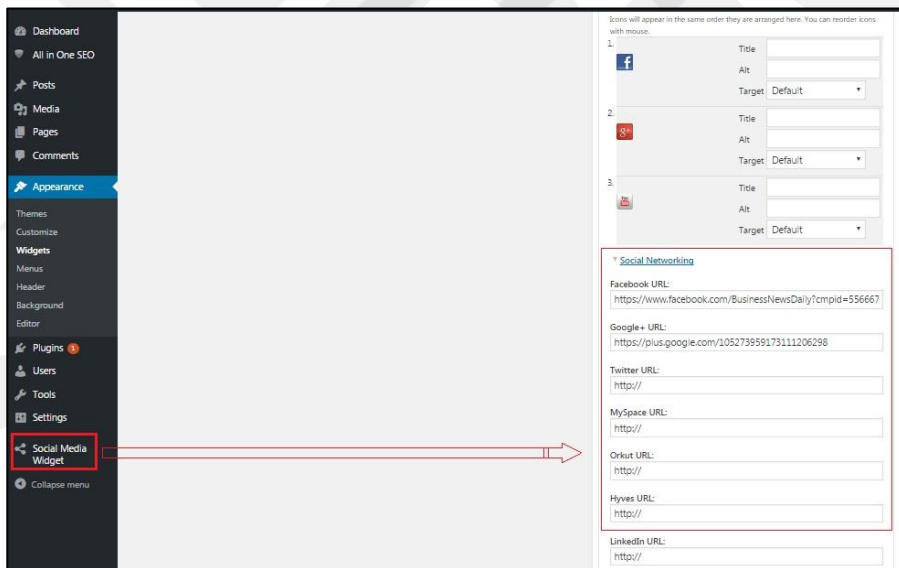
## 25. Charts and Graphs support



## 26. Mobile Friendly



## 27. Facebook Integration



## 28. YouTube Integration



## 29. Real Simple Syndication Feeds

**Social News & Feeds**

Digg URL:

Reddit URL:

Delicious URL:

StumbleUpon URL:

Buzz URL:


FriendFeed URL:

**RSS URL:**  →

Slashdot URL:

E-mail URL:

**FOLLOW US!**



**RSS service appeared on the website**

## 30. Web Push Notifications support

WordPress test website

WordPress 4.7 is available! [Please update now.](#)

**New Notification** Notification settings

Notification Title:  Limit 77 Characters

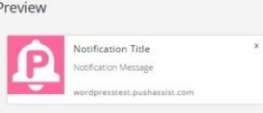
Notification Message:  Limit 138 Characters

Notification URL:

Notification Logo:  Image size must be exactly 250x250px.

Add UTM Parameters

**Preview**



URL to open when user clicks the notification:

## 31. Posting Comments support

**Discussion Settings**

**Default article settings**

- Attempt to notify any blogs linked to from the article
- Allow link notifications from other blogs (pingbacks and trackbacks) on new articles
- Allow people to post comments on new articles

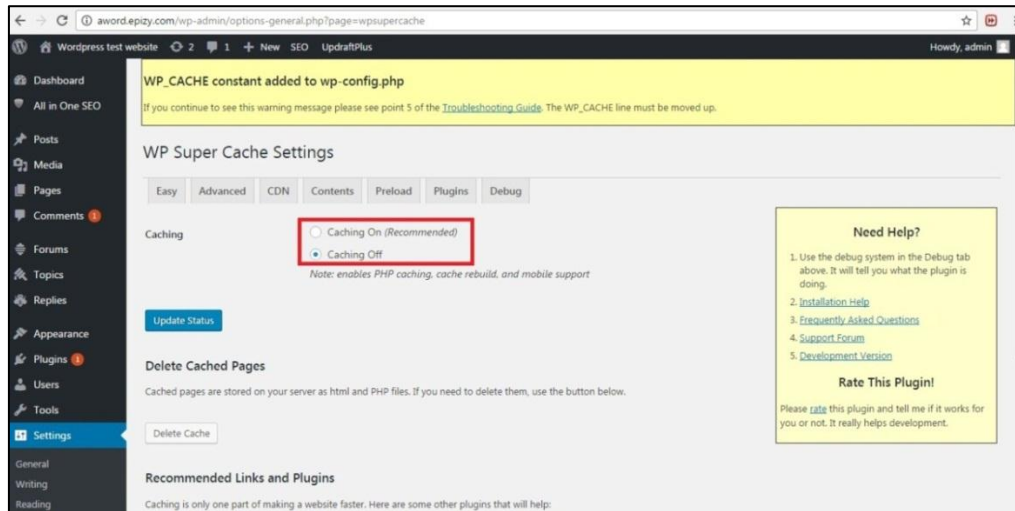
*(These settings may be overridden for individual articles.)*

**Other comment settings**

- Comment author must fill out name and email
- Users must be registered and logged in to comment
- Automatically close comments on articles older than  days
- Enable threaded (nested) comments:  levels deep
- Break comments into pages with  top level comments per page and the  page displayed by default

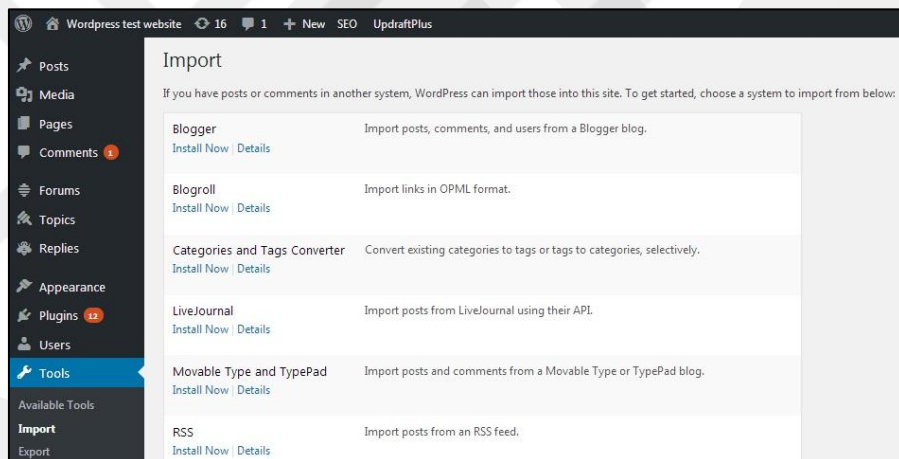
Comments should be displayed with the  comments at the top of each page

## 32. Page Caching



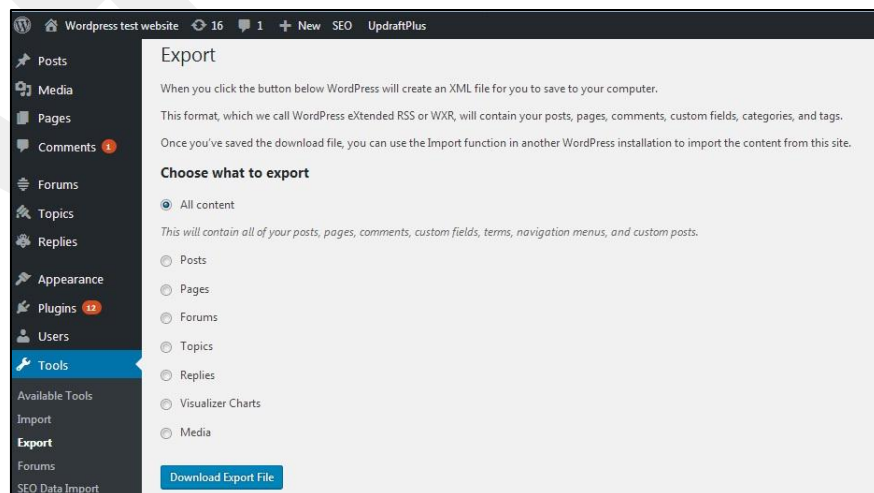
The screenshot shows the WP Super Cache settings page in a WordPress admin dashboard. At the top, a yellow notification banner states: "WP\_CACHE constant added to wp-config.php. If you continue to see this warning message please see point 5 of the [Troubleshooting Guide](#). The WP\_CACHE line must be moved up." Below this, the "WP Super Cache Settings" are displayed, with tabs for Easy, Advanced, CDN, Contents, Preload, Plugins, and Debug. The "Caching" section has two radio buttons: "Caching On (Recommended)" and "Caching Off". The "Caching On" option is selected and highlighted with a red box. A note below reads: "Note: enables PHP caching, cache rebuild, and mobile support." There is an "Update Status" button. Below that is the "Delete Cached Pages" section, which includes a "Delete Cache" button. At the bottom, there is a "Recommended Links and Plugins" section. On the right side, there is a "Need Help?" section with links to "Installation Help", "Frequently Asked Questions", "Support Forum", and "Development Version", along with a "Rate This Plugin!" section.

## 33. Import and Export Content



The screenshot shows the "Import" screen in the WordPress admin dashboard. The page title is "Import". Below the title, it says: "If you have posts or comments in another system, WordPress can import those into this site. To get started, choose a system to import from below:". There are several import options listed in a table:

System	Description
Blogger	Import posts, comments, and users from a Blogger blog.
Blogroll	Import links in OPML format.
Categories and Tags Converter	Convert existing categories to tags or tags to categories, selectively.
LiveJournal	Import posts from LiveJournal using their API.
Movable Type and TypePad	Import posts and comments from a Movable Type or TypePad blog.
RSS	Import posts from an RSS feed.

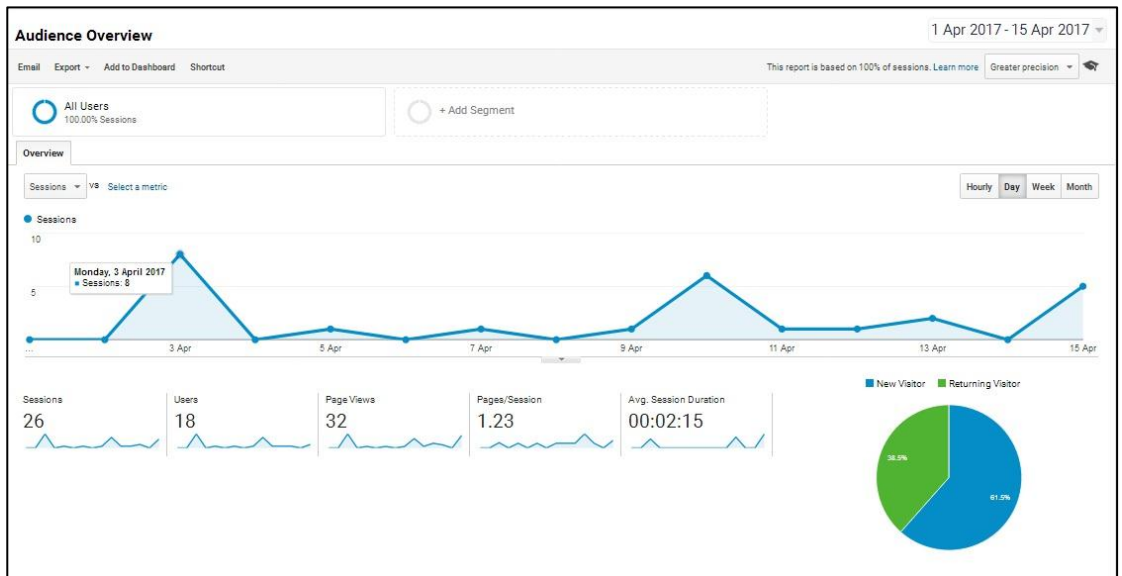


The screenshot shows the "Export" screen in the WordPress admin dashboard. The page title is "Export". Below the title, it says: "When you click the button below WordPress will create an XML file for you to save to your computer. This format, which we call WordPress eXtended RSS or WXR, will contain your posts, pages, comments, custom fields, categories, and tags. Once you've saved the download file, you can use the Import function in another WordPress installation to import the content from this site." Below this is the "Choose what to export" section with radio buttons for:

- All content (selected)
- Posts
- Pages
- Forums
- Topics
- Replies
- Visualizer Charts
- Media

At the bottom, there is a "Download Export File" button.

### 34. Tacking Statistics



### 35. Maintenance Mode

WP Maintenance Mode

Announcement: Introducing Codepad.co from WP Maintenance Mode authors!

Codepad is a new developers community who like to share/save code snippets and get/give feedback.

You always can follow the best developers on the [Codepad developers page](#).

Open Codepad!

General Design Modules

» Content

Title (HTML tag): Maintenance mode

Heading: Maintenance mode

Text: Sorry for the inconvenience. Our website is currently undergoing scheduled maintenance. Thank you for your understanding.

This message appears for website visitors when this plugin activated while making a website maintenance.

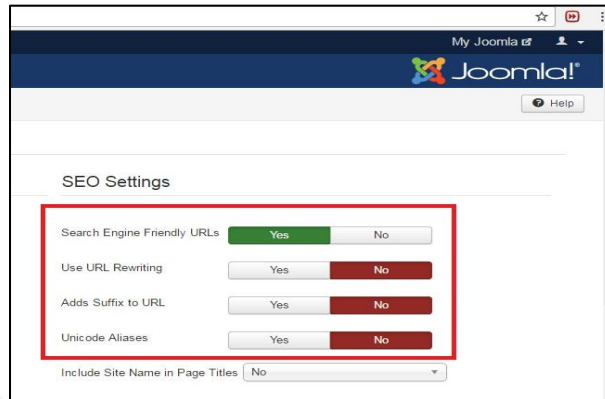
### 36. CMSs' Usage Statistics

Top in Open Source · Week beginning Apr 17th 2017	
Name	Entire Web
<a href="#">WordPress</a>	↑ 18,308,117
<a href="#">Joomla!</a>	↓ 2,166,689
<a href="#">Drupal</a>	↑ 701,774

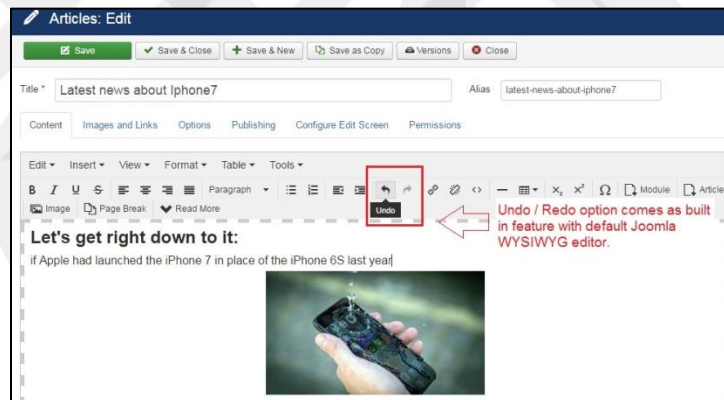
## APPENDIX E

### Joomla Content Management System Screenshots

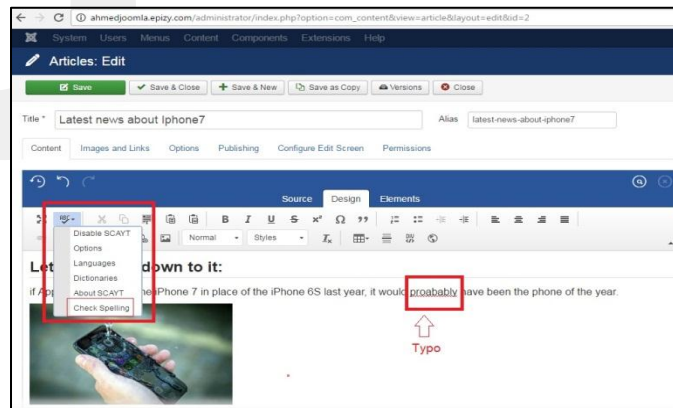
#### 1. Friendly URLs



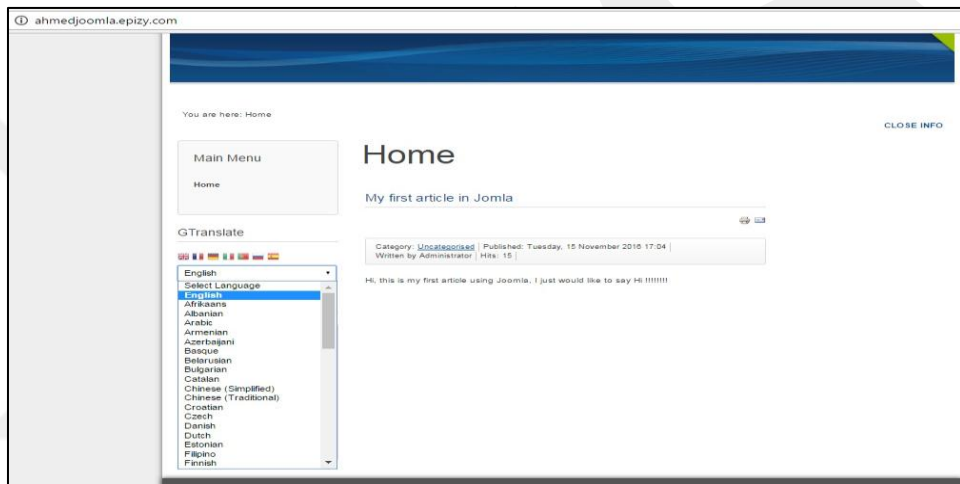
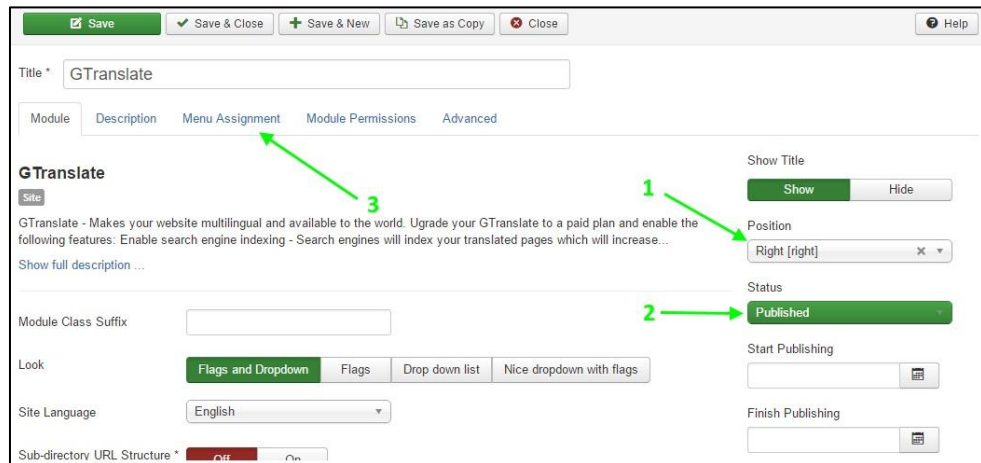
#### 2. Undo/Redo Functionality



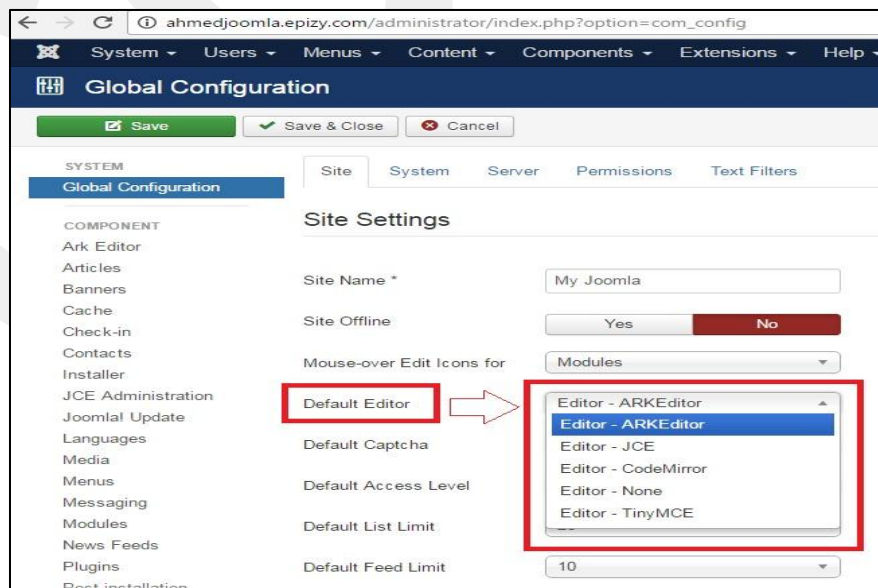
#### 3. Spell Checking

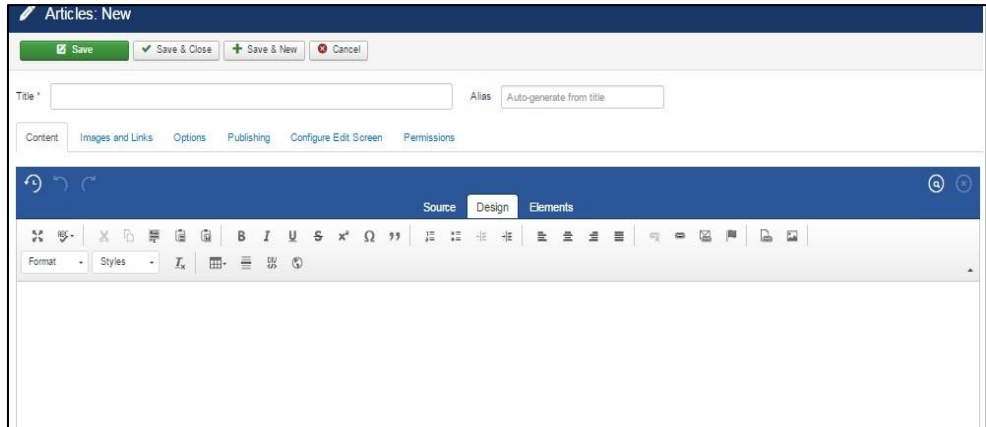


#### 4. Multilingual Site support

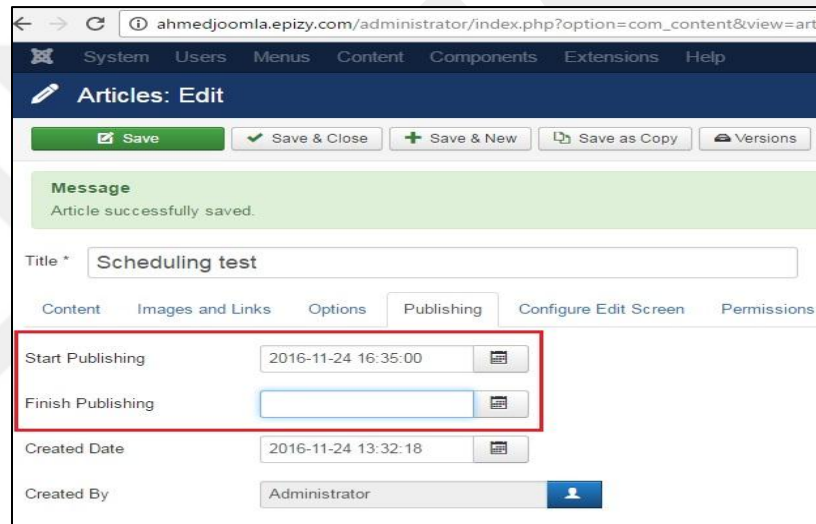


#### 5. Content Editor

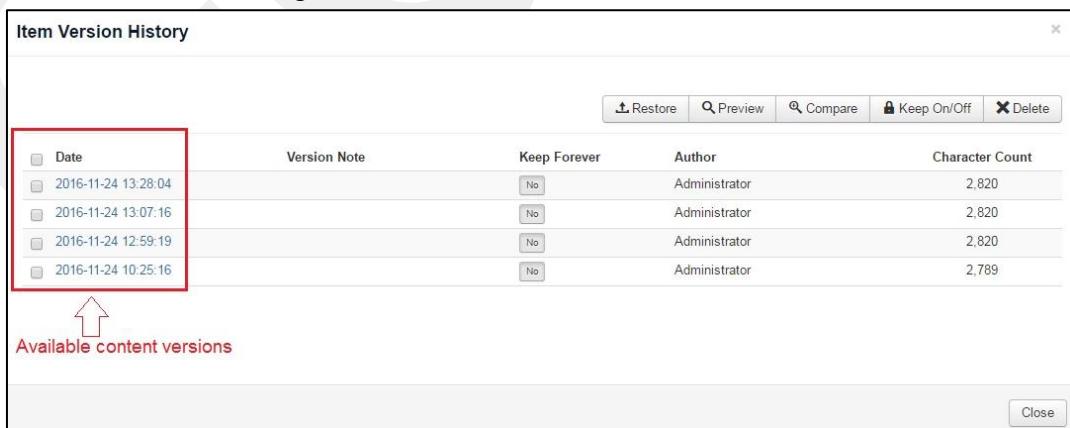




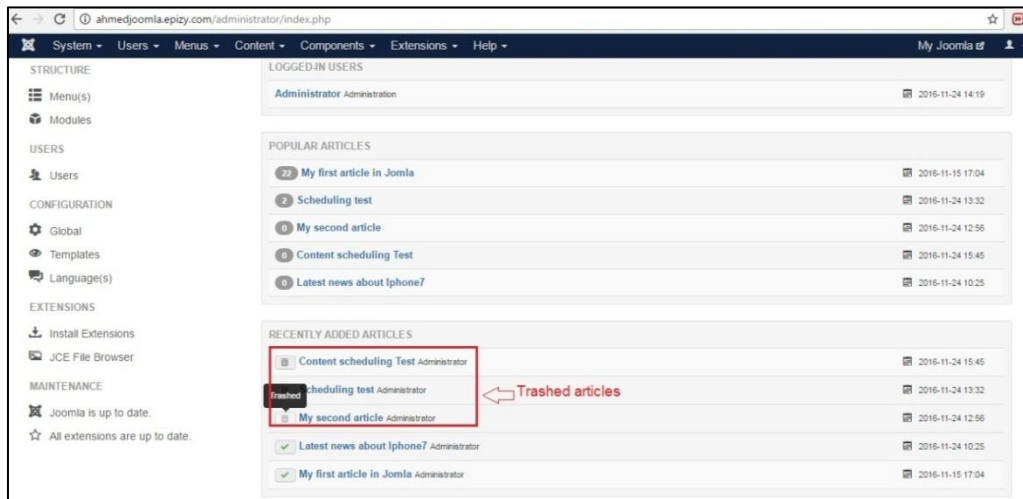
## 6. Content Scheduling



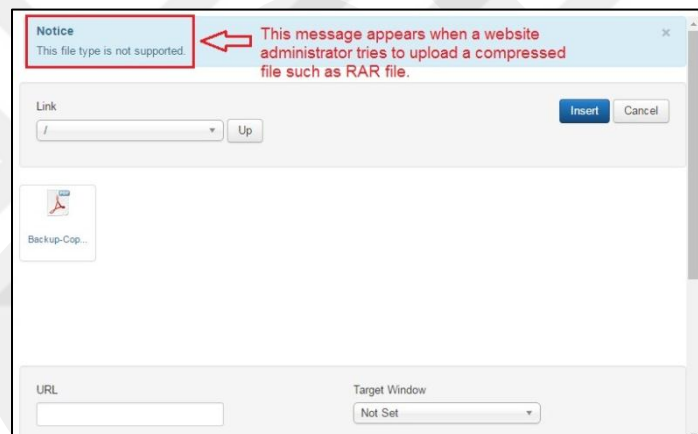
## 7. Content Versioning



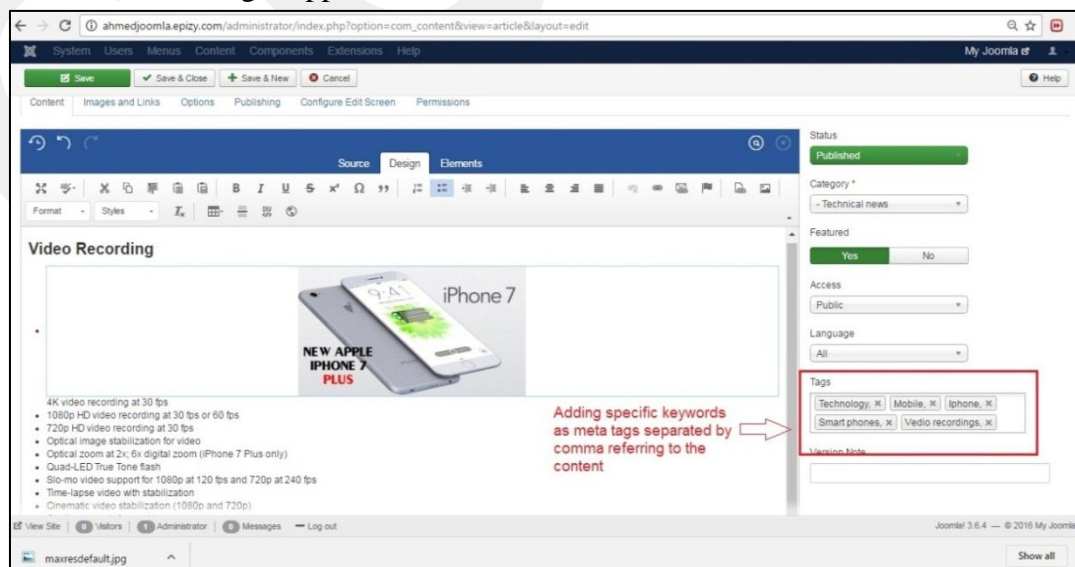
## 8. Trashed Content support



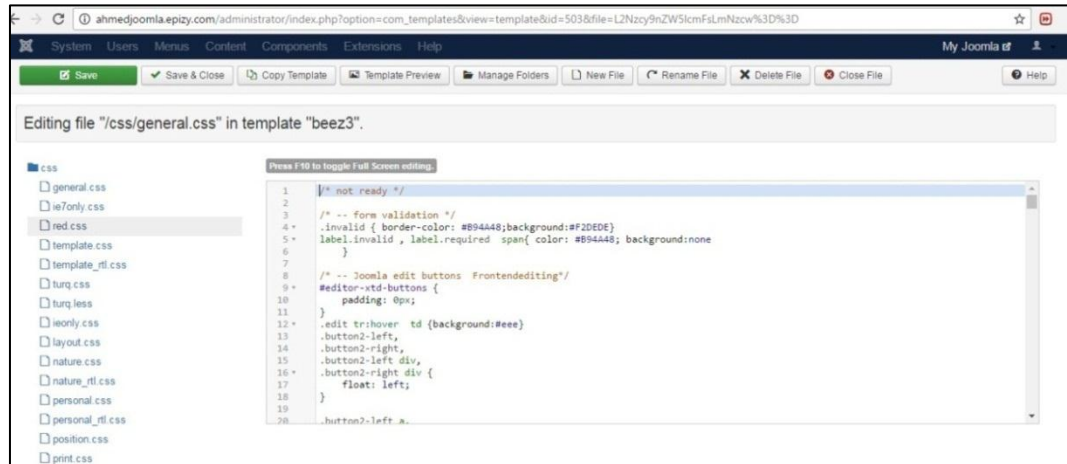
## 9. Compressed Files Upload



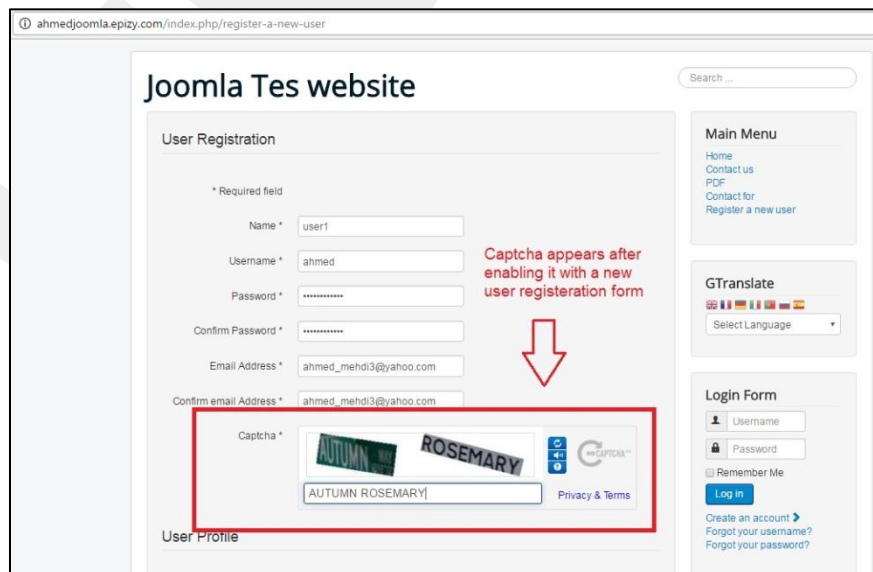
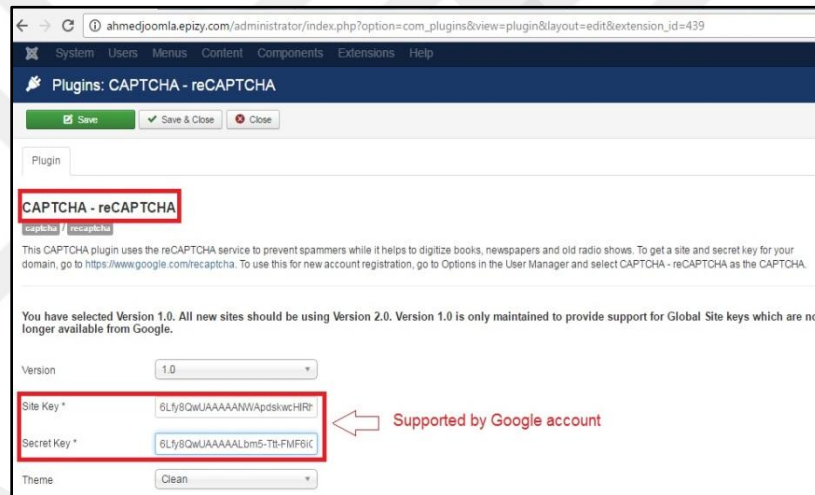
## 10. Metadata / Tags support



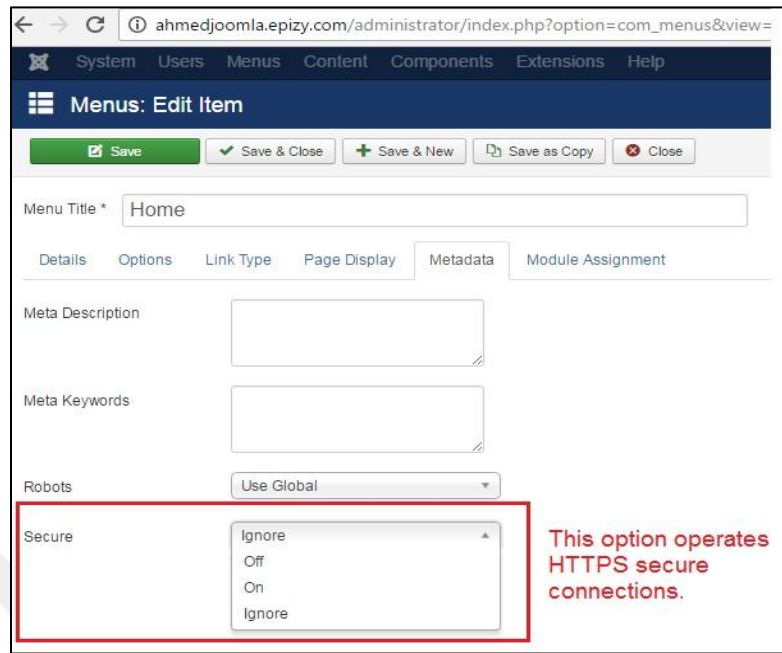
## 11. Application Programming Interface



## 12. CAPTCHA support

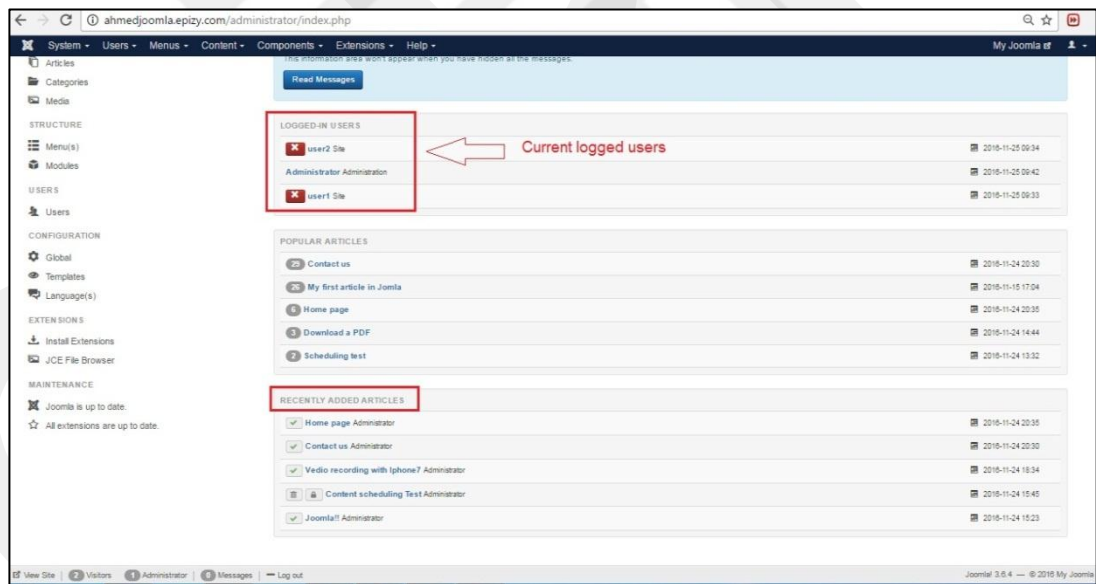


### 13. Secure Sockets Layer Certificate support



The screenshot shows the Joomla! administrator interface for editing a menu item. The 'Metadata' tab is selected, and the 'Secure' dropdown menu is highlighted with a red box. The dropdown options are 'Ignore', 'Off', 'On', and 'Ignore'. A red arrow points to the dropdown with the text: "This option operates HTTPS secure connections."

### 14. Log History



The screenshot shows the Joomla! administrator interface with the 'LOGGED-IN USERS' section highlighted. A red box highlights the 'user2 Site' and 'Administrator Administrator' entries, with a red arrow pointing to them and the text "Current logged users".

LOGGED-IN USERS	LOGGED-IN TIME
user2 Site	2016-11-25 09:34
Administrator Administrator	2016-11-25 09:42
user1 Site	2016-11-25 09:33

POPULAR ARTICLES	POPULAR TIME
Contact us	2016-11-24 20:30
My first article in Joomla	2016-11-15 17:04
Home page	2016-11-24 20:35
Download a PDF	2016-11-24 14:44
Scheduling test	2016-11-24 13:32

RECENTLY ADDED ARTICLES	RECENTLY ADDED TIME
Home page Administrator	2016-11-24 20:35
Contact us Administrator	2016-11-24 20:30
Vedio recording with Iphone7 Administrator	2016-11-24 18:34
Content scheduling Test Administrator	2016-11-24 15:45
Joomla! Administrator	2016-11-24 15:23

## 15. Authorized Access Control

Group Title	Enabled users	Disabled users	ID
Public	0	0	1
- Guest	0	0	9
- Manager	0	0	6
- Administrator	0	0	7
- Registered	0	4	2
- Author	0	0	3
- Editor	0	0	4
- Publisher	0	0	5
- Super Users	1	0	8

## 16. Email Verification

Account Details for user4 at My Joomla

My Joomla <admin@ahmedjoomla.epizy.com> to me - 3:11 PM (3 minutes ago)

Hello user4,  
 Thank you for registering at My Joomla. Your account is created and must be activated before you can use it.  
 To activate the account select the following link or copy-paste it in your browser:  
[http://ahmedjoomla.epizy.com/index.php?option=com\\_registration&view=registration&layout=edit&token=4042959867115499a9b0c472ad9e2f5](http://ahmedjoomla.epizy.com/index.php?option=com_registration&view=registration&layout=edit&token=4042959867115499a9b0c472ad9e2f5)  
 After activation you may login to <http://ahmedjoomla.epizy.com/> using the following username and password:  
 Username: joomla  
 Password: 123456

Get premium hosting from <https://fastnet.com>, free domain name, unlimited disk space... far too many features to list.

Spam Filtered (19148557)

Click here to Reply or Forward

0 GB (0% of 15 GB used) [Messages](#) [Terms](#) [Privacy](#) [Last account activity: Nov 11 Details](#)

## 17. Backup and Restore

ahmedjoomla.epizy.com/administrator/index.php?option=com\_akeeba

System - Users - Menus - Content - Components - Extensions - Help -

Akeeba Backup :: Control Panel

Active Profile: #1, Default Backup Profile [Switch Profiles](#)

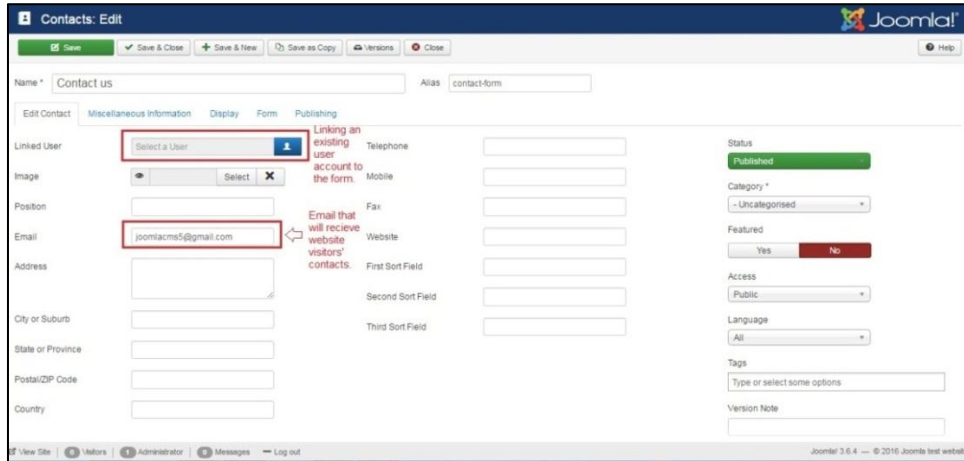
**One-click backup**

Default Backup Profile

**Basic Operations**

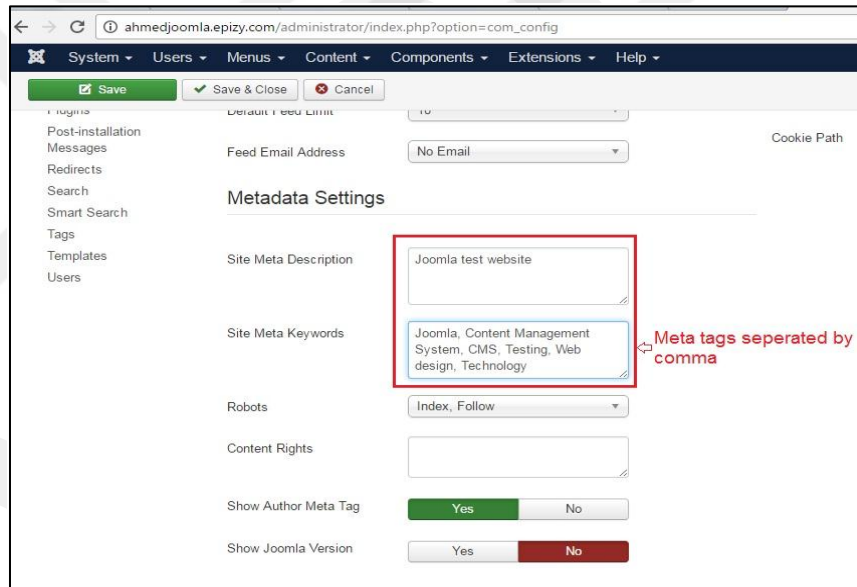
Backup Now Site Transfer Wizard Manage Backups Configuration Profiles Management

## 18. Contact Form



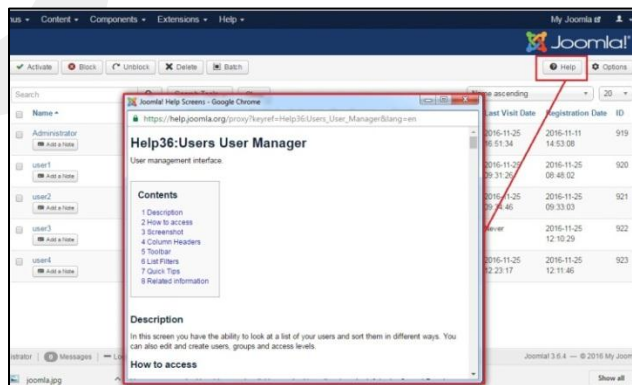
The screenshot shows the Joomla! 'Contacts: Edit' form. The 'Name' field is 'Contact us' and the 'Alias' is 'contact-form'. The 'Linked User' dropdown is highlighted with a red box and contains the text 'Select a User'. The 'Email' field is 'joomiacms@gmail.com' and is also highlighted with a red box. A red arrow points to the email field with the text 'Email that will receive website visitors' contacts'. The form includes fields for Telephone, Mobile, Fax, Website, and various sort fields. The status is 'Published'.

## 19. Search Engine Optimization SEO



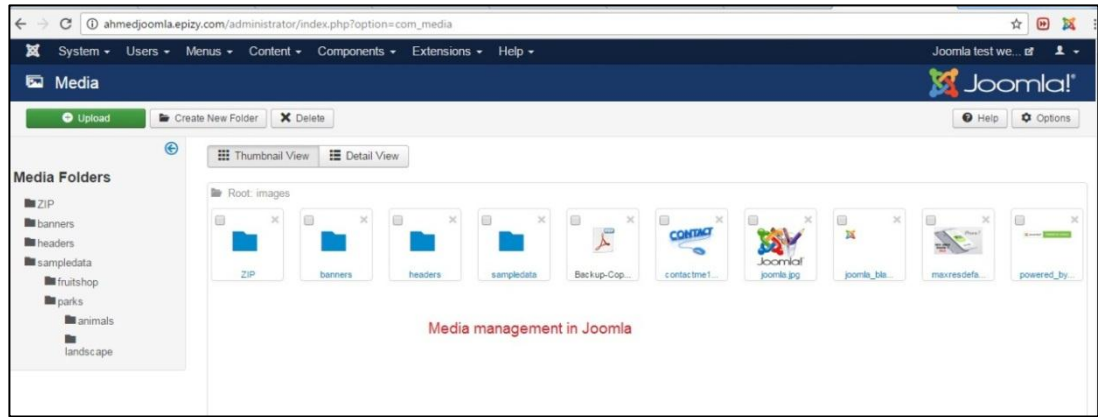
The screenshot shows the Joomla! 'Metadata Settings' page. The 'Site Meta Description' is 'Joomla test website'. The 'Site Meta Keywords' field is highlighted with a red box and contains the text 'Joomla, Content Management System, CMS, Testing, Web design, Technology'. A red arrow points to this field with the text 'Meta tags seperated by comma'. The 'Robots' dropdown is set to 'Index, Follow'. The 'Show Author Meta Tag' and 'Show Joomla Version' options are both set to 'Yes'.

## 20. Help File

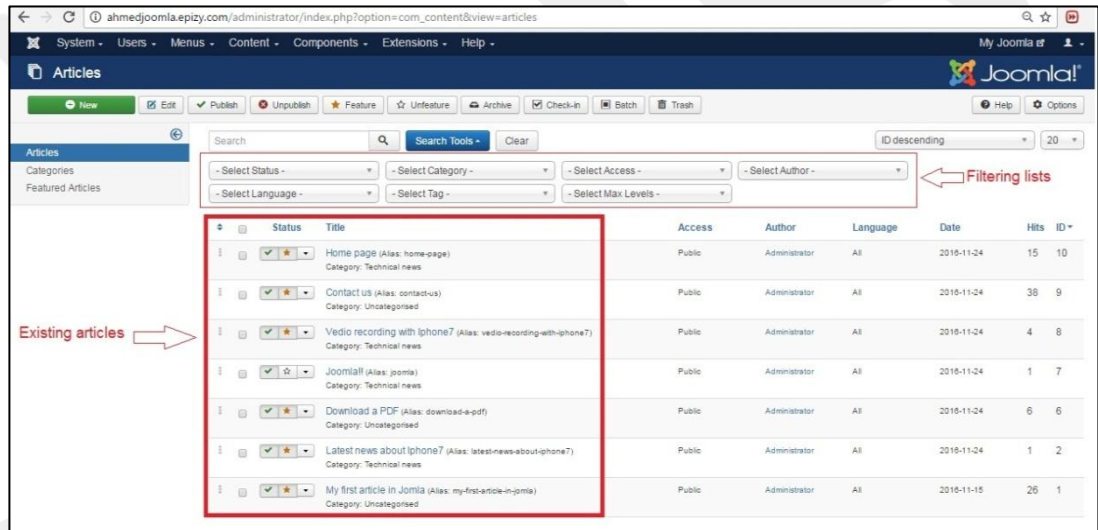


The screenshot shows the Joomla! Help File for 'Help36:Users User Manager'. The 'Contents' section is highlighted with a red box and lists: 1 Description, 2 How to access, 3 Screenshot, 4 Column Headers, 5 Toolbar, 6 List Filters, 7 Quick Task, 8 Related information. The 'Description' section states: 'In this screen you have the ability to look at a list of your users and sort them in different ways. You can also edit and create users, groups and access levels.' The 'How to access' section is also visible.

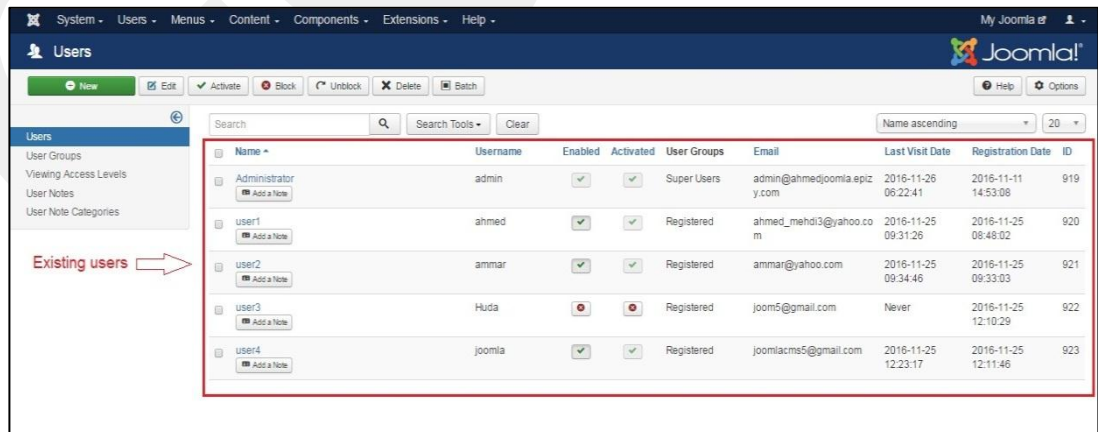
## 21. Media Management



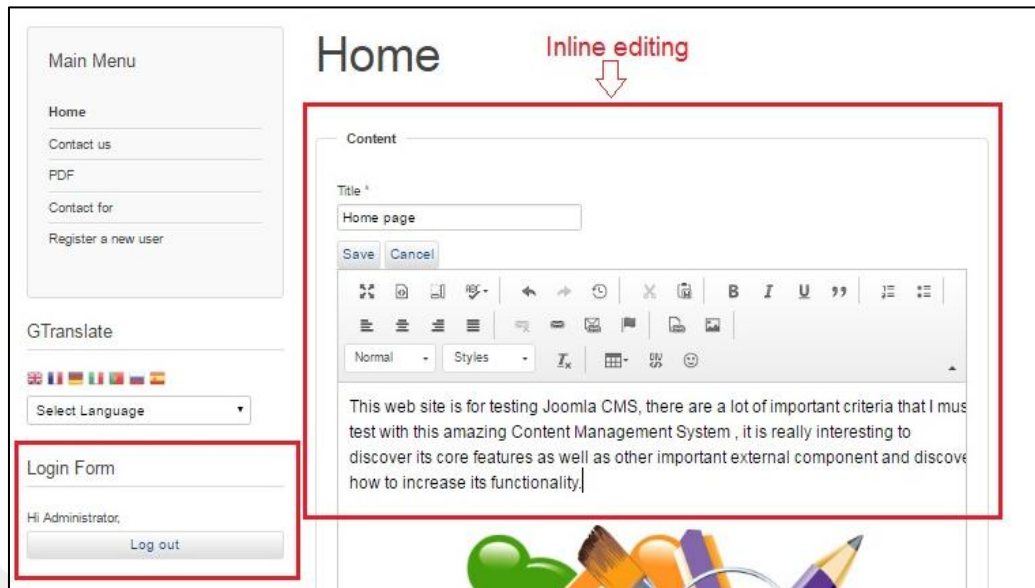
## 22. Content Management



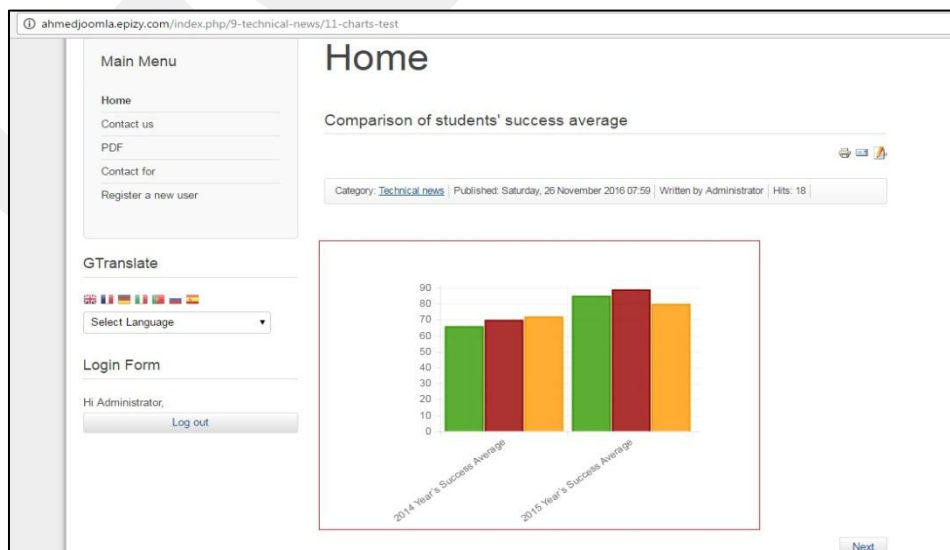
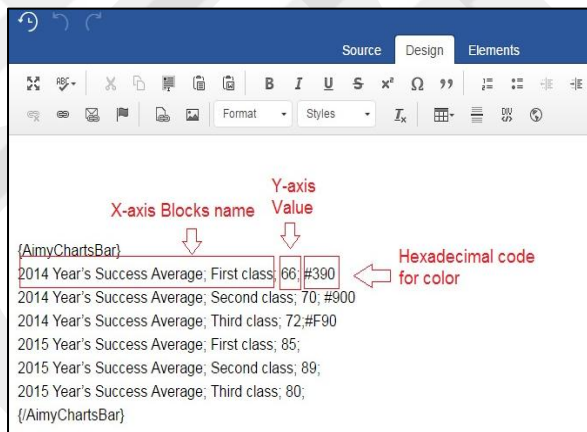
## 23. Users' Management



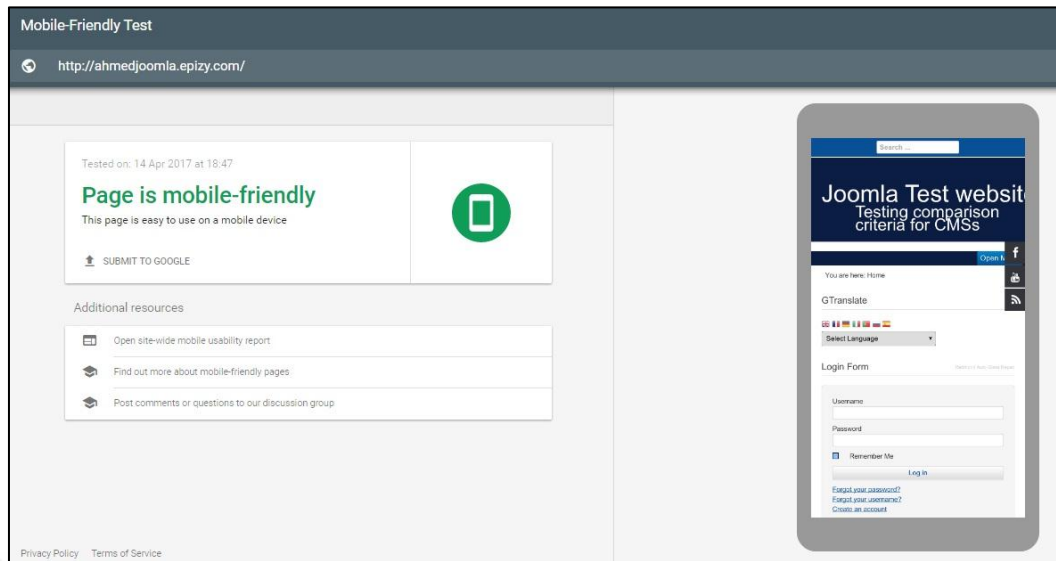
## 24. Inline Editing support



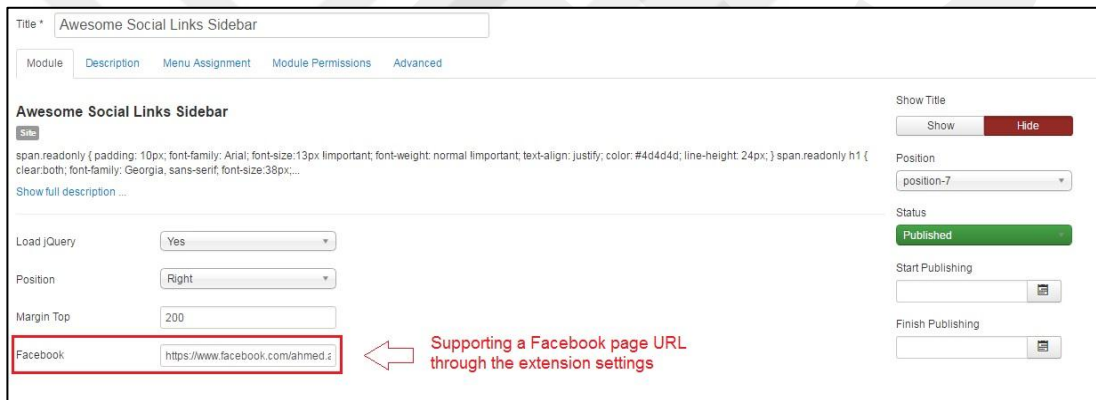
## 25. Charts and Graphs support



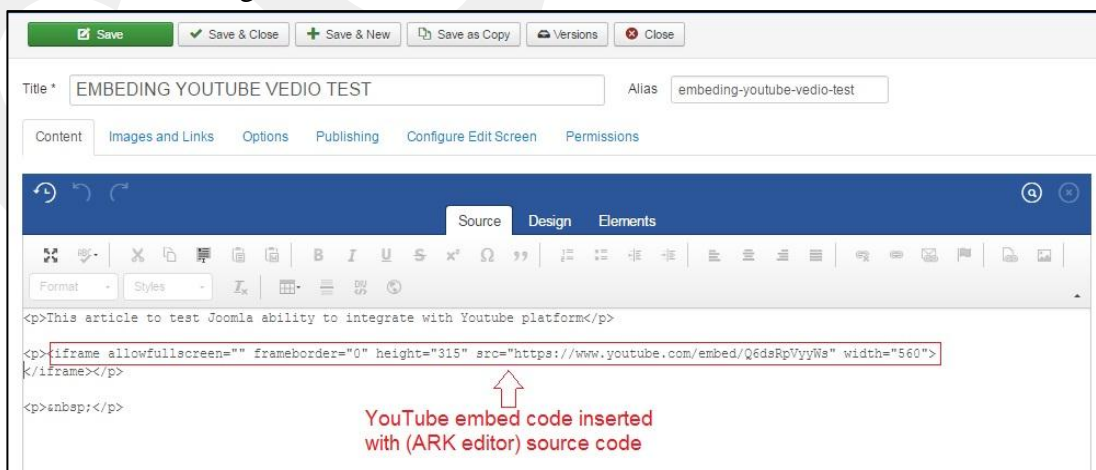
## 26. Mobile Friendly



## 27. Facebook Integration



## 28. YouTube Integration



## 29. Real Simple Syndication Feeds

System Users Menus Content Components Extensions Help

**Modules: Syndication Feeds**

Save Save & Close Save & New Cancel

Title \* RSS feed

Module Menu Assignment Module Permissions Advanced

**Syndication Feeds**

Site

Smart Syndication Module that creates a Syndicated Feed for the page where the Module is displayed.

Display Text Yes No

Text

Feed Format RSS 2.0

## 30. Web Push Notifications support

pushcrew

Your free plan allows for 499 more subscribers Upgrade Get Support Admin

Send Push Notifications

Title 40 Characters max

Message 100 Characters max

Landing Page URL Other URLs with http or https

Image

Send to All Subscribers Segments

Notification will be sent to all 1 subscribers

Advanced Options

Auto-hide notification after 20 seconds

Don't attempt sending this notification after 7 days hours from now

Schedule Notification

Date 07-01-2017 Hours 00 Minutes 00

Send Notification

Chrome on Desktop Notification Title Notification Message ahmedjoomla.pushcrew.com

Firefox on Desktop Notification Title ahmedjoomla.pushcrew.com Notification Message

Note: These previews are for representational purposes only based on how they may look on Mac OS. Actual notifications may differ based on text length and Operating System. If you're adding emojis, Chrome automatically appends a space next to each emotion in the actual notification.

## 31. Posting Comments support

ahmedjoomla.epizy.com/administrator/index.php?option=com\_plugins&view=plugins

System Users Menus Content Components Extensions Help My Joomla! Joomla!

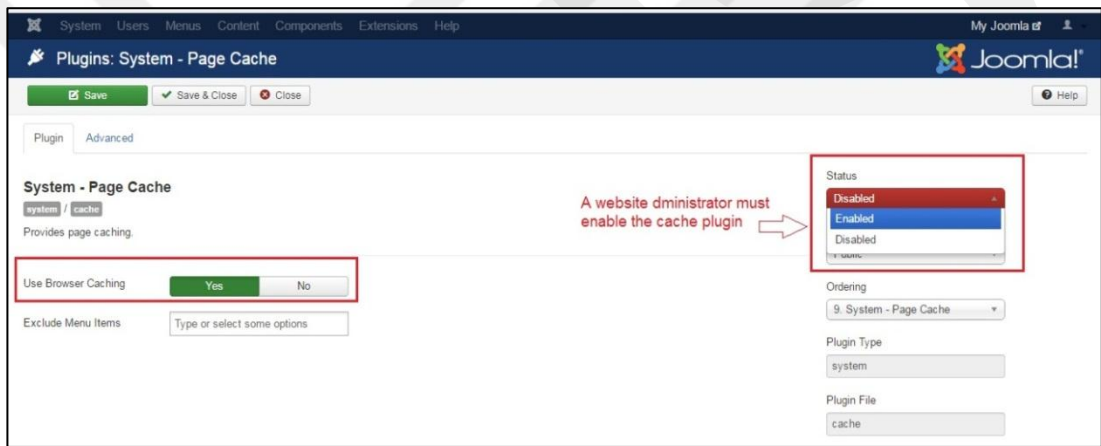
Edit Enable Disable Check-in Help Options

comments Search Tools Clear Type ascending 20

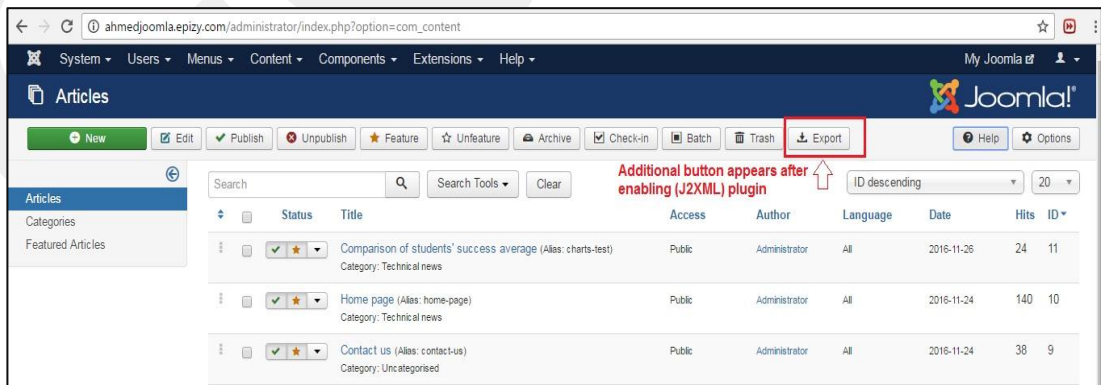
Status	Plugin Name	Type	Element	Access	ID
<input checked="" type="checkbox"/>	Disqus Comments (for Joomla) [by JoomlaWorks]	content	jw_disqus	Public	10113
<input checked="" type="checkbox"/>	System - Disqus Comments (for Joomla) [by JoomlaWorks]	system	jw_disqus	Public	10114



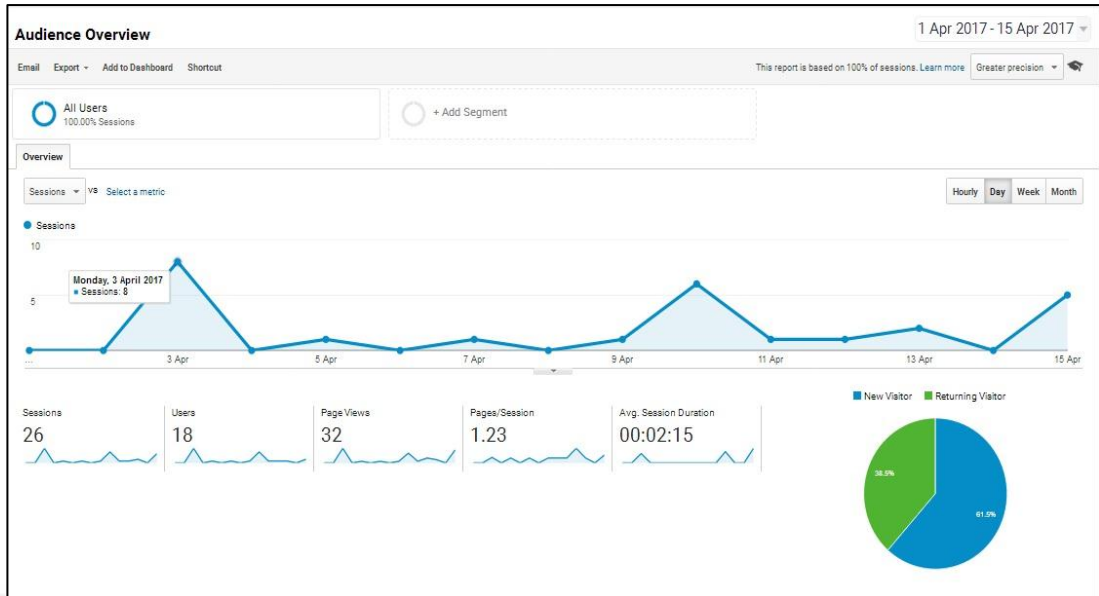
### 32. Page Caching



### 33. Import and Export Content







### 36. Maintenance Mode:

#### Site Settings

Site Name \* Joomla test website

Site Offline  Yes  No

Offline Message Use Custom Message

Custom Message This site is down for maintenance.<br />Please

Offline Image  Select

#### Joomla test website

This site is down for maintenance.  
Please check back again soon.

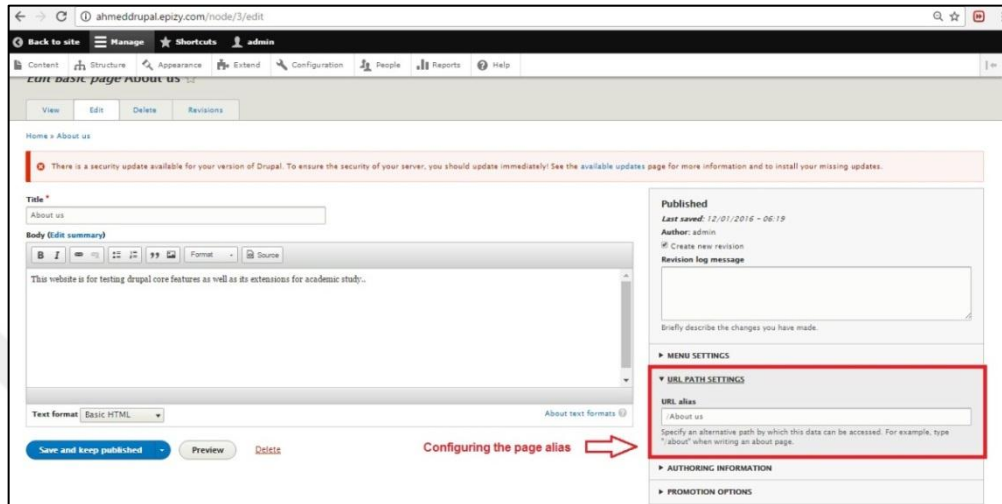
Username

Password

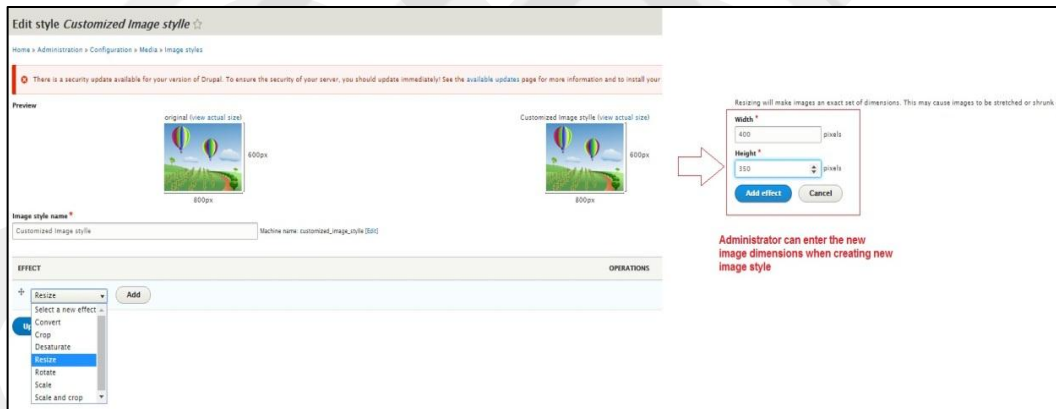
## APPENDIX F

### Drupal Content Management System Screenshots

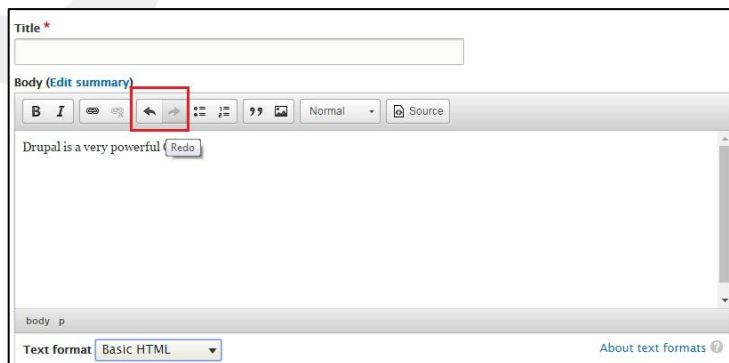
#### 1. Friendly URLs



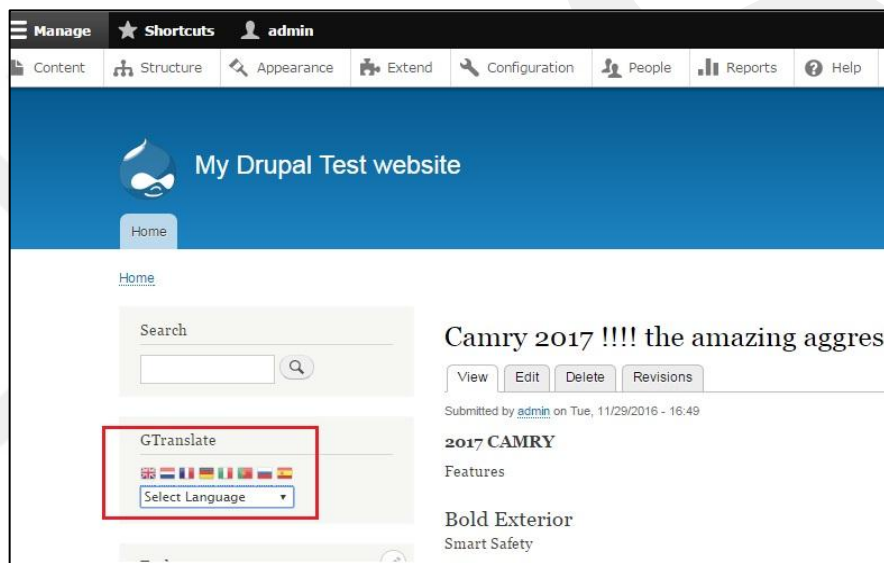
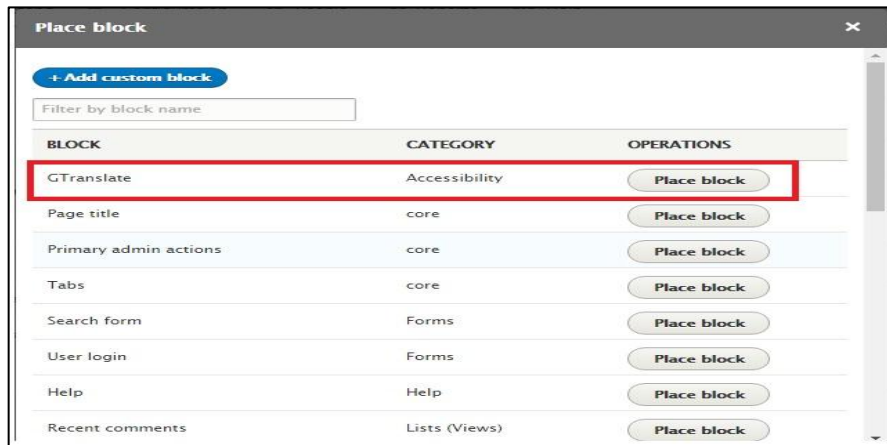
#### 2. Image Responsiveness:



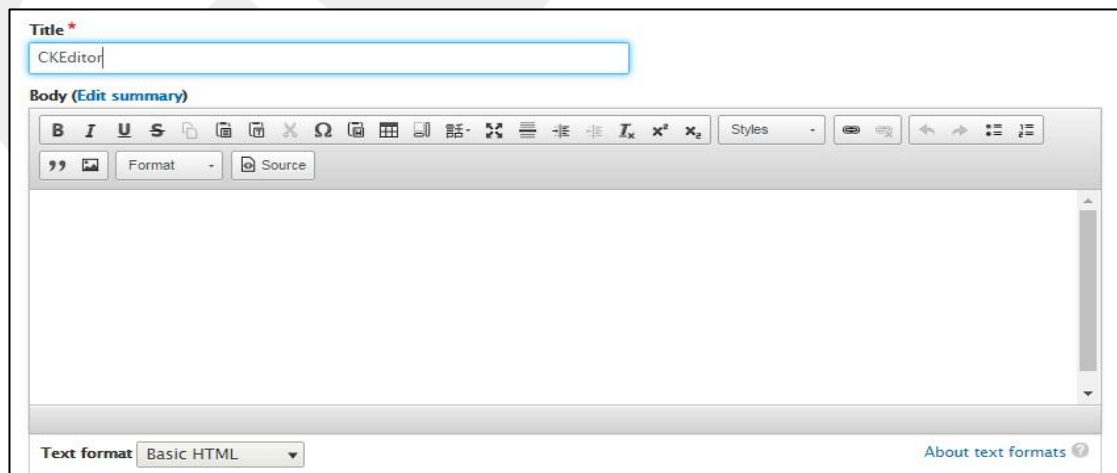
#### 3. Undo / Redo Functionality



#### 4. Multilingual Site support



#### 5. Content Editor



## 6. Content Scheduling

The screenshot shows a content editor interface. The main editing area contains a text field with "Scheduling test" and a rich text editor with "Hi there". On the right sidebar, the "SCHEDULING OPTIONS" section is highlighted with a red box. It includes a "Publish on" field with the date "12/01/2016" and time "02:21:00 PM". Below it, a note states: "Format: 2016-12-01 11:26:33. Leave the date blank for no scheduled publishing." A red arrow points to this section with the text "A new option appears after installing scheduler module".

## 7. Content Versioning

The screenshot shows the "Revisions for Scheduling test" page. It features a table with two columns: "REVISION" and "OPERATIONS". The first row is highlighted in yellow and indicates the "Current revision" with a date and time of "12/01/2016 - 11:31" by "admin". The second row shows a previous revision from "12/01/2016 - 11:22" by "admin", and the third row shows another from "12/01/2016 - 11:19" by "admin". The "OPERATIONS" column for the second and third rows includes "Revert" and "Delete" buttons. A red box highlights the first two rows of the table.

REVISION	OPERATIONS
12/01/2016 - 11:31 by admin	Current revision
12/01/2016 - 11:22 by admin	Revert
12/01/2016 - 11:19 by admin	Revert Delete

## 8. Compressed Files Upload

The screenshot shows an "Image" upload form. A red error message box at the top states: "The specified file JPCS.rar could not be uploaded." Below this, a list of allowed file extensions is provided: "Only files with the following extensions are allowed: gif png jpg jpeg." The form includes a "Choose File" button, a text field for "Alternative text", radio buttons for "Align" (None, Left, Center, Right), a checkbox for "Caption", and a "Save" button.

## 9. Metadata/Tags support

Back to site | Manage | Shortcuts | admin

Content | Structure | Appearance | Extend | Configuration | People | Reports | Help

Browse available tokens.

**BASIC TAGS**

Simple meta tags.

**Page title**  
  
 The text to display in the title bar of a visitor's web browser when they view this page. This meta tag may also be used as the title of the page when a visitor bookmarks or favorites this page. It is common to append "[site.name]" to the end of this, so the site's name is automatically added.

**Description**  
  
 A brief and concise summary of the page's content, preferably 150 characters or less. The description meta tag may be used by search engines to display a snippet about the page in search results.

**Abstract**  
  
 A brief and concise summary of the page's content, preferably 150 characters or less. The description meta tag may be used by search engines to display a snippet about the page in search results.

**Keywords**  
  
 A comma-separated list of keywords about the page. This meta tag is not supported by most search engines anymore.

← Meta tags separated by comma

ADVANCED

Save Delete

## 10. CAPTCHA support

This page gives an overview of all available challenge types, generated with their current settings.

**CHALLENGE MATH BY MODULE CAPTCHA**

**Math question\***

3 + 0 =

Solve this simple math problem and enter the result. E.g. for 1+3, enter 4.  
 10 more examples of this challenge.

**CHALLENGE IMAGE BY MODULE IMAGE CAPTCHA**

**What code is in the image?\***

Enter the characters shown in the image.  
 10 more examples of this challenge.

**CAPTCHA challenges with installed module**

**CAPTCHA appears with a new user registration form**

▼ CAPTCHA

This question is for testing whether or not you are a human visitor

**What code is in the image?\***

Enter the characters shown in the image.

Create new account

## 11. Log History

ahmeddrupal.epizy.com/admin/reports/dblog

Back to site | Manage | Shortcuts | admin

Content | Structure | Appearance | Extend | Configuration | People | Reports | Help

**FILTER LOG MESSAGES**

Type: access denied, contact, content, cron, file system, system, user

Severity: Emergency, Alert, Critical, Error, Warning, Notice, Info, Debug

Filter Reset

TYPE	DATE	MESSAGE	USER	OPERATIONS
user	12/02/2016 - 07:38	Session opened for admin.	admin	
user	12/02/2016 - 07:23	Session closed for admin.	admin	
user	12/02/2016 - 06:57	Session opened for admin.	admin	
user	12/01/2016 - 20:42	Session closed for admin.	admin	
user	12/01/2016 - 20:16	Session opened for admin.	admin	
user	12/01/2016 - 19:51	Session closed for admin.	admin	
user	12/01/2016 - 19:18	Session opened for User1.	User1	
user	12/01/2016 - 19:17	Login attempt failed for User1.	Anonymous (not verified)	
user	12/01/2016 - 19:17	Login attempt failed for User1.	Anonymous (not verified)	

## 12. Authorized Access Control

PERMISSION	ANONYMOUS USER	AUTHENTICATED USER	ADMINISTRATOR	EDITOR
<b>BYPASS CONTENT ACCESS CONTROL</b> <i>Warning: Give to trusted roles only; this permission has security implications. View, edit and delete all content regardless of permission restrictions.</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Delete all revisions <i>Role requires permission to view revisions and delete rights for nodes in question or administrator nodes.</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Revert all revisions <i>Role requires permission view revisions and edit rights for nodes in question or administrator nodes.</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
View all revisions	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
View own unpublished content	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
View published content	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Article Create new content	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Article Delete any content	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Article Delete own content	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Article Delete revisions	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>

**1 - Assigning Permissions to the new user role.**

**2- Creating a new user account and giving him editor role**

Roles

- Authenticated user
- Administrator
- Editor
- Notify user of new account

## 13. Email Verification

**REGISTRATION AND CANCELLATION**

**Who can register accounts?**

- Administrators only
- Visitors
- Visitors, but administrator approval is required
- Require email verification when a visitor creates an account  
New users will be required to validate their email address prior to logging into the site, and will be assigned a system-generated password. With this setting disabled, users will be logged in immediately upon registering, and may select their own passwords during registration.

Enable password strength indicator

**When cancelling a user account**

- Disable the account and keep its content.
- Disable the account and unpublish its content.
- Delete the account and make its content belong to the *Anonymous* user.

Users with the *Select method for cancelling account* or *Administer users permissions* can override this default method.

Account details for Joomla! at My Drupal Test website (approved)

My Drupal Test website <admin@ahmeddrupal.epizy.com>  
3:22 PM (17 minutes ago)

Joomla,  
Your account at My Drupal Test website has been activated.  
You may now log in by clicking this link or copying and pasting it into your browser:  
[http://ahmeddrupal.epizy.com/user/reset/15/14806813719/IN6aA\\_PPV1aWtEMUJJPXNNTUkRz80T6RtE%TD8e0](http://ahmeddrupal.epizy.com/user/reset/15/14806813719/IN6aA_PPV1aWtEMUJJPXNNTUkRz80T6RtE%TD8e0)  
This link can only be used once to log in and will lead you to a page where you can set your password.  
After setting your password, you will be able to log in at <http://ahmeddrupal.epizy.com/user> in the future using:  
username: Joomla  
password: Your password  
-- My Drupal Test website team

Get premium hosting from <https://fastnet.com>, free domain name, unlimited disk space..., far too many features to list.

## 14. Backup and Restore

The screenshot shows the 'Backup and Migrate' configuration page in a Drupal administration interface. The breadcrumb trail is 'Home > Administration > Configuration > Development'. The page title is 'Backup and Migrate'. There are tabs for 'Backup', 'Restore', 'Saved Backups', 'Schedules', and 'Settings', with 'Backup' selected. Below the tabs are links for 'Quick Backup' and 'Advanced Backup'. The 'QUICK BACKUP' section has 'Backup Source' set to 'Default Drupal Database' and 'Backup Destination' set to 'Download'. A 'Backup now' button is present. A red arrow points to this button with the text: 'A website administrator can backup the website database to be restored later'. The 'Module options' section is also visible.

## 15. Contact Form

### Contact the website administrator


Your name\*

Your email address\*

Subject\*

Message\*

Telephone

▼ CAPTCHA  
*This question is for testing whether or not you are a human visitor and to prevent automated spam submissions.*  
  
What code is in the image? \*  
  
Enter the characters shown in the image.

## 16. Search Engine Optimization SEO

Check off each SEO-related task as you complete it. Don't forget to click the **Save** button!

Last updated Fri, 12/02/2016 - 17:12 by admin 4 of 77 (5%)

Hide item descriptions

### Recommended tasks by SEO checklist module for best SEO .

While not strictly necessary for SEO, these tasks will set you up to get things done much quicker.

- Install and Enable SEO Checklist module** - Completed 12/02/2016 - 17:12 by admin  
The Drupal SEO Checklist uses Drupal SEO best practices to check your website for proper search engine optimization. See *Drupal 8 SEO Chapter 2, p. 19*.  
Download | Install | Configure permissions | Configure
- [Optional] **Install and Enable Coffee module**  
The Coffee module helps you to navigate through the Drupal admin faster, inspired by Mac apps Alfred and Spotlight. See *Drupal 8 SEO Chapter 2, p. 27*.  
Download | Install | SEO training camp
- [Optional] **Configure Coffee module**  
Set up which menus Coffee will display. See *Drupal 8 SEO Chapter 2, p. 31*.
- [Optional] **Install and Enable Admin Toolbar module**  
Provides quicker access to administration pages by adding drop-down and pull-out menus to the Drupal admin toolbar. See *Drupal 8 SEO Chapter 2, p. 35*.  
Download | Install | SEO training camp
- [Optional] **Install Composer command line tool**  
Composer is the package manager for PHP. It installs modules and keeps a configuration file for faster deployment. See *Drupal 8 SEO Chapter 1*.  
Download
- [Optional] **Install Drupal Console command line tool**  
Drupal Console is a newer command line tool that also helps you to install modules faster. See *Drupal 8 SEO Chapter 1*.  
Download | SEO training camp

## 17. Help File

Follow these steps to set up and start using your website:

- Configure your website** Once logged in, visit the [Administration page](#), where you may customize and configure all aspects of your website.
- Enable additional functionality** Next, visit the [Extend page](#) and enable modules that suit your specific needs. You can find additional modules at the [Drupal.org modules page](#).
- Customize your website design** To change the "look and feel" of your website, visit the [Appearance page](#). You may choose from one of the included themes or download additional themes from the [Drupal.org themes page](#).
- Start posting content** Finally, you may add new content to your website.

For more information, refer to the help listed on this page or to the online documentation and support pages at [drupal.org](#).

### Module overviews

Module overviews are provided by modules. Overviews available for your installed modules:

- Actions
- Automated Cron
- Block
- Breakpoint
- CAPTCHA
- CKEditor
- Checklist API
- Color
- Comment
- Configuration Manager
- Configuration Translation
- Contact
- Content Translation
- Contextual Links
- Custom Block
- Custom Menu Links
- Database Logging
- Datetime
- Field
- Field UI
- File
- Filter
- Forum
- GTranslate
- Help
- History
- Image
- Image CAPTCHA
- Interface Translation
- Internal Dynamic Page Cache
- Internal Page Cache
- Language
- Link
- Menu UI
- Metatag
- Node
- Options
- Path
- Quick Edit
- RDF
- Scheduler
- Search
- Shortcut
- System
- Taxonomy
- Telephone
- Text
- Text Editor
- Token
- Toolbar
- Tour
- Update Manager
- User
- Views
- Views UI

## 18. Media Management

Home » Administration » Content

[+ Add media](#)

Publishing status:  Provider:  Media name:  Language:

THUMBNAIL	MEDIA NAME	PROVIDER	AUTHOR	STATUS	UPDATED	OPERATIONS
	First video	Video	admin	Published	11/30/2016 - 15:41	<input type="button" value="Edit"/>
	Image 2	Image	admin	Published	11/30/2016 - 15:27	<input type="button" value="Edit"/>

## 19. Content Management

The screenshot shows the Drupal administration interface for content management. At the top, there are navigation tabs for 'Content', 'Scheduled', 'Comments', and 'Files'. Below these, there are filter options for 'Published status', 'Content type', 'Title', and 'Language', with a 'Filter' button. An 'Action' dropdown menu is set to 'Delete content'. A table lists content items with columns for 'TITLE', 'CONTENT TYPE', 'AUTHOR', 'STATUS', 'UPDATED', and 'OPERATIONS'. The table contains four rows of content items, each with an 'Edit' button. Red annotations highlight the filter options, the action menu, and the content table.

Published status:  Content type:  Title:  Language:

Filter

Action:

Apply to selected items

TITLE	CONTENT TYPE	AUTHOR	STATUS	UPDATED	OPERATIONS
About us	Basic page	admin	Published	12/02/2016 - 18:32	<input type="button" value="Edit"/>
Drupal discussion forum	Forum topic	admin	Published	12/01/2016 - 20:38	<input type="button" value="Edit"/>
Scheduling test	Article	admin	Published	12/01/2016 - 14:21	<input type="button" value="Edit"/>
WYSIWYG Editors	Article	admin	Published	12/01/2016 - 14:18	<input type="button" value="Edit"/>

## 20. Users' Management

The screenshot shows the Drupal administration interface for user management. At the top, there are navigation tabs for 'Content', 'Structure', 'Appearance', 'Extend', 'Configuration', 'People', 'Reports', and 'Help'. Below these, there are filter options for 'Name or email contains', 'Role', 'Permission', and 'Status', with a 'Filter' button. An 'Action' dropdown menu is set to 'Add the Administrator role to the selected users'. A table lists registered users with columns for 'USERNAME', 'STATUS', 'ROLES', 'MEMBER FOR', 'LAST ACCESS', and 'OPERATIONS'. The table contains five rows of user information, each with an 'Edit' button. Red annotations highlight the filter options, the action menu, and the user table.

Name or email contains:  Role:  Permission:  Status:

Filter

Action:

Apply to selected items

Registered users and their roles

USERNAME	STATUS	ROLES	MEMBER FOR	LAST ACCESS	OPERATIONS
Fatma	Active		22 hours 50 minutes	never	<input type="button" value="Edit"/>
Joomla	Active		23 hours 10 minutes	22 hours 58 minutes ago	<input type="button" value="Edit"/>
User1	Active	• Editor	1 day 16 hours	1 day 16 hours ago	<input type="button" value="Edit"/>
Ahmed	Active		4 days 2 hours	3 days 18 hours ago	<input type="button" value="Edit"/>
admin	Active	• Administrator	3 weeks	18 seconds ago	<input type="button" value="Edit"/>

## 21. Inline Editing support

The screenshot shows a Drupal website with a blue header and navigation menu. The main content area displays a text block with a WYSIWYG editor overlay. The editor has a toolbar with various formatting options like bold, italic, underline, and link. The text in the editor reads: 'This article is for future publishing to test the ability of Drupal to schedule the content'. A red annotation points to the editor overlay, indicating inline editing support.

My Drupal Test website  
The best place to test Drupal core features.

Home About us Drupal discussion forum Contact

Home

Search

GTranslate

Select Language

Body → WYSIWYG Editors

Inline editing directly from the front end

This article is for future publishing to test the ability of Drupal to schedule the content

Add new comment

Subject



## 25. YouTube Integration

Home » Testing embedded YouTube video

**Title \***  
A YouTube video integration Test

**Body (Edit summary)**

**Source**

```
<p>This article to test Drupal ability to operate a YouTube video</p>
<p><iframe allowfullscreen="" frameborder="0" height="315"
src="https://www.youtube.com/embed/Q6dsRpVyyWs" width="560"></iframe></p>
```

A YouTube video embed code with the Full HTML text format

Text format: Full HTML

## 26. Real Simple Syndication Feeds

Home » Administration » Structure » Menus

**Menu link title \***  
Follow us on RSS

**Link \***  
http://feeds.feedburner.com/DrupalTestWebsite

Enabled

**Description**

Show as expanded

**Parent link**  
<Main navigation>

**Weight**  
2

Save Delete

## 27. Posting Comments support

PERMISSION	ANONYMOUS USER	AUTHENTICATED USER	ADMINISTRATOR
<b>Comment</b>			
Administer comment types and settings <i>Warning: Give to trusted roles only; this permission has security implications.</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Administer comments and comment settings	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Edit own comments	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Post comments	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Skip comment approval	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
View comments	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

Default comments permissions

## 28. Page Caching

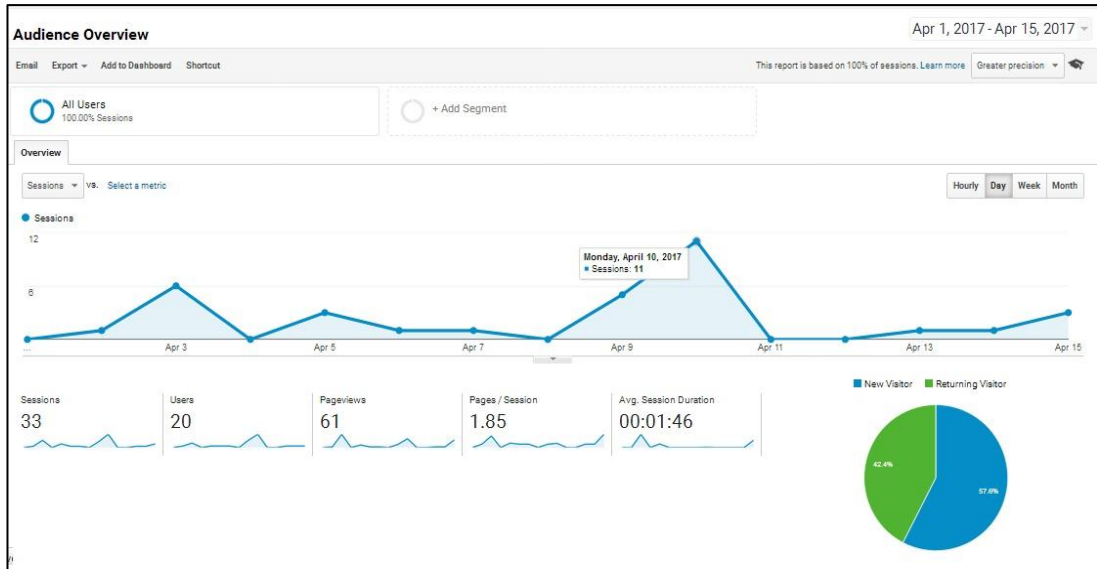
The screenshot shows the Drupal administration interface with the 'Extend' tab selected. A list of installed modules is displayed, including History, Internal Dynamic Page Cache, Internal Page Cache, Menu UI, Node, Path, and Quick Edit. The 'Internal Page Cache' module is highlighted with a red box, and a red arrow points to it with the text 'Page caching module installed and activated by default.' The module details for 'Internal Page Cache' are: Machine name: page\_cache, Version: 8.2.3, and a Help link.

## 29. Dynamic Page Caching

The screenshot shows the Drupal administration interface with the 'Extend' tab selected. A list of installed modules is displayed, including Custom Menu Links, Database Logging, Field, Field UI, Filter, Forum, Help, History, and Internal Dynamic Page Cache. The 'Internal Dynamic Page Cache' module is highlighted with a red box, and a red arrow points to it with the text 'Dynamic page cache module installed and activated by default.' The module details for 'Internal Dynamic Page Cache' are: Machine name: dynamic\_page\_cache, Version: 8.2.3, and a Help link.

## 30. Tracking Statistics

The screenshot shows the Google Analytics configuration page in the Drupal administration interface. The 'Web Property ID' field is highlighted with a red box, and a red arrow points to it with the text 'Tracking ID supported by Google analytics'. The Web Property ID is UA-88435723-1. Below the Web Property ID field, there is a section for 'Tracking scope' with sub-sections for Domains, Pages, Roles, Users, and Links and downloads. The 'Pages' section is expanded, showing a list of pages to track: admin, admin/\*, /batch, /node/add\*, node/\*, and user/\*.



## 31. Maintenance Mode

Back to site Manage Shortcuts admin

Content Structure Appearance Extend Configuration People Reports Help

### Maintenance mode

Home » Administration » Configuration » Development

Use maintenance mode when making major updates, particularly if the updates could disrupt visitors or the update process. Examples include upgrading, importing or exporting content, modifying a theme, modifying content types, and making backups.

Put site into maintenance mode **Activating maintenance mode**

Visitors will only see the maintenance mode message. Only users with the "Access site in maintenance mode" permission will be able to access the site. Authorized users can log in directly via the user login page.

**Message to display when in maintenance mode**

Site is currently under maintenance. We should be back shortly. Thank you for your patience.

**Offline mode message**

**Save configuration**

## CURRICULUM VITAE

### PERSONAL INFORMATION

**Surname, Name:** AL-TAMEEMI, Ahmed Abdulmahdi Hussein

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### EDUCATION

Degree	Institution	Year of Graduation
M.Sc.	Çankaya University The Department of Mathematics/ Information Technology Program	2017
B.Sc.	AL Yarmouq University College, Computer Sciences	2004
High School	Ali Bin Abi Talib High School	2000

### WORK EXPERIENCE

Year	Place	Enrollment
2005-present	Ministry of Water resources, General Directorate for Dams and Reservoirs, Hemreen Dam Project.	Senior Programmer

### LANGUAGES

Arabic (Native), English.