Lappeenranta University of Technology

School of Industrial Engineering and Management

Department of Software Engineering and Information Management

MASTER THESIS

USABILITY COMPARISON OF OPEN SOURCE CONTENT MANAGEMENT SYS-TEMS

EXAMINER(s):   Professor, Ph.D Kari Smolander

M.Sc, Erno Vanhala

Supervisor: Professor, Ph.D Kari Smolander

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Mohamed Hassan Ibrahim

Pakilantie 12 C 113

00630 Helsinki

maxamedxasan@yahoo.com

Abstract

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Mohamed Hassan Ibrahim

Usability Comparison of open source Content Management Systems

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Examiners: Professor, Ph.D Kari Smolander

M.Sc Erno Vanhala

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The purpose of this thesis is to study, investigate and compare usability of open source cms. The thesis examines and compares usability aspect of some open source cms. The research is divided into two complementary parts –theoretical part and analytical part. The theoretical part mainly describes open source web content management systems, usability and the evaluation methods. The analytical part is to compare and analyze the results found from the empirical research. Heuristic evaluation method was used to measure usability problems in the interfaces. The study is fairly limited in scope; six tasks were designed and implemented in each interface for discovering defects in the interfaces. Usability problems were rated according to their level of severity. Time it took by each task, level of problem's severity and type of heuristics violated will be recorded, analyzed and compared. The results of this study indicate that the comparing systems provide usable interfaces, and WordPress is recognized as the most usable system.

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Table of Contents

The List of Figures

The List of Tables

ABBREVIATIONS

CMS	Content Management System
CSS	Cascading Style Sheet
DAM	Digital Asset Management
DP	Drupal
ECMS	Enterprise Content Management system
GPL	General Public License
HCI	Human Computer interaction
HTML	Hypertext Markup Language
JM	Joomla
OSCMS	Open Source Content Management Systems
OSI	Open Source Initiative
OSS	Open Source Software
PHP	Hypertext Preprocessor
RDF	Resource Description Framework
RPC	Remote Procedure Call
RSS	Really Simple Syndication
SQL	Structured Query Language
URI	Uniform Resource Identifier
URL	Uniform Resource locator
WCMS	Web Content Management system
WP	WordPress
WYSIWYG	What You See Is What You Get
XML	Extensible Markup Language
XSS	Cross Site Scripting

1 Introduction

The last years have seen an enormous change in the way we use and comprehend information technology within the business context. The extensive use of Internet during the last decades has dramatically shifted the usage of computers, which has made computer and Internet technology inseparable. Improvements in the field of research and development to technologies such as; distributed computing, content management systems, data mining and processing, are designed to meet a range of business needs (Carchiolo *et al.*, 2006).

Open source software can be defined "software that is made available freely to all." the open source development projects, is a projects intended to produce a software packages by software developers who "voluntarily collaborate to develop software that they or their organizations need". The term "open source" is sometimes compatible with free software, but sometimes it is seen as a conflict. The word "open source" is applied to refer an environment where the source code is free and ready for analysis, code enhancement and inspection. (Hippel *et al.*, 2003)

Content is an array of information that can be in text, pictures, videos, sounds, document, record and data (Naik & Shivalingaiah, 2009). The major challenge is how to manage this information in the dynamic web environment (Rawtani & Chidambaram, 2009). However content management system (cms) provides a viable solution in managing variety of information, cms is a software package that allows you to construct a website that can be swiftly and easily updated by technical and non-technical staff (Quinn, 2010). It is a tool that lets you create, update, manage and publish different contents which are limited by a set of rules (Rawtani & Chidambaram, 2009). The field of content management system has shown rapid and strong growth in open source solutions (Naik & Shivalingaiah, 2009). Despite this, the term "content management" is somehow new, content management employment have been around since the late 1980's and it drew from the existing techniques. The term itself didn't become famous until the corporate business started employing it. On the other hand the term was already being used through other field of management within business. (Michelinakis, 2004)

Nowadays, usability of open source software has become an important issue that vendors started to pay more attention to. Particularly WCMS needs more attention in order to be used easily due to a massive volume of data being manipulated by a different level of users including less technical user. The thesis presents empirical study of usability of content management systems. In this study it was chosen to investigate and compare usability of three most used open source cms. The systems selected for evaluation were WordPress, Joomla and Drupal. Despite the fact that usability inspection methods are varying, discount usability inspection method was used. Heuristic evaluation method was used for discovering usability problems in systems.

1.1 Objective

The objective of this thesis is to compare and analyze usability of various open source content management systems (cms). Despite the very huge availability of the numbers of open source cms; the most prominent products have been selected. WordPress, Joomla and Drupal are the candidates to be evaluated. The comparison is based on evaluation criteria set in the research methodology section, which aims to discover the usability problems in the selected systems' interfaces and to foresee an open source cms solution that is easily liked by the user.

1.2 Research questions

Open Source Content Management System is a fast growing technology which comprehensively responds to the dynamically changing website demands. However, to select easily used open source cms, all the necessary usability aspects should be considered that the software could provide. The research question investigates and emphasizes usability of the selected software with regards to ease of use and how the selected software is easier to learn.

- Which open source cms (WordPress, Joomla and Drupal) is easier to use in terms of technical and non-technical staff?

1.3 Outline of the thesis

This study comprises eight different sections where each section accentuates an important portion of the thesis. The first section is an introduction section which may provide the purpose, motivation and clear introduction of the thesis. The reader may find this part clear picture of the forthcoming sections.

The second section provides theoretical part of content management. The reader may find here the knowledge of content management. General outlook of content management and related technologies will be presented here.

The third section is about content management systems. The basic functionality of cms, its technology and licensing issues such as open source licenses are revealed here.

The fourth section is the core section of the theoretical part of the thesis. Usability aspect of the comparing systems will be emphasized. Usability measurement methods such as usability inspection and testing methods will be presented. Nielsen's heuristic methods, cognitive walkthrough and thinking aloud will be broadly explained in this section.

The fifth section comprises research methodologies where the research process, approaches, methods and evaluation criteria will be defined and discussed.

The sixth section will present the results found from the tasks. Usability problems and their level of severity and the time it took to implement the tasks will be revealed in this section.

The seventh section is about the discussion, analysis and comparison of the systems based on the criteria mentioned in the research method. The full discussion of the research questions and the results founded in the research are to be revealed in this section. Moreover, comparison of system usability with other systems' usability will be presented in this section. In addition to that researches done in recent years are also re-

ferred and combined with this study. This thesis also includes detailed further work that is vital for the improvement of the study in future years.

The last section provides review of the result and summary of the concept which then indicates the results found from the research.

2 Content Management

Content Management can be expressed as a process of creating, gathering, arranging, categorizing and structuring contents of any kind or format. It is a rules and practices for improvement, management, preserving and employment of content in the organization. The goal is to publish content by using WCMS and to coordinate the entire process of writing and publishing content by incorporating web authoring tools with a large database of information resources. Moreover, as it is to provide full guarantee for content users to receive well-managed and updated information, the databases are to be well designed in order to make a possible and easier to manage for retrieving resources and incorporation of different of web appearances. Besides of managing content in repositories, contents should be prepared for publication. You can make content obtainable by taking component out of the database and building suitable publication such as web sites, printable documents and email newsletters. (Sunny, 2008; Boiko, 2001)

Content management covers wide areas such as Document Management (DM), Record Management (RM), Knowledge Management (KM), Web Content Management (WCMS) and Electronic Content Management (ECM). CM brings together different business process over the web, where they share information. For instance information in the production department about product is being easily accessed by the marketing department over the web. (Sunny, 2008)

2.1 Defining Data, Information, and Content

As the people confuse for the differences between data, content and information, many people come to the idea of content management very simply prior to understand the real semantics of the important terms. They just buy automatic tools that manage information resources without knowing semantic distinction between the terms. People think content to be as simple and straightforward as data. (Boiko, 2001)

First and foremost of building computers are to process data. Data is a small part of computer information such as numbers, words, images and sounds that people gather, join together in data records, and accumulate in databases. Data can be defined unana-

lyzed facts, figures and events in a raw. The term data, information, and content are usually consider indistinguishable terms, the key variation is the grade of abstraction. Data has the lowest level of abstraction, and are usually representing a structured form such as tabular form, graphs and other structures. Data is first collected from measurement and presented using graphs or images. (Boiko, 2001)

Information has bigger scope than data, when data is processed, it produces information. Information exposes and defines the meaning of the data. As the Boiko defined "Information is what human beings transform their knowledge into when they want to communicate it to other people. It is knowledge made visible or audible, in written or printed words or in speech" (Boiko, 2001).

Nowadays content plays big roles in our business life and business people have used it for years. The information becomes content when it is arranged a usable shape supposed for more than one purpose. All the information is not content, information can be content after someone gets it and transform it a usable form. Boiko has put in his book "Content Management Bible" a very descriptive example that sheds on the light the difference between data, information and content. "The title of this chapter is a piece of data, if you gather all the chapter titles and headings together, you have a piece of information called table of contents. When you included this information at the beginning of this book and you make use of it to navigate and find something of value to you, it is a piece of content" (Boiko, 2001).

2.2 Metadata

Metadata is structured information that illustrates, clarifies and places, or on the other hand makes possible to retrieve, manage and use of information. As the Boiko describes "metadata is called data about data or information about information"(Boiko, 2001). Metadata is used to facilitate finding of relevant information, structure electronic resources, assist interoperability and legacy resource integration, identifies objects, and facilitates archiving and preservation of resources (NISO, 2004; Library of Congress, 2009).

The term metadata is employed in a different ways. Some communities refer machine understandable information, while others refer for records that explain resources. For example, metadata is being used resource description in the library environment which can be applied any form of resource whether it is digital or non digital. Metadata can be classified into three main different types. (NISO, 2004)

- **Descriptive metadata** which describes an object, and provides resource identification such as title, author, abstract and keywords.
- **Structural metadata** describes the order of the object; how compound objects are constructed in order such as how pages are put together in order to arrange chapters.
- **Administrative metadata is** how to manage the resource, this is a huge area where different managerial department meet in companies. It can include elements file type, when and how it was created, how to preserve information and access rights of that information.

Descriptive metadata has been in use for a very long time, as it has been needed to describe analog objects for decades. The term descriptive metadata fundamentally indicates bibliographic descriptions. As more and more technologies have changed to digital, its significance of application has impressively increased, and many communities have discovered its use for different needs. However the scope of different sorts of descriptive metadata and how the objects put together in constructing description of resources are very imperative to be understood properly. (NISO, 2004; Library of Congress, 2009)

Administrative metadata provides information needed to manage the object such as how and why it was created, file format information, right access and actions performed on the pieces. These are usually categorized into three different parts- structural metadata, preservation metadata and rights metadata. Metadata ensures resources will survive and be accessible into the future. Preservation and archiving need exceptional way for tracking the root of a digital object, It makes clear where the object came from and how it has altered over time. Full details of its physical characteristics and clear document of its behavior is done for the alignment to future technology. Defining metadata schemes

for digital preservation have been involving by many organizations such as National Library of Australia, the British Cedars Project, and the Joint working group of OCLC and the Research Library Group. (NISO, 2004; Library of Congress, 2009)

2.3 Content Management and Web Technology

The rapid growth of the World Wide Web has reached a point that could be recognized as a global information room on top of the internet. Different kind of resources has been kept in it and shared between organizations and individuals as well. Resources can take numerous dissimilar shapes such as documents, images, audio and video. The most prominent and inevitable language is HTML which facilitates document to be embedded on the web and displayed on different places (Grosskurth & Godfrey, 2006). HTML is not the only language used for web pages, but other technologies emerge extensively, Cascading Style Sheet, Java Script and much more scripting languages (W3Schools-html, no date). A web browser is also another important tool that fetches data or information from distant servers and published on the web, a lot of web browser are used today (Grosskurth & Godfrey, 2006). Transmission of data and exchange of information is being employed by HTTP protocol (Grosskurth & Godfrey, 2006).

The important terms that should be known before we go further to the topics will be illuminated in the subsections.

2.3.1 HTML

Hypertext Markup Language (HTML) is a markup tags or symbols entered in a file for display and present a page's text and images on a World Wide Web. The markup tags notify the web browser how to display the contents of the page on a World Wide Web. W3C has accepted HTML as a formal recommendation and it mainly adhered to all the web browsers like Internet Explorer, Mozilla Firefox, Google Chrome and other browsers. Web browsers are mainly designed for reading HTML documents and composing them into observable or audible website. The tags in the HTML document would not been displayed on the web rather than are used to interpret the content of the file. (W3Schools-html, no date)

2.3.2 XML

Extensible Markup Language (XML) and other technologies that come together with it such as Namespace and Schemas are rules for encoding and structuring data on the web. XML is a markup language which was designed just to carry data between all kind of applications without displaying it as W3school defines "XML is a software- and hardware-independent tool for carrying information". Unlike HTML, XML tags are not defined beforehand, so you have to name and define your tags within process of structuring data. XML tags flow general rules of simplicity, generality and comprehensible usability. XML is a textual format which supports the languages of the world through Unicode. The history of XML is dated back at the end of $90^{ths,}$ in February 1998 W3C accepted XML as a W3C recommendation. (W3Schools-xml, no date)

2.3.3 CSS

Cascading Style Sheet (CSS) is designed to support the format of displaying the HTML. CSS covers the organization of fonts, margins, colors, background images, width and height. Before HTML 4.0 document formatting and styling were part of HTML files, so developing of a bulky website would be a terrible and costly task because each and every page of HTML is consisted of some of styling attributes such as font and color. CSS style sheet can be classified into external style sheet, internal style sheet and inline style sheet. (W3Schools-css, no date)

2.3.4 JavaScript

JavaScript is a one of the web-boosted technologies that lay on client computer, that is why called client-side scripting. JavaScript is a lightweight programming language integrated into HTML document, it executes without compilation. JavaScript provides variety of functions, it is mainly changes a static content page to a dynamic and interactive page; it reacts to events by executing JavaScript code when some actions happen, it is also used to validate the forms prior to send to a server. Moreover, it detects visitor's browser and creates cookies for keeping information. Many people they do mistake

when they believe java and JavaScript are synonyms. Indeed Java and JavaScript are totally different than they are similar. (W3Schools-js, no date)

2.3.5 Unicode and URI

Unicode is a standard for computer characters which assigns a unique number for every character, and provides a standard for representing characters of the main world languages. The Unicode is necessary almost all other standards such as XML, Java, LDAP, WML, etc, and is supported in almost every contemporary web browsers and operating systems as well. The Unicode have overcome encoding proliferation problem where variety of encoding systems are used for different languages. (Berners-Lee & Masinter, 2005)

Uniform Resource Identifier (URI) is a compact sequence of characters that used to locate and identify resources on the web. It provides a ways of finding the resource by identifying its main access means such as it is network locations. (Berners-Lee & Masinter, 2005)

2.3.6 Really Simple Syndication (RSS)

Really Simple Syndication (RSS) is a family of web feed format which enable to discover updated works from blogs and web pages and syndicate content automatically to RSS-enabled websites and blogs without effort to navigate the sites. In technically RSS is a standardized XML file format which facilitates the information is to be emerged once in a website or blog, and used extensively in many different sites. Feed reader and aggregator are imperative software that must be installed on your computer in order to use feed prospective. You need to subscribe to a feed, so a new updates is regularly downloaded from the site. Sometimes you can subscribe a feed from web browsers that have integrated feed readers and you can effortlessly update feeds to your website. (Anderson, 2007; W3Schools-rss, no date).

RSS is not the only syndication specification which is available, but other syndication specifications are obtainable. Atom is one of the specifications intended at resolving the

inconsistencies between RSS versions and provides viable solutions for interoperating of various incompatible versions. Atom mainly consists of two standards: Atom Syndication Format and Atom Publishing Protocol. Atom Syndication format (ASF) is being dedicated to use for web feed. On the other hand Atom Publishing Protocol is used for creating and updating web resources. (Anderson, 2007)

2.3.7 Blog and Weblog

Blog is a website that maintains frequent chronological publications. Blogs are alternative term of weblogs. Blogs are used a wide range of topics from diary of personal life to political thoughts and analysis. The content of the blog topics are published on the website by blogger in an ordered way based on a time. Google's blogger and WordPress.com are the most famous places where you can get blogging website. Blogs are organized as journal styles, the entries of the blogs can be text, images and link to other blogs and to other websites. Blog contents may contain title, body, links, postdate, category, pingback, tags and other more entries. Writers can write usually to their blogging website based on scheduled time that can be hourly, daily, weekly and monthly. Tags are used to separate posts, each posts are labeled with one or two tags that facilitates the theme of the post to be classified within the blog or website. Some blogs are very huge due to the numerous blogs were linked together, the interconnected posts are easier to access just in one click on a post's tag or description; this will enable you to get access of other posts with the same author. Many terms are involved to blogging such as blogosphere which covers all blogs as a community or social network. Also Bloggers exchange posts and comments. The other important term is a blog-roll which is a list of links to other blogs that blogger may read frequently. (Anderson, 2007; Murugesan, 2007)

2.3.8 Web services

Web service is a system designed to provide a support between interoperating machines over network that have different software application. It consists of much interactive software such as WSDL, SOAP with conveyed means (HTTP with XML). Usually Web service is a combination of various web-related standards. Typically piece of software

and hardware called agent must implement by sending and receiving messages. The definition of web services can be summarized as WebServices.org defined "Web services are encapsulated, loosely coupled contracted functions offered via standard protocol". Finally, web services are modular, reusable software components that can be used by others without starting from scratch. (Gunzer, 2002; Booth *et al*., 2004)

2.3.9 Web Semantic

The meaning of some web terms are confusing, the people may talk similarity and differences between Web 2.0, Web 3.0 and Semantic Web. Indeed there are huge misconceptions about their meaning. The meaning of Semantic Web is "a Web that is able to describe things in a way that computers can understand" as W3C defined. The semantic Web is intended to present a web page's data in a way that machine can understand, it allows machine to do searching, collecting and combining the related web information without human serving. (Mathews, 2005; W3C-tutorial, no date)

The broader definition has been made in the article written by Tim Berners-Lee, Jim Hendler and Ora Lassila in Scientific American in May 2001 "The Semantic Web will bring structure to the meaningful content of Web pages, creating an environment where software agents roaming from page to page can readily carry out sophisticated tasks for users (Berners-Lee, 2001).

2.3.10 Platforms

CMS developers use open platforms such as PHP, Java and Python for development of open source cms, this lessens relying to particular company. All these technologies provide key building blocks for content management tools. Moreover it boosts the supporting software and trims down the charges used to spend a new developers. The most popular and used platform by open source cms is PHP which is a commonly used scripting language for web development. PHP is more versatile programming language that is well-known inside web communities. PHP content management tools are very robust which creates and handles a large database of images, videos, audio, as well as text. The most popular open source cms are built in PHP such as Drupal, Joomla and WordPress.

Java is also popular and more used platform by cms developers due to acceptance and portability. There is a lot of cms that are built in Java tools such as OpenCms, Fedora and dotcms. Python content management tools are less popular than its counterparts (php and java). Django-cms, Merengue and Plone are the open source Content management tools incorporated in Python programming language. There are also other platforms that play a significant role in development content management tools these include Perl and other non-open platforms. (Abbott, no date)

2.3.11 Databases

Apparently content management systems keep the actual content (text and image) in database. The content management tools fetch the content from the database and publish it out to appropriate page according rules defined earlier. There are a lot of database engines that can be used for developing an open source content management systems. MySQL and PostgreSQL are the most broadly used databases in open source content management systems due to their nature of open source software. Both of them provide variety of features that may need in different type of business from small size to large size. Commercial database engines such as Oracle and SQL servers also play a vital role in content management systems, but they are particularly used by proprietary software. (Michelinakis, 2004)

Structured Query Language (SQL) is a powerful and diverse standard language used to access all database engines. It's clear syntax makes it easy to learn quickly, but mastering it needs longtime practice. ANSI/ISO committee defined the SQL standard despite many servers use customized version of SQL. SQL covers a very important context within information society; it is firmly focusing Data definition language (DDL) for creating tables and their databases, and Data Manipulation Language (DML) querying and retrieving data from the databases. (Sybex, 2001)

3 Open source Content Management Systems

In recent days almost every company has its own homepage, no matter if it is small or big company. Creating a company's home page plays a significant role for business success. Mainly companies have more than a page whether it is internal (intranet) for communicating inside the company or external for communicating outside world. However setting up a page is an easy task, but managing contents in the page is a problem and challenging task (Giri & Nirgude, 2009). Open Source Content Management Systems (cms) allow producing a robust and flexible site that satisfies dynamically changing requirements and frequently emerging demands that a company often meets (Husain, 2012). The area of Content Management Systems (cms) has been predominantly strong rise in open source solutions, possibly in direct response to overprice that proprietary cms have historically required (Robertson, 2004). Open source cms has shown rapid and strong growth to the point where should be considered the real alternative to commercial solutions (Robertson, 2004).

Content is an array of information that can be text, pictures, videos, sounds and data (Naik & Shivalingaiah, 2009). The major challenge is how to manage this information in the dynamic web environment (Rawtani & Chidambaram, 2009). However content management system (cms) provides a viable solution in managing variety of information. Content Management System is a software package that allows you construct a Web site that can be swiftly and easily updated by a technical and non-technical staffs (Quinn, 2010). It is tool that lets you create, update, manage and publish a different of contents which is being limited by set of rules (Quinn, 2010). Web content management system uses different technologies for creating and publishing content in the web formats like HTML, XML and PDF (Gilbane *et al*., 2003). In addition to that WCMS allows users archive, approve and review content and also provides version control scheme (Boiko, 2001). WCMS also offers a mechanism to set and control user roles according to their privileges such as consumers, reviewers and authors (Quinn, 2010).

Especially, cms carry out the so called content-driven paradigm. cms implements partition between page content and page presentation which means users disregard all the features related with scripting and markup languages that are essential to setup a page.

Moreover cms uses prebuilt templates, as well as WYSIWIG concept. Likewise other open source software, cms is developed and maintained by a community of developers and can be downloaded for free of charge. (Rawtani & Chidambaram, 2009)

Despite the term "content management" is somehow new, content management employment have been around since the late 1980's and is drew from the existing techniques. The term itself wasn't come famous until the corporate business started employing it. On the other hand the term was already being used through other field of management within business. (Michelinakis, 2004)

A lot of different types of cms are obvious such as Web Content Management systems (wcms) which has more features particularly customized to manage web site content. A Digital Asset Management (dam) has more features such as cataloging, storing, retrieving and annotating of digital material. An Enterprise Content Management system (ecms) is a constituent of a wcms and dam which brings further knowledge management and document management as well. The features that cms came with vary between systems and tend to purpose of use whether it is a large, medium and small business. (Chantel, 2007)

However content management system provides a common features that each and every cms should fulfill such as (Rahmel, 2007):

- Ability to manage and administer the system
- Recognition of users and their assigned roles
- Aptitude to define roles and responsibility
- Aptitude to identify workflow
- Ability to schedule and put contents out
- Ability to extend core template and add more components and functionalities
- Ability to make the site offline and do maintenance work.

Open source Content Management System has many advantages over commercial ones. Open source cms provides same degree of functionality with commercial one but com-

paratively less cost. Although there is also other benefits that open source cms over commercial one but cost-to-benefit ratio is the major force for the victory of the systems. However, bear in your mind that open source is not identical with "free". Although there are no license fee is charged, but on the other hand support, development and maintenance cost may be considerably greater with open source than with proprietary software. Open source cms shares most of the benefits with other open source software such as. (Robertson, 2004)

- Low cost: The source code of cms can be acquired for free, or fewer prices compared with proprietary product. Most of the open source cms you pay services but not software, so you direct the largest part of the budget to important supporting tasks such as matching product to specific business, and developing new modules and templates. This benefit guides open source cms to be particularly attractive for non-profit organizations, government departments and individuals developing websites.

- Ease of adaptation: as the source code is freely accessible, it lets developers to make any modification and adapt it to specific need. Same access rights for developers and users as well, so customization is easy.

- Community support: Large community of developer and users are operating effectively and in parallel which results fast and diverse innovation.

- Open platforms: Open platforms such as PHP, Python and Perl are used for developing open source cms. This minimizes or eliminates dependability to particular company or software package. (Robertson, 2004)

As the name of the thesis implies the details of open source content management system will be focused and discussed further in the subsequent sections. Nowadays Open Source cms industry has been growing extensively and it is impossible to sum up the entire open source cms in one thesis or one book only. Therefore in the coming sections will be focused on the most popular and used open source cms that have got already full acceptance and remarkable reputation in the web community. WordPress, Drupal and Joomla are the competing technologies that should be compared with each other with regarding of their usability and learnability of their components, with also considering pros and cons that have been experienced with them.

The open source content management systems employ different licenses approved by Open Source Initiatives. Since the topic of this thesis is related to open source cms, It was scrutinized to know which licenses were used frequently by a different cms software. It was found that the most popular Open Source content management systems are under GPL license such Drupal, Joomla, WordPress and MovableType (Toptenreviews, 2014).

3.1 WordPress

WordPress is one of the best and popular open source content management systems that provide editors a web interface to keep their sites instead of uploading files to a server. WordPress Started as a blogging tool, but gradually the idea expanded and developers added more features until it came in the current position where WordPress is recognized as a one of the prominent open source cms. This gives opportunity those who want to create and manage real website for maintaining and managing an organization's content. Indeed WordPress plays both of the roles blogging or actual content management systems, but depends on your decision or your organizations demand. (WordPress page, no date)

The history of WordPress is dated back to 2001; the name of WordPress has not always been the present invoked name. In 2001 some motivating individuals who anticipated the demand of web publishing site have started to create b2/cafelog. Their goal was to bring blogging software. The name WordPress was came up in 2003 when Matt Mullenweg and Mike Little begin to modify and enhance the original b2/cafelog. The first version (0.7) of WordPress has released in May 2003. Despite the first version had enough capability to perform many tasks and surely exposed very important features such as Administration interface and link manager, but it was not enough to perform numerous things needed for web page publishing. The endless effort of WordPress team has resulted in to reveal in January 2014 "WordPress 3.8.1", this release has more new features and upgraded items as well. The production of a new release of WordPress it goes a very high speed, sometimes in a year it may release nearly 10 versions of it. For

instance in 2011 nine versions have been released. (Jones & Farrington, 2011; McKeown, 2013)

Then WordPress become well-known blogging system that has been accepted by many bloggers and is used on millions of sites. The market dominance and growing reputation of WordPress is an outstanding and impressive, the survey conducted W3Tech clearly shows how WordPress out-distant than its rivals. "56% of the sites that use a content management system are using WordPress, and that percentage is even growing. For most users, WordPress seems to offer the best balance of features and easy-of-use" (Gelbmann, 2010).

Some questions are asked frequently about why WordPress is one of the favorite systems and why it acts as an amazing framework. Actually WordPress has many qualities that allow it to be adopted as content managements system; these features are summarized as follows:

- Easy to setup: You can easily install, just few minutes without previous experience on it. WordPress is written a famous platform and database (PHP and MySQL) that lets you to use most commercial hosting. WordPress come with all the necessary pages that a website may need such as posts and pages, Media files, links(blogroll), categories, tags, user roles and profiles, feeding system(RSS, ATOM and OPML), clean URL, spam protection and automatic upgrade. (Leary, 2010)

- Easy to use: WordPress has beloved user-friendly Interface that allows administrator to start and build a website in a just few hours. The WordPress learning is not daunting task, even web novices can learn easily with very small time and training. The most important features that WordPress's interface came with include rich text editing, media uploads and embeds, and menu management. (Leary, 2010)

- Extensible and Flexible: WordPress provides a strong template system that comprises all the core functionalities with more themes and plug-ins that extended the functionality of WordPress (Leary, 2010). The core part is intended to provide the basic features and designed to be lean and fast as it satisfy the

majority of end-users (WordPress philosophy, no date). In addition to that, someone who has a good programming background can develop the custom plug-ins, and can modify the basic template as well. WordPress team has left a space that an organization or individual to exercise in order to meet their demand "different people have different needs, and having the sheer number of quality WordPress plugins and themes allows users to customize their installations to their taste" (WordPress philosophy, no date).

The WordPress team always strives to make WordPress easy to install and easy to use. And every new release emerged is much easier than its predecessor as WordPress defined in the document called Philosophy "We're never done with simplicity. We want to make WordPress easier to use with every single release. . . . In past releases we've taken major steps to improve ease of use and ultimately make things simpler to understand. . . .We love to challenge ourselves and simplify tasks in ways that are positive for the overall WordPress user experience, every version of WordPress should be easier and more enjoyable to use than the last" (WordPress philosophy, no date). This makes the WordPress to be chosen by 25 million people all over the World as it clearly depicted in the WordPress.org page. Hundreds of geographically dispersed community developers participates the development of WordPress as it's the nature of open-source software (WordPress philosophy, no date).

3.2 Joomla

Joomla is also another open source content management system that provides technology, services and powerful online applications needed to build a website and to manage huge contents. Joomla is one of the top open sources content management system used widely in business context and it is award-winning content management system that allows you to easily create and manage the contents of a page. Most of the open source content management system has characterized to be used by a person who doesn't have experience in programming language, in Joomla you don't have to be a programmer because you are not supposed to deal with code. Nowadays Joomla has become a popular content management system due to the easiness of use and rich of substantial features. (Rahmel, 2007)

The history of Joomla started in august 2005 when the project diverged from already exist open source content management system "Mambo". After that the idea spread over the internet and in particular the open source community where a huge contributions and substantial support have been offered for the new project. In September 2005 the first release of it has came up, since that date Joomla is getting acceptance and has been grown-up consistently, it has gone winning after another. Many versions have been released since September 2005, with the latest version (3.2.1) being released in 2014. Users of Joomla can easily migrate to the latest version with upgrading of their previous versions and they exploit of all security advantages combined with this release. (Joomla doc, no date)

Joomla has been accepted and adopted widely by a wide spectrum of individuals, non-profit organizations, corporations and public organizations. There are many reasons for Joomla's acceptance but ease of use is the most important reason. Joomla has robust features that allow you to design a Joomla site that can do almost everything you need, the core template with extended modules and plug-in makes possible to enlarge the use of the software. Joomla is used all over the world for different purpose ranging from small business to corporate business. In addition to that the success history of it shows many famous companies and organizations has powered Joomla to their website such as Harvard University(educational) "http://gsas.harvard.edu", MTV Networks Quizilla (Social networking) "http://www.quizilla.com", PlayShakespeare.com (Cultural) "http://www.playshakespeare.com" and more examples of companies powered Joomla can be found "Joomla Community site showcase". Easiness of use associated with richness of important features make it possible webmasters to prefer Joomla than other cms. The most important features that Joomla be preferred by webmasters include: (Rahmel, 2007; Joomla doc, no date)

- Comprehensive management tools through strong web interface
- Moderating features for content approval
- User group management
- Automated menu management
- Good security measure and content management

- Ability to schedule content publication and deletion of content. (Rahmel, 2007)

As it was delineated previously, Joomla provides strong infrastructure for easy way of creating useful site, core modules associated with add-on modules support an extensive diversity of functionalities. Despite the mentioned simplicity is practical, there is also a bit of a learning curve to realize how the system works.

3.3 Drupal

Drupal is an open source, flexible, robust, modular content management system and framework written in the popular script PHP and supports MySQL and PostgreSQL. Drupal's use ranging from small personal weblogs to bulky enterprise and political website. Likewise other Open source software, Drupal is open source software licensed under the GPL and is being developed and improved by hundreds of thousands of inspired persons located from all over the globe. Drupal offers a wide range of core features and services such as user administration, blogging, discussion forums, publishing workflow, user role and much more. The core features can be extended by using other contributed modules and themes. (Tomlinson, 2010)

Drupal History is started in the end of 1998 when Belgium student named Dries Buytaert wanted to create a message board for sharing and distributing information among a group working with same project on Local area network. After his graduation he developed more about the idea from message boarding to live website on the internet. Dries wanted to register "Dropje" as the name of the site which means in English little village, but by accidentally he made error type and wrote "Drop" instead of "Dropje. After a year around 2000 many concerns and interests emerged from a people that willing to contribute a new ideas and features for augmenting the Message Board. When interest has increased the Software become community software that can be developed and improved by geographically scattered developers. (Kadhem, 2008)

The growth of the Drupal community is incredible; the number grows rapidly and extensively. The estimate figure in august 2011 of subscribed members is around 630,000.

These members contribute different kind of supports that adds a value to the core and extended templates. The website "Drupal.org" was first registered on 26 April 2001 where countless copies of Drupal applications have been downloaded since that date. As the growth of the community, reputation and use of the software increase the version rate also goes dynamic and fast. The community always works hard to produce a version after version, the latest version that is available for download is version 7.9 and version 8 is under development and will be released soon (Kadhem, 2008).

Drupal software is being used extensively by different sized organizations from small to large. As the Drupal designed to be flexible and meet the needs of different type of business, Drupal is employed in different kind of business sectors. Drupal can be used for community website, news portals, international site, education site, arts and music site, social networking site and much more targets. Moreover, from the success story of the software, Drupal is powered by some of big companies such as the economist "economist.com", "examiner.com", the white house "whitehouse.gov" and much more websites (Drupal website, no date). Many questions are raised often "Why Drupal is so popular" and why it is on top position from the list of open source cms. Indeed it has matchless qualities; some of the remarkable qualities are as follows:

- Ease of use: Drupal is easy to use as administrator or user, it has friendly web interface that allows you to install and built site quickly (Drupal 7, no date).
- Modular and extensible: powerful core modules that adequately meets basic business needs and more extended modules and plug-ins that can be used as the business requirement features grows (Drupal 7, no date).
- Scalable: As it was mentioned earlier, the scale of usage of Drupal is ranging from small business to big business (Drupal 7, no date).
- Proven security measure: Drupal emphasizes security seriously; it has well established security measure and mature security capability for authentication, authorization and protection against different form of threats (Meike, 2009).

4 Usability

4.1 Definition of Usability

Using internet in our day-to-day business has significantly increased the web usability. Users visit enormous websites that provide same services, but they like better to visit those are simple to learn, manage and aesthetically fascinating (Banati *et al*., 2006). Web usability is a subject that emphasizes what factors the user's ability to navigate through a website. There are a lot of literatures of usability available; some of them outline specific guidelines while others are generic guidelines. International Organization of Standardization has set a standard and defined the usability. Definition of usability from ISO 9241-11 "the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use" (ISO9241-11, 1998). In addition to that another international standard - ISO9126 has characterized usability as one of the important software quality and defined as "the capability of the software product to be understood, learned, used and attractive to the user, when used under specified conditions" (ISO/IEC9126-1, 2001). Shackel has defined usability a bit different than ISO "the capacity in human functional terms to be used easily and effectively by the specified range of users, giving specified training and user support, to fulfill the specified range of tasks, within the specified range of environmental scenarios" (Shackel, 1991).

Usability has become an important attribute to be assessed along with the functionality of the software. Therefore organizations can take into consideration during selection of software, with the aim of getting software that will be swiftly and easily adopted by the users (Robertson, 2007). Usability concerns to all aspect of a system with which a user might interact including installation and maintenance procedures (Nielsen, 1993).

4.2 Usability Attributes

As Nielsen defined usability is measured in multiple dimensions and is recapped with the following five usability attributes (Nielsen, 1993):

Learnability: the system should be easily learned in order the user can swiftly getting some work done with the system.

Efficiency: the system should be efficient to use, then high level productivity is possible.

Memorability: the system should be easy to remember therefore no need to learn again after not used a while by the casual user.

Errors: the system should have a low error rate and can be easy to recover if some errors occur. Moreover, catastrophic errors mustn't occur.

Satisfaction: the system should be pleasant to use, so that users are subjectively satisfied when using it.

It is not only Nielsen who proposed the criteria to measure usability. Different scientists have different proposal. Sheckel defined usability speed effectiveness, error effectiveness, learnability and attitude (Sheckel, 1991). Hix and Hartson defined learnability, long term performance, retainability and long term user satisfaction (Hix, 1993). Preece *et al* described usability in terms of throughput, learnability and attitude (Preece *et al*., 1994). Wixon and Wilson described usability by learnability, efficiency, memorability, error rates and satisfaction (Wixon, 1997). Constantine and Lockwood characterized usability in terms of efficiency in use, learnability, remember ability, reliability in use and user satisfaction (Constantine & Lockwood, 1999). Shneidermann defined usability criteria as time to learn, speed of performance, retention over time, rate of errors by users and subjective satisfaction (Shneiderman, 1998).

4.3 Usability Principles

In this section the usability principles that Dix *et al* (2004) has defined in their book will be summarized. Dix *et al* (2004) has clarified that principles of interaction between the user and computer are independent of the technology employed. (Dix *et al*., 2004)

Despite, it is not easy to discover a comprehensive catalogue of usability principles, general principles can be provided and that can be increased as more knowledge is obtained. The principles are classified into three main categories. (Dix *et al.,* 2004)

4.3.1 Learnability

Learnability involves how a new user effectively learns and interacts with the features of interactive system and achieves maximum level of performance. When we are talking learnability we often refer Nielsen's definition which is the ability of interface to permit users to complete task on the first attempt. Users can be expert or novice in software engineering. The main issue is users shouldn't have previous experience or at least have little experience to task or the interface to be evaluated.

There are specific principles that support learnability such as Predictability, Synthesisability, Familiarity, Generalisability and Consistency. All these specific principles of learnability will be clearly discussed. (Dix *et al*., 2004)

Predictability

People are usually trying to get what they expect according to their actions. Sometimes people demonstrate a confidence about the future outcome of their actions. The bases of their actions are the knowledge that they accumulated during all their lifetime about how things works. People can foresee the outcome of their actions according on their knowledge. This concept can be applied to human computer interaction (HCI) field. Dix *et al* has illuminated the idea of predictability in the HCI book as "Predictability of an interactive system means that the user's knowledge of the interaction history is sufficient to determine the result of his future interaction with it". The interactive system acquires predictability if it provides and support user to recognize and predict the result of a certain action. Therefore, the user should have capability to choose a particular action in the system and be happy that this maneuver will function decently and will present the anticipated consequences. (Dix *et al*., 2004; Lopez, no date)

The user's knowledge of the interaction can be restricted to the currently perceivable knowledge, it means that the user not to remember anything except what is presently observable. The limit of the knowledge can be elevated where the user is required to remember what each previous keystroke was and what every previous screen display contained in order to perceive determination of the next input. Both users and interac-

tive system are required to possess predictability; the interactive system should have capability to guide the user to the next operation. This means the interactive system should expose the next available operation to the user. On the other hand, the user should be able to remember what the next operation is and when he can perform the operation. (Dix *et al*., 2004; Lopez, no date)

Synthesizability

Predictability concerns user's ability to decide the result of future interactions. After user performs an action to attain a particular goal, it is important the interactive system could provide some sort of feedback. The interactive system must provide the user effective and reliable information about the outcome of the action after its execution. Dix *et al* have presented in their book a detailed description as "Synthesis, therefore, is the ability of the user to assess the effect of past operations on the current state. When an operation changes some aspect of the internal state, it is important that the change is seen by the user. The principle of honest relates to the ability of the user interface to provide an observable and informative account of such change". The notification and feedback from the system can come immediately, or should come eventually. This means the users not need further interaction to verify the effect of the actions performed. Good example of honest principle is an emailing system, when you send email to a person, you get immediate notification "your email has been sent" or another notification that specifies the reason that the email can't succeed to send. (Dix *et al*., 2004; Lopez, no date)

Familiarity

New users come with the system a rich of experience across an extensive of application domains. This experience is acquired in the course of interaction in the real world and through interaction with other computer applications. Many interactive systems such as software applications are invented for aiming to help the user to create an analogy between an object or situation and the computer application. The familiarity of an interactive system measures the relationship between the existing knowledge of the user and the knowledge needed to attain effective interaction. Some objects may also have physi-

cal properties that provide us indication and visual clue to its function and how they can be used. These properties are very important for the use of the object and are called affordances. Affordances can increase the level of familiarity. Therefore, it is a very important the interactive system should have affordances for decreasing the cognitive friction that the computer system must have. The term familiarity is suggested by Dix *et al* (1992), but is known to by other authors under different names such as guessability. Good example of familiarity is presented in Dix *et al* (2004), the shape of a door handle can suggest how it should be manipulated to open the door, and a key on a keyboard suggested to us that it can be pushed. (Dix *et al*., 2004; Lopez)

Generalizability

Users always try to apply their knowledge of specific interaction behavior within and across application that are similar but not previously came across. Generalization can happen with a single situation or across different situations. For example, Multi-windowing systems use cut/paste/cope operation to all applications in same manner. (Dix *et al*., 2004)

Consistency

Consistency is one of the most important usability principles. If the user acknowledges that the same action will have same outcome, they will feel more confident in using the system and they will get energy to discover a new things because they already have a share of the knowledge needed. The same information should be shown in the same position in the user interface and it should be manipulated in the same way to simplify recognition. (Nielsen , 1993)

4.3.2 Flexibility

Flexibility is the multiplicity of ways in which the end-user and the system exchange information. Dix *et al* Identified principles that support flexibility of interaction, and are depicted as follows.

Dialog Initiative

All interactive systems clearly need some kind of interaction between the user and the system to attain something significant. This interaction can be considered as a dialog between partners. One important issue is to consider who has the control or initiative in this dialog. If the system has the dialog initiative and inquires the user for information, in that case the user only responds for the request. This type of dialog system is called system pre-emptive. On the other hand, the user must have freedom from the system imposed restraints. It means the user must be able to move freely for resuming, abandoning and suspending any activity at any point. This kind of dialog is called user-pre-emptive. (Dix *et al*., 2004; Lopez, no date)

 It is a good solution to maximize the user's ability to control the system and to lessen the system's ability to preempt the user. In some situation it is better to combine both types of dialog since it is not needed to give the user all the control to do whatever he thinks. (Dix *et al*., 2004; Lopez, no date)

Multi-threading

Multithreading allows the user to execute simultaneous tasks. The term multithreading is usually related to operating system and computer architecture, the term which more associated to human computer interaction field is multi-modality. The interactive system should support multi-modality for allowing simultaneous communication of information relating to separated tasks or single task. There are two kinds of multi-modality concurrent and interleaving. Concurrent multi-modality allows the user to do separate tasks at the same time. Interleaving multi-modality allows two tasks to occur at the same time and in the same place, the dialog is limited to a single task. A windowing system obviously allows multithreading dialog that is interleaved between number of overlapping tasks. (Dix *et al*., 2004; Lopez, no date)

Task migratability

Task migratability concerns how easily the control of the execution of task can be moved between user and system. In some situations it is possible for the user or system to transfer the control of a task to other part. Good example of migratability is spell checking, user may check spell errors itself or may pass it to the system. The advantage of this is to decrease the probability of making errors and save times. (Dix *et al.*, 2004; Lopez, no date)

Substitutivity

Substitutivity is a kind of flexibility allowing equivalent values of input and output can be substituted for each other. Substitutivity can reduce user errors and cognitive struggle. Good example of the subtitutivity is the automatic changing from Fahrenheit to Celsius. (Dix *et al.*, 2004; Lopez, no date)

Customizability

Customizability is an important principle that contributes toward flexibility. People may need interface to adapt to their needs and customs. Therefore it is the modifiability of the user interface by the user or the system. User's action to modify the user interface is called adaptability, while system's action to modify the user interface is called adaptivity. (Dix *et al.*, 2004; Lopez, no date)

4.3.3 Robustness

User is involved with computer in order to attain successful achievements and assessment of goals. The robustness of interaction contributes features that support the successful achievement and evaluation of goals. The principles that support robustness are as follows.

Observability

Observability allows the user to figure out what is the current state by simply its perceivable representation at the interface. The interface must offer useful and intuitive information to the user. Observability can be classified into five other principles: Browsability, defaults, reachability, persistence and operation visibility. The smart phone technology companies such as iPhone, Samsung and Sony apply observability in their products. If you look a smart phone's user interface, users can easily assess the internal state of the system. They provide browsability where icons and features are clear and intuitive that gives the users a quick snapshot of the tasks. They also support persistence, if you miss some calls the phone icon will have sign that indicates missing call, the sign will not disappear until the user checks the missed call. (Dix *et al.*, 2004; Lopez, no date)

Recoverability

Recover from errors are very important feature in the interactive systems. Recoverability is the ability to undo errors after recognition. The system must provide the user a means to tackle and make correction after error has occurred. It is also important that system should offer the user a chance to go back to any previous steps; this is called reachability. (Dix *et al.*, 2004; Lopez, no date)

Responsiveness

In order to maintain user's confidence, the response time of the system should be fast. If the system has experienced delay response users may think ineffectiveness. Responsiveness determine the communication time between the system and the user. This means short duration and immediate response time are needed. It is also important the system must give some kind of notification after a task has been executing. (Dix *et al.*, 2004; Lopez, no date)

4.4 Usability Evaluation Methods

Usability of a system can be evaluated broadly by two methods, usability inspection and usability testing methods. Usability inspection methods, a small number of professionals evaluate the product. Usability testing methods involves empirical data from the user; user experience (UE) is a vital component in this method. (Dix *et al*., 2004) Heuristic evaluation, cognitive walkthrough and formal inspection are examples of inspection methods. Think aloud, Performance measurements and eye-tracking are also examples of testing methods.

Usability evaluation methods are broadly classified into formative or summative evaluation. These general classifications are based on the goals of usability evaluation, whether to improve usability of a system or compare it with other product.

4.4.1 Formative Usability Evaluation

Formative usability evaluation involves improving usability of an interface in earlier stage of product design and development, with the goal of detecting and eliminating usability defects. One important issue of formative evaluation is the spectators for the observation and recommendations is the project team that instantly improve the design of the product and refine the specifications. Users are not involved in this process; therefore results can be less formal than summative evaluation. Thinking-aloud is one example of a formative evaluation. (Redish *et al*., 2002; Nielsen, 1993)

4.4.2 Summative Usability Evaluation

Summative evaluation is done outside the product development cycle and is implemented after product has been developed. Summative evaluation aims at judging completed product with specific goals and comparing it with competing products. It is an assessment of deciding between two options or competitive analysis to study how good the competition reflects. Summative evaluation needs more time and resources because it is mainly implemented outside the development environment. It is more formal than

formative evaluation. One example of methods to use summative evaluation is measurement test. (Hartson, 2000; Nielsen, 1993)

4.4.3 Usability inspection methods

Usability inspection methods were introduced 90s and still are appropriate to contemporary systems. The inspection methods involves in detecting the usability problems by developers or usability experts. Therefore the role of the end-user is limited. Several different methods were suggested such as Heuristic evaluation, the cognitive walkthrough, the pluralistic walkthrough and formal inspections.

Heuristic Evaluation

In 1990, a new usability inspection method was introduced by Nielsen and Molich. The method describes a group of usability professionals evaluate a user interface by using set of guidelines and recording the severity of each usability problem and where that problem exist in the user interface. It is effective method that turns out the problem in the user interface with low cost. It is a very useful when resources are limited such as money, time and evaluators (Jeffries & Desurvire, 1992). In principle, one evaluator can conduct heuristic evaluation and find 35% of usability problems in the interface (Nielsen & Mack, 1994). However, if the number of evaluators increases the number of problems found increases as well. It is likely to achieve substantial better performance by collecting the evaluations from different evaluators (Nielsen & Mack, 1994). Each evaluator evaluates the interface alone. After all evaluations have been accomplished, the evaluators communicate and share their findings (Nielsen & Mack, 1994). Figure 2 shows the percentage of usability problem found by having more evaluators (Nielsen & Mack, 1994).
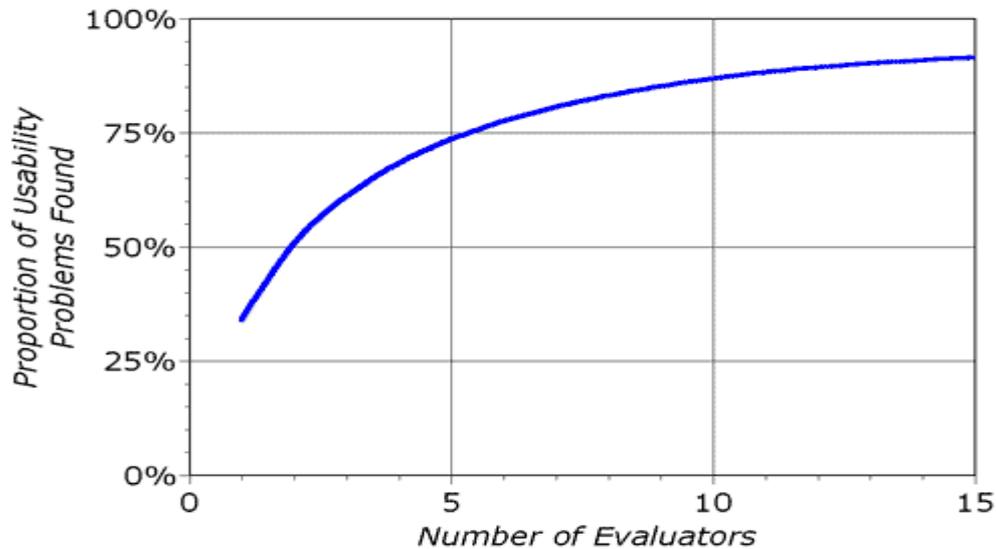
Figure 1: the percentage of usability problem found by having more evaluators.

The exact size of evaluators to employ would depend on the cost-benefit analysis, it is recommended to use more evaluators where usability is important (Nielsen, 1993).

Nielsen's Heuristic is the most used heuristics for user interface design. They are called heuristics because they are broad of" rule of thumb", rather than specific usability guidelines. The evaluation criteria of this study will be ten usability heuristics proposed by Nielsen (Nielsen & Mack, 1994).

The main advantages of heuristic evaluation are recapped as: low cost (best cost-benefit ratio), it is intuitive and gives motivation to users to do the task, less number of evaluators are needed, and it provides high success rate (Bos *et al*., 2005). On the other hand number of disadvantages is highlighted, but the major disadvantage is its high dependency of expert. As Nielsen mentioned in his book without expert evaluator Heuristic will entail poor evaluation (Matera, 2006).

Cognitive Walkthrough

In cognitive walkthrough involves user's problem solving process. It relates how easily the user to complete tasks with the system. It evaluates the design of a user interface in a way that user typically learn the system by using it to complete tasks (Novick &

Hollingsed, 2007). User must guess what to do by using clues given by the system, instead of having knowledge of the system. It is particularly preferable for the finding the problems relating to application learnability. Cognitive walkthrough can be carried out on an interface at any time from the development stage through the final release. Evaluators go through the interface using a task scenario. This is the preparatory phase, the inspector determine the interface to be used, the task and action to be taken. Then again, the evaluation phase, the evaluator analysis the steps forward for the satisfaction of end user goal. He/she follows with the four steps of human computer interaction. (Lewis, 1990; Novick & Hollingsed, 2007)

- The user sets a goal to be achieved within the system
- The user determines the currently available actions (menu items, buttons, command-line inputs, etc.).
- The user selects the action that they believe will deliver them to their goals.
- The user performs the action and evaluates the system's feedback for proof that goal is being achieved. (Novick & Hollingsed, 2007)

In the processes of interactive system evaluation, these steps are repeated many times to make sure that the tasks have completed.

4.4.4 Usability testing methods

Usability testing uses different techniques, that data is collected while representative users use the system to carry out representative task. The test can be done in different kind of places such as usability lab, office workplace and through internet. The aim of this kind of test is to identify the maximum number of problems as proficiently as possible. This method is implemented by assigning tasks to users, and experimenter follows users' behavior and gathers data the way the users implement the allocated tasks. The important data that experimenter should collect are number of errors, execution time and user satisfaction. (Matera, 2006)

To maintain the reliability of usability test result, the plan of the test should be carefully designed and managed. A good usability should be well defined and outlined as follows (Matera, 2006):

- **Defining the objectives of the test:** The aim of the test should be carefully articulated, it can be nonspecific, as enhancement of end users reliability, and the future design of the product to be easy of use. Or it can be specific as evaluating the easiness of use for one component of the interface.

- **Defining the sample of users that will take part in the test:** The sample of participant of the test can be constituted the different part of the end-users such as expert, novice, aged, young, frequently user and rarely user. There is debate about the number of participant; Nielsen and Molich assert that with three users be found 50% of the most imperative defects in the interface while others opposing and stating more testers are to be employed in order to produce reliable result.

- **Selecting tasks and scenarios:** users are guided to perform a set of tasks and evaluators observe and learn about the usability problems of the interface during this process. Scenarios can be chosen from the results acquired during the analyses. In addition to that, unpredictable situation may come during testing process, so testers have to be prepared.

- **Establishing how to measure the level of usability of the system:** prior executing usability testing, it is paramount to set the basic parameters for measuring the reachable results.

- **Preparing the needed material and the experimental environment:** Usability testing can be done almost anywhere, but the experimental environment has to be prepared and equipped with the necessary equipment such as computers, video camera and other facilities needed. Rehearsal period is important before the actual testing started for making sure how testers could follow test procedures (Matera, 2006).

There are number of different kind of data that the tester can collect. This data includes quantitative measure of performance; this concerns how many tasks were successfully accomplished, how long the user has spent to complete it and the quantity of errors

found and time it took the user to recover. Thinking aloud Protocol is another type of collecting data from the interface. Users are guided to express their thoughts verbally during the completion of the task. Users may put forward their thoughts and reveal fractions of the interface that are satisfying and fractions of the interface that are confusing. These recommendations should be recorded by observers/moderators, or should be recorded on video and audio. Coaching method is also another type of collecting data. This type, the user is supported by evaluator, who guides how to use the interface. The last is satisfaction survey, users can be asked questions about the interface, or can be asked to fill questionnaire at the end of usability testing. (Lazer, 2005; Matera, 2006)

4.4.5 Summary of the Usability evaluation methods

Table 1 presents summary of usability evaluation methods. The table provides the number of users needed, advantages and disadvantages for each method (Nielsen, 1993).

Table 1: Summary of usability evaluation methods

Method	Users Needed	Main Advantage	Main Disadvantage
Heuristic evaluation	0	Finds individual usability problems. Can address expert user issues.	Does not involve real users, so does not find "surprises" relating to their needs.
Performance measures	At least 10	Hard numbers. Results easy to compare.	Does not find individual usability problems.
Think aloud	3-5	Pinpoints user misconceptions. Cheap and easy to conduct.	Unnatural for users. Hard for expert users to verbalize.
Observation	3 or more	Ecological validity; reveals users' real tasks. Suggests functions and features.	Appointments hard to set up. No experimenter control.
Questionnaires	at least 30	Finds subjective user	Pilot work needed

		preferences. Easy to repeat.	(to prevent misunderstandings).
Interviews	5	Flexible, in-depth attitude and experience probing.	Time consuming. Hard to analyze and compare.
Focus groups	6-9 per group	Spontaneous reactions and group dynamics.	Hard to analyze. Low validity.
Logging actual use	at least 20	Finds highly used (or unused) features. Can run continuously.	Analysis programs needed for huge mass of data. Violation of user's privacy.
User feedback	Hundreds	Tracks changes in user requirements and views.	Special organization needed to handle replies.

4.5 Web Usability

Web usability means designing websites that are easy to use and manipulate. Users are like to use a website that are easy to use and making them possible to accomplish their tasks. User-centered web development has become an adopted approach to web design by the companies, organizations and government agencies. The acceptability of website depends on its usability. Users are fascinated by the websites that perceives useful information in the website, organized in a way that makes possible to easily access and navigate them. Usability is considered one of the important qualities of web applications. Nowadays Usability has been receiving big consideration, being accepted as a primary property for the success of web applications. (Lazer, 2005; Matera, 2006)

Web usability is completely an emerging field, user-driven experience which imposes companies and site owners to thoroughly understand the goals, demands and attitude of their users. Companies are starting to realize that to guarantee customer constancy; they must provide their websites all the necessary information that the customer may need. (Lazer, 2005; Matera, 2006)

4.6 CMS Usability

Content Management Systems functionality has been long time key deciding factor when obtaining a new product, but purchasers has recognized the usability has equal importance[Robertson, 2007). The success of cms software depends how the software is easily adopted by the authors for creating content and users navigating the site (Robertson, 2003). If users are experienced with an easy to use technology, they will be more likely to remain using it. (Angeles, 2006)

However, comparing a cms product for easiness of use, many important issues should be considered such as ease of hosting and installations, easy of setting up a simple site, ease of site, easy of user management and content administering. All of these factors play a vital role in the process of measuring easiness of use of an interface. (Quinn, 2010)

5 Research Methodologies

5.1 Research Process

The aim of this research is to evaluate and compare usability of the selected systems (WordPress, Joomla and Drupal). The research process of this study is the one suggested by Nielsen for Heuristic evaluation. "Heuristic evaluation is performed by having each individual evaluator inspect the interface alone" (Nielsen, 1993). After evaluation has been completed the findings are aggregated (Nielsen, 1993). "The results of the evaluation can be recorded either as written reports from each evaluator or by having an observer present during the evaluation sessions and having the evaluators vocalize their comments as they go through the interface" (Nielsen, 1993). In the evaluation process, the evaluator must go over the interfaces several times and scrutinize and compare with the evaluation criteria (Nielsen, 1993). The expected output of this research is attained by using Nielsen's process for recording and listing problems. Usability problems in the interfaces are to be listed and identified corresponding to usability principles that were violated by interfaces based on the opinion of the evaluator (Nielsen, 1993). This research has adopted the process of recording the results as written reports. The recorded result is further analyzed, evaluated and compared with the list of heuristic evaluation criteria.

5.2 Method

As it was mentioned in chapter four there are different methods that can be used for usability evaluation of user interfaces. Each method provides its own way to measure the defects in the user interface. Usability evaluation method used in this thesis is Nielsen's heuristic method. Nielsen's recommendation to heuristic evaluation proves that heuristic evaluation is valuable when resource and time is limited. Moreover, single evaluator can measure problems in user interface of systems by using Heuristic method.

In order to make empirical usability measurement the comparing products have been downloaded and installed on a laptop. The table below shows the evaluating products with a version number.

Table 2: Software versions used for the evaluation.

WORDPRESS	VERSION 3.8.1
JOOMLA	VERSION 3.2.3
DRUPAL	VERSION 7.26

Then the components of the comparing software were used by creating websites, analyzing the usability of their interfaces, features and flexibility of each system.

Tasks have been designed to gauge usability of each interface. Each task is implemented in each interface for scrutinizing violations in the interfaces. WordPress was evaluated first because is the only one that I have previous knowledge with. Joomla will be the second one to be evaluated and Drupal will be the last one to be evaluated. Then, the results found from the evaluation will be discussed broadly in the result of the tasks and discussion sections.

Usability measurement reflects the performance measured by the completion time for each scenario. The task completion rate will be gauged a simple way of whether or not to complete the task. Completion time of each task is constantly recorded. Difficulties and confusions during implementation of a task will be also recorded and rated. In order to improve usability, we must prioritize the problems as suggested by Nielsen & Loranger (2006). In order to do that, we need a systematic evaluation of the severity of web usability problems (Nielsen & Loranger, 2006). Problems found during task implementation will be rated major, moderate, minor or no issues. The problem is rated major if it takes more time to solve, or to cause not to complete the task or bring more than three defects. The problem is rated moderate if it brings two or three defects, or challenges the user to try several times. The problem is rated minor if it brings one error or term confusion. Lastly task is rated no issues if there is no problem.

However the evaluation criteria mentioned in section 5.3 are the baseline of the measurement. Each criterion is used to measure how interfaces fulfill the requirements needed. Each system is required to be easily used by technical and non-technical user. Moreover, in order to get rational and sensible outcome, the previously done researches will be comparing with the empirical results found from the investigation.

5.3 Evaluation Criteria

Setting up criteria for evaluating and comparing cms software is not an easy task; it depends on the hypothesis and research problem that you are answering. Having read different literatures and explicated the aim of the thesis, the evaluation criteria can now be easily conceived and proposed. As our study is to compare the most renowned open source content management system named (WordPress, Joomla and Drupal), a lot of contemporary literatures for setting up evaluation criteria that answer research question have been read. The data from the various sources indicated to the same direction and encouraged pre-understanding of the topic, and thus the data sources were regarded valid and relevant in regards to the scope of the research.

These criteria measure the various aspects related to usability. The following usability principles will be used as evaluation criteria for investigating the usability problems in the interfaces of the comparing product (Nielsen & Mack, 1994). The following table illustrates Nielsen's heuristic evaluation which was used to evaluate the interfaces of the selected systems.

Table 3: The ten Nielsen's heuristic evaluation for user interface design and evaluation

Number	Heuristic	Description
1	**Visibility of system status**	*The system should always keep users informed about what is going on, through appropriate feedback within reasonable time*
2	**Match between system and the real world**	*The system should speak the users' language, with words, phrases and concepts familiar to the user, rather than system-oriented terms. Follow real-world conventions, making information appear in a natural and logical order.*
3	**User control and freedom**	*Users often choose system functions by mistake and will need a clearly marked "emergency exit" to leave the unwanted state without having to go through an extended dialogue. Support undo and*

		redo.
4	**Consistency and standard**	*Users should not have to wonder whether different words, situations, or actions mean the same thing. Follow platform conventions.*
5	**Error prevention**	*Even better than good error messages is a careful design which prevents a problem from occurring in the first place. Either eliminate error-prone conditions or check for them and present users with a confirmation option before they commit to the action.*
6	**Recognition rather than recall**	*Minimize the user's memory load by making objects, actions, and options visible. The user should not have to remember information from one part of the dialogue to another. Instructions for use of the system should be visible or easily retrievable whenever appropriate.*
7	**Flexibility and efficiency of use**	*Accelerators -- unseen by the novice user -- may often speed up the interaction for the expert user such that the system can cater to both inexperienced and experienced users. Allow users to tailor frequent actions.*
8	**Aesthetic and minimalist design**	*Dialogues should not contain information which is irrelevant or rarely needed. Every extra unit of information in a dialogue competes with the relevant units of information and diminishes their relative visibility.*
9	**Help user recognize, diagnose, and recover from errors**	*Error messages should be expressed in plain language (no codes), precisely indicate the problem, and constructively suggest a solution.*
10	**Help documentation**	*Even though it is better if the system can be used without documentation, it may be necessary to provide help and documentation. Any such information*

		should be easy to search, focused on the user's task, list concrete steps to be carried out, and not be too large.

All these criteria are measured carefully and discussed deeply. Each of the comparing software will be observed and analyzed based on the evaluation criteria. Moreover referring some of formal evaluations made by web evaluators will be somehow crucial point for consequences of delivering reliable result. Sometimes data from web technology evaluators are not contemporary; instead the updated data from comparing products' website will over-compensate the deficiencies.

5.4 Tasks

Different tasks were designed and carried out on the comparing interfaces; each task is intended to show up a real problem in the interface. Tasks were designed to guide how to do usability measurements of the systems and to recognize difficulties that come with a system. Tasks were designed to be realistic to implement and not to be confusing. Five tasks were selected and presented below with the aim of usability measurement and to find defects in the user interfaces. The following tasks were selected:

1. **Installing the systems on laptop**

   Each open source cms needs a web hosting and installation services. This has to be done by a third party web hosting company, in-house web hosting service or localhost service. Most of the cms support automated installation packages that lessen the effort of installing software. All the comparing systems will be installed on a laptop from scratch and implement the installation process with step by step.

2. **Appearance setting – installing a new theme and activating it**

Default theme of each system will be changed and a new one will be installed in order to recognize the type of problems that associate with this task, when a new theme is installed and activated.

3. **Creating a new page and adding it to the main menu**

A new pages will be created such as "About Us", and adding that page to the main menu of the site. This will be investigating how contents such as pages, articles and blog posts are used in each interface.

4. **Adding image to the site**

An image will be uploaded to the website and it should go on anywhere on the site. This task will reveal how easily is possible to use the media option of these interfaces.

5. **Creating Contact page**

A contact page that contains contact form will be added to each system. This task will show up how contact form's plug-ins are to be extended in the core functionality of these software. In addition to that it shows how easy it is to create a contact form which can be used without trouble by the users.

6. **Creating a new user and managing its role**

A new user will be created and assigned a username, password, operational role and access level.

6 Results of the Tasks

After systematically implemented tasks mentioned in section 5.4, the comparisons of the results found are carefully compared in this section. Many important aspects in the comparison will be considered such as the time it took to complete the task which implies the efficiency of a system, the problems encountered during the task implementation which indicates the complexity of the user interface that a user may come across. Results of the tasks found are separately presented here. WordPress is presented first, then Joomla and then Drupal.

Usability problems found during implementation of the tasks have been recording and will be discussed largely in the discussion section. A further analysis based on the evaluation criteria are revealed in the discussion chapter.

6.1 WordPress

The summary of the tasks findings for the WordPress are presented in the following table.

Table 4: Results of tasks for WordPress

Tasks	CMS	Time (min)	Observation	Problems	Level of severity
T1	WP	4	Installed WordPress on the local-host by using automatic installation package.	0	No Issues
T2	WP	9	Small problem related to terminology like "widget" which is known normally block or module.	1	Minor
T3	WP	11	Different between page and post is not clear. Image button is not perceivable. Publish is used rather than save.	3	Moderate
T4	WP	7	All the media related options are ag-	1	Minor

			gregated in the media button where you can easily get the library of the images, and possibility to upload a new one. In the page creation section, add image icon is not perceivable well.		
T5	WP	17	Extended Functionality is needed. Confusion for selecting suitable form when there are varieties of contact forms available. Coding is possible.	3	Moderate
T6	WP	14	Plug-in extension is needed for role assignment. The capability is used instead of permission. Too much information in capability area	4	Major

6.1.1 Task 1: WordPress installation and setting up

Installing WordPress is a very easy process which takes maximum 5 minutes with a novice user and less than five minutes with an expert user. Likewise other cms, WordPress uses automated installation packages that lessen the effort of installing software. The installation and setting up have taken four minute after apache and MySQL installation. Then filling database information such as database name, database username, database password, database host and table prefix have been implemented. In addition to that, a site was created and filled all the necessary information like site title, username, password and email.

This shows that the installation and setting up WordPress is straightforward that it needs less effort to learn. Less time to complete the task indicates that the efficiency of completing this task is highly respected by the users. In addition to that, the simplicity of WordPress installation encourages users to take further step for using WordPress. However, both novice and expert users can learn and handle WordPress installations easily.

6.1.2 Task 2: Appearance setting – installing a new theme and activating it

There are many predefined themes in WordPress which you can adapt to your site. WordPress has Appearance button that constitutes all the components related to layout of the site such as theme, menu, widgets, background and header. In WordPress all the themes are under theme option which lies under the appearance button. Under the theme option you will see all the available themes in WordPress. To install one of the currently available themes are only one click button to activate the selected theme. To add a new theme is also a straightforward step, inside the theme option there is "Add new theme" button. A new theme can be either used in the search field which will retrieve a theme from WordPress.org theme directory, or will give you possibility to upload from local hard disc.

It was found a very intuitive and inspiring results during the implementation of this task. It was added a new theme from WordPress.org theme directory on my WordPress site. The theme is called responsive which is the one of the featured themes in WordPress. The theme is a very flexible in a way that it adapts the site to a mobile device, desktop and any other viewing environment.

The process of adding, installing and activating the new theme has taken a very minimal time and no error and complication was faced.

6.1.3 Task 3: Creating a new page and adding it to the main menu

In the administrative panel of WordPress, on the right hand side there is a button called "Pages" where you can use to create a new page or edit the existing one. The pages button has two sub-options "All Pages" and "Add New". All previously created pages are collected in "All pages" option and "Add new" option is for newly creating pages. Creating a new page is not complicated, you click "Add new" button and fill the name of the page in the name field and contents of the page in the content field. Likewise other comparing cms WordPress provides WYSIWYG editors for content creation that lessen the effort for using HTML editors. Moreover it provides with a possibility to attach easily any media such as image and video with the page.

It was created five different pages and added to the main menu of the Blackwhite theme that has been installed previously. The process of creating new pages was straightforward, but adding them to the main menu is a bit challenging. Different pages were created such as "Home", "About-us", "How to create websites", "Contact us" and "Images". Then contents were added to all these different pages.

The conclusion of this task has been reached with reasonable time and effort, and no major errors occurred. There was also some confusion for the novice users which is related to term understanding. For instance difference between page and post is bit problematic for perceiving in the first time. In addition to that image button is not clearly seen around the editor.

6.1.4 Task 4: Adding image to the site

In the administrative panel of WordPress on the left hand side of the window, there is a button called media that handles all the related media issues. In the media button there is library option where the images are stored. In Addition to that, add new option is used to append more images to the library. WordPress provides a basic image editing tool that allows cropping, scaling image size, rotating and flipping vertically or horizontally. Advanced settings are possible such as image alignment to any place of the site, CSS class of the image and image property are also available in WordPress.

A new image have been uploaded to the library and inserted to page called "About-Us". No major usability problem was found; just add media button in page creation section is not intuitive.

6.1.5 Task 5: Creating Contact page

In WordPress contact page is not part of the core functionalities; it needs to add on plug-ins called contact form. In order to get contact form functionality you need to install and activate the contact form plug-in. After activation of the plug-in you will see

contact form button in the left side of the control panel where you can start to create contact form and insert it into the site.

As it was mentioned before in WordPress it is not possible to create contact form without installing new plug-ins. A contact form called "Contact form 7" has been installed. A number of different plug-ins for creating contact form were also available to install. This plug-in was selected because of the highest rate provided.

6.1.6 Creating a new user and managing its role

User roles and groups of WordPress are limited in the core modules. You need to install and activate add-ons in order to get important functionality for roles and permissions. A new add-on for extending user functionalities in the core modules has been installed. It is called WPFront User Role Editor that provides opportunity to modify default roles and create new roles as much as you want. A new user was created and provided a role and access level. There are some usability problems in the interface. These problems will be explained in the discussion chapter.

6.2 Joomla

The table below clearly depicts the findings of the tasks for Joomla. Detailed explanations of how tasks are being implemented will be presented in the subsections.

Table 5: Results of tasks for Joomla

Tasks	CMS	Time (min)	Observation	Problems	Level of severity
T1	JM	43	Automated installation package were used. Creating database tables were very problematic. *Database* engine name was not recognized. Selecting site type from different options was problematic due to a number	4	Major

			of unfamiliar options available.		
T2	JM	32	No appearance button and no theme button. Everything is under extension button. Not easily conceivable terms like template, plug-ins and modules. Also term confusion for publish and un-publish where other cms use "ena-ble" and "disable". Main menu as-signment is also a problem.	5	Major
T3	JM	13	Joomla uses term article instead of page which is confusion. Sounds like news article. All related page creation is under article button. Too many op-tions for article creation. Image button is not perceivable for image insertion in the content.	2	Moderate
T4	JM	6	Media manager is in content button. Image button is not clearly seen in the content creation area.	1	Minor
T5	JM	4	Contact form is part of core modules in Joomla 3. Contact button is under component button and users can't see right away.	1	Minor
T6	JM	14	Irrelevant fields that is impossible to fill such as last visited date. The term Group is used instead of role. Setting permission is not easy. The term Ac-cess level is used instead of permis-sion.	4	Major

6.2.1 Task 1: Joomla Installation and setting up

Installing Joomla it is not an easy process as WordPress. There is a bit of learning curve to all less technical users. Despite the fact that Joomla also comes with automated installation package, sometimes you can encounter a serious problem with database configuration. It depends on the platform and web servers used, in this case, XAMPP platform were used. A severe database problem that took a lot of time to solve was experienced. The server was not able to create database tables, so it was stuck on that process for a long time. However, trial and error method was used to overcome that problem. Some changes have been made for the execution time to 3000 seconds in the "PHP.ini" file and database engine name from "InnoDB" to "MyIsim" in "joomla.sql" file. The second problem that has been encountered during the installation was the selection of site type. There were six options as you can see from the figure below.

Figure 2: Joomla installation process

The novice user will get confuse of selecting appropriate option for their preference therefore installing Joomla is not straightforward as WordPress is for novice users. Time to read installation guides are recommended. On the other hand, experienced user may handle this automated package easily.

6.2.2 Task 2: Appearance setting – installing a new theme and activating it

Managing layout of Joomla site is not straightforward as WordPress. It is a process of combining different tasks. Instead of the term theme Joomla uses template which can't stand alone without augmenting modules and plug-ins in order to get complete layout of the site. Joomla has extension button that provides most of the options related to installing and activating a new theme. Extension button has a sub button called extension manager that provides options for uploading, searching from Joomla folder or searching from URL and installing a new template in your site. In the extension button, sub buttons template manager, module manager and plug-in manager are where you can activate and manipulate the installed template, module and plug-in.

During the installation of a new theme in Joomla was found a bit challenging. Real understanding of different terms (template, module and plug-in) and their role in the process of installing a new theme was somehow troublesome. A new theme was downloaded and installed in the Joomla site. The theme is called "it_Blackwhite2" which is fully responsive and adaptive to any viewing environment such as mobile device, desktop and other viewing environment. It is lightweight design which is super-fast in loading time.

However, the process of adding, installing and activating a new theme in Joomla site needs an average time and some effort depends on the user's experience. Some errors may have occurred due to the variety of tasks that are being accomplished.

6.2.3 Task 3: Creating a new page and adding it to the main menu

The term page is not known in Joomla environment, instead it uses the term "Article" which is not intuitive for the novice users. In the administrative panel of Joomla provides "Add New Article" and "Article Manager" where you can add a new article or manage the exiting one respectively. In the "Add New Article" option provides best possible option for creating a new article or page. It gives you possibility to set title, content, category, tags and access control of the article. In addition to that there are op-

tions for inserting images and other media as well. Article Manager lists all the articles that have already created and their features.

In Joomla creating a page is not a complex task, but in the first time you get confused of the term "Article" which reflects post or news article. Five pages or articles were created in the Joomla site. During the process of creating the pages all the necessary fields such as title, content, category and access level (public or private) were filled.

Joomla provides WYSIWYG editors that make life easy for creating articles. However understanding of some of the terms is troublesome first time around. Assigning articles into the menus is also a challenging task. However, creating a page and assigning it into the main menu may need some time and learning effort. Some errors have occurred during the publishing the article. Implementing task 3 in WordPress is much easier than in Joomla

6.2.4 Task 4: Adding image to the site

In Joomla media manager button is in the content button where images are uploaded and linked to content. All images are kept in the media manager where it is possible to view images both in thumbnail and detailed view.

A new image was uploaded and inserted into the content page called "About-Us". There is no major problem for uploading and inserting processes except for a very minor usability problem, the image button in the content editor area is not adequately visible. The image button is below the editor, and it might take the user some time to see it.

6.2.5 Task 5: Creating Contact page

In Joomla creating a contact page is a straightforward task. Everything related contact is under the contact button which lies under the component in administrative panel. Basic content page is a two-step process; fill the information of contacted page where users send the information and link it to the contact page on the main menu. Instead of using basic contact form, enormous extension modules are possible to add on Joomla.

A contact page was created by downloading and installing Alfa-contact form extension. This is a free extension from Joomla extension site. The process of doing contact page went smoothly and no usability errors were found. The reason as to why this extension was selected over the others was because it had more reviewers and it was rated extensively.

No issues score was rated in this task because technical and non-technical user can easily implement this task. Joomla provides ready contact forms that lessen the effort of downloading and extending extra modules.

6.2.6 Creating a new user and managing its role

Joomla has versatile user group that can be extended, modified and removed. Joomla 3 has nine default user groups and access levels for users. You can have possibility to modify default groups and add new user groups as many as you wish. Two new user groups were created and assigned their roles. It was bit challenging due to the non-standard terms such as group, access level and overly information in the permission section.

6.3 Drupal

The table below clearly illustrates the findings of the tasks for Drupal. Detailed explanations of how tasks being implemented are presented in the subsections.

Table 6: Results of tasks for Drupal

Tasks	CMS	Time (min)	Observation	Problems	Level of severity
T1	DP	30	Likewise Other cms, Drupal uses automated installation package. Problems were faced during installation problem. Syntax error for some php	2	Major

			files, and which option is to be select-ed for the site "standard" or "mini-mal".		
T2	DP	12	Likewise WordPress Drupal uses Appearance button in the administrative section. The Plus sign for add new theme is not seen and not perceivable immediately. Sub-theming is a big problematic for non-technical user.	2	Moderate
T3	DP	17	Type of content is confusion such as page, article, book, blog post and story. Save button is not intuitively seen. Publishing option is not easily perceivable. Promoted to front page in the Publishing option is confused by the user. No visual editors for formatting texts.	5	Major
T4	DP	19	Image insertion mechanism is not easily conceivable. No media button. Only article content has image field. Other content types (basic page, blog post) image field is to be added.	4	Major
T5	DP	4	Out of the box. Just enable contact module.	0	No issues
T6	DP	22	Plus sign for add user is so small and not placed standard location. Only two roles are out of the box (Authentic user and anonymys). Assigning role is not intuitive. Too many information in the permission area. Update options such as block, unblock, remove and add users are in drop down box, and not	5	Major

			visible.		

6.3.1 Task 1: Drupal installation and setting up

Likewise other open source cms Drupal has come with automated installation package that lead installation process to be easy and elegant. In the Drupal installation, a serious problem was encountered during installation process "*Parse error: syntax error, unexpected '{' in .../includes/bootstrap.inc"*. Changing php version to a newer version has solved this problem. Second confusion was selecting the suitable installation profile while there were two options "Standard" and "minimal". Standard was selected because of the word standard itself as it shows during installation process of software which is always against "customize". However, Drupal installation has been taking less time than Joomla, but more time than WordPress.

6.3.2 Task 2: Appearance setting – installing a new theme and activating it

In Drupal for managing the way of your site looks is straightforward. Drupal has appearance button in the administrative control panel. All the options related to appearances and layouts of the site are aggregated in the appearance button. Options for adding and installing new themes are placed under the appearance button. The available themes that are classified enabled and disabled can be found in the appearance option. Therefore disabled theme can be transformed to enable by clicking the "enable" option. In the appearance button there is "Install new theme" option that allows adding and installing a new theme in the interface. Install new theme provides options for uploading from the local disc or installing from a URL, specifically Drupal.org. The process of installing a new theme in Drupal is intuitive and relatively undemanding. A theme called Omega was installed in the Drupal site which is responsive and flexible in terms of small screen devices such as smart phones and iPads. Drupal has term called sub-theme which provides unique look and extra functionality in the site. So implementing sub-theme is a bit complicated that needs extra effort for changing contents of some files in the base-theme.

However, the process of adding, installing and enabling a new theme needs relatively minimal time and effort. Some errors may occur for extending the base-theme to sub-theme where it is needed to have some knowledge of coding for changing some lines of the code.

6.3.3 Task 3: Creating a new page and adding it to the main menu

Apparently Drupal has more functionality than Joomla and WordPress. Drupal uses different terms for content creation "Article", "Basic Page", "Book page" and "Blog entry". The article is used for dynamic content like news and press release. Basic page is used for static content that rarely changes. Book page is used for document creation such as books and tutorials. Blog entry is used for creating blog posts such as personal blog or company's information blog. It is a bit confusing to select a suitable option if you are not familiar with Drupal environment. In Drupal all the content creation options are under content button in the administrative panel.

During implementation of the task three, one basic page and three articles were created; all these pages were added to the main menu. Despite the creation of content needing some time and effort for learning the system, the process went smoothly. The editors for creating contents in Drupal are not visual editor where user can't change the format of text. For instance if user want to make bold some text in the input field, it is difficult to grasp immediately. However, visual editors can be downloaded and extended to core functionalities. Save button and publishing options are at the bottom of the window which is not intuitive for the novice user. It is good that save button should be at the top of the input field. It is also good that publishing option is displayed at the top of the input field where it is possibly that the user can see first.

6.3.4 Task 4: Adding image to the site

Image insertion mechanism is not easily perceivable in Drupal 7. There is no media button in Drupal 7 whereas the other compared cms have this option available. In Drupal 7 there is a module called image which is part of the core functionalities for image insertion in the content field. Previous versions of Drupal such as Drupal 6 image mod-

ule is to be augmented to core functionality. Despite this, the image field is available in the article editor, the other content types such as basic page need extra effort to activate image module. Image formatting options such as image scale change and crops are not easily conceivable.

6.3.5 Task 5: Creating Contact page

In Drupal 7 creating contact form is a very intuitive. It creates a contact form for administrator out of the box. Likewise other cms Drupal comes with many core modules. These modules are not all enabled out of the box. The contact form module is one of the disabled modules that have to be enabled for use. When creating contact page important fields in the contact form section need to be filled. This can be done by going to Structure >>Contact form. The important fields that need to be filled are category, recipient email, auto-reply and selected.

The process of creating contact form went very smoothly. A contact page called "Contact Us" was created and added to the main menu. It took less time than others and no errors were found during the implementation of this task.

6.3.6 Creating a new user and managing its role

Drupal provides advanced user roles, limitless user roles can be created and weighted into hierarchical roles. Drupal provides anonymous and authenticated user out of the box. Other user roles must be created and assigned permissions. All related users are under people button in the administration area.

It was struggle to implement task six. Creating a new user is not so complicated, but creating a new role and selecting access level (permission) was incredibly complicated. Updating user's information such as activating, blocking, removing and changing was not intuitive way.

6.4 Summary of Results

As it is evident from the tables in sections 6.1, 6.2 and 6.3 (results of tasks), each interface pose difficulties that user may struggle to complete the task. The efficiency and difficulties are different from one interface to another. The summary of the results of each interface are discussed here distinctly. The following figures provide a clear image about the time it took by each task and summary of level of problem severity by each system. The detailed analysis will be revealed in the comparison section.
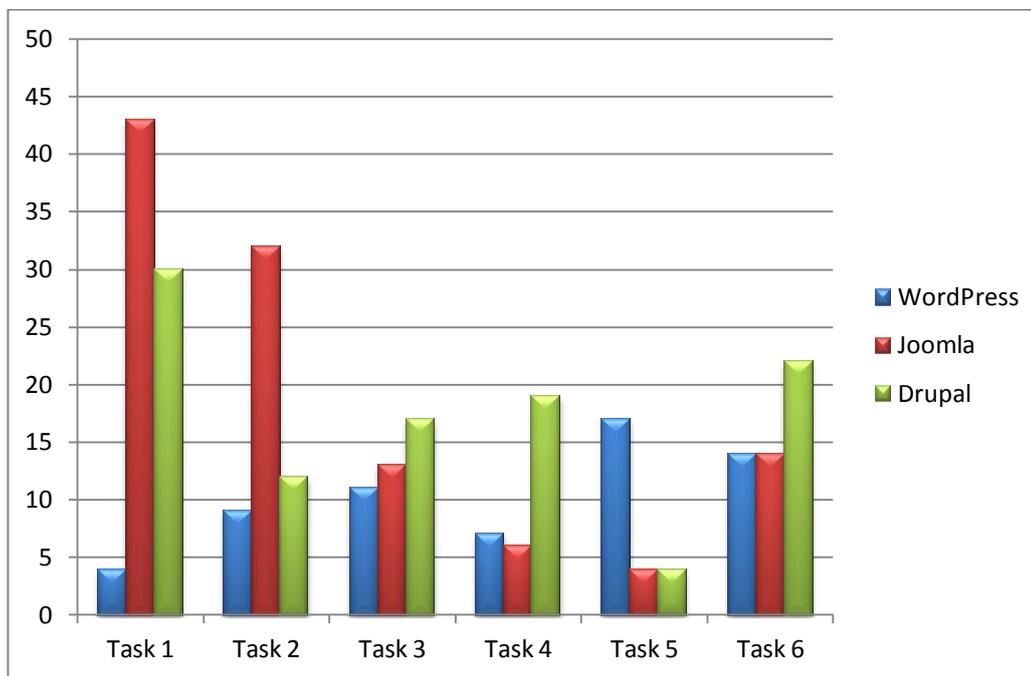

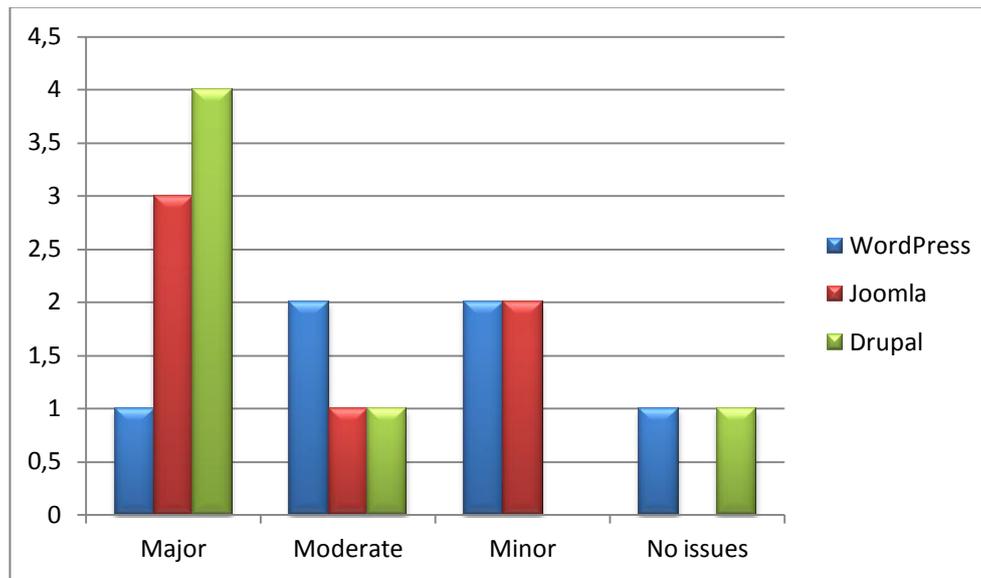*Figure 3: Tasks completion time by each system*

Figure 4: Severity of problems by each system

6.4.1 WordPress

In WordPress task one has no problems and it took less time to complete. Therefore it was found that WordPress installation was as the WordPress developers' claim it to be, which was simple and only took five minute. Regardless of the time it took to complete the second task, this was also a clear-cut in terms of terminology, downloading, installing and activating a new theme as well. Task three has taken more time and found more problems than other previous ones due to the number of sub-tasks to be accomplished. Linking the created pages to the main menu was bit challenging for novice users. Task four which is adding image to the site and task two about themes have same number of problems but task two has more time to complete due to the number of sub-tasks to be completed and more time is needed to select a suitable theme from the pool of themes available in WordPress. Task five took more time and had more problems than the others, because contact form in WordPress is add-on modules to be extended to the core functionality which results in more time to search install and fill the input fields.

6.4.2 Joomla

In Joomla the first task was challenging and spent more time than others. Many trials have been made for completing this task due to technical problems that were not expected. Task one has got four problems which was the second highest on all the tasks. As it was mentioned in section 6.2, the most dominant problem that took a lot of time was creating database table which wasn't possible to succeed until some change have been made in system files. Apparently task two was so complicated due to extra works needed to augment add-ons to the core functionality. Adding add-ons to Joomla is not easily done, because the extension manager has many options that needed to know before you use them. Templates, modules and plug-ins are to be installed, activated and assigned to the main menu and other menus as well. Task three is about page content and adding to main menu of the navigation area. Although the term article was a bit confusing, the task was completed successfully. Task four was finished in minimum time without severe problems, and it was the easiest one to do. Task five was also very easy compared to WordPress, because contact form was part of the core functions in Joomla. It is apparent that task six had more problems and it took more time therefore the task was not completed successfully.

6.4.3 Drupal

During task one in Drupal a reasonable amount of time was spent and no major problems were found. Just like in Joomla some technical errors occurred, but were not on the same level of severity as Joomla. Setting the layout of Drupal was straightforward which again took a reasonable amount of time to complete task two. Similar to WordPress, Drupal uses same terms such as appearance and theme that WordPress users can quickly adapt to the layout setting of Drupal. Sub-theme is a unique and non-standard term that Drupal uses. Sub-theme made task two a bit complicated, because it needs some coding skills. Task three spent more time and found more problems due to term confusion. Terms article, basic page, story and book need more time to know the distinction between them and when to use each option. In addition to that some of the buttons were not clearly visible in the content area. Despite this, there is no media option and extra effort needed to activate media plug-in, task four went smoothly and

quickly. No major problems were found in task four as clearly shown from the graph. In task five less time was spent and no errors were found as the graphs depicts. Task six was very complex and took more time to complete. Assigning roles and permission to Drupal is a demanding task. Role option are not placed in standard location, it is under the permission tab. There is excessive and duplicate information in the permission button, this overly information would lead to demotivate the users to complete the task.

7 Discussion and Analysis

It is impossible to judge easily which interface is easier to use in terms of technical and non-technical staff unless you refer a number of analysis based on empirical research, or personal experience on the systems you are investigating. Moreover, ease of use in a cms system is a primary requirement for many organizations. The website of an organization may be updated and edited consistently by non-technical staff, so that if using a system shows any kind of difficulty, it would cause an extra cost for staff training and third-party exploitation. If the system has user-friendly interface and easily manipulated tools such as tools for creating content, controlling layouts, colors and media options then administrator can easily edit and update content. (Quinn, 2010)

This chapter is about analysis of the results found from the research. The three comparing systems are considered their usability separately. Comparison of the systems based on the criteria will be uncovered. Detailed discussion of usability problems found by the research is presented. Data analysis about the time it took by each task and severity of problem will be presented. The type of heuristics violated by each task is also shown. During the implementation of the tasks the severity level of usability problems and the type of heuristics violated will be identified. Each problem encountered violates one or more heuristic rules. As the Nielsen's Heuristic was the inspection method selected for this thesis, our evaluation criteria is based on that. In addition to that, personal opinion and existing results from previous researches are also combined and referred.

7.1 WordPress

WordPress is the easiest and smallest in size than other compared cms. As we know WordPress has historically been designed to be a blogging site but it still lacks overwhelming features that other cms (Joomla and Drupal) provide.

Despite of some problems occurred during tasks implementations the overall perception of tasks execution was positive in WordPress. WordPress provides an intuitive way of implementing tasks and aesthetic interface that are easily learned and managed.

7.1.1 WordPress: Heuristics Evaluation

WordPress has fewer problems than other comparing cms, so it means less number of heuristics was violated. The table below illustrates the type of heuristics violated by ach task.

Table 7: WordPress Heuristic evaluation

WordPress Heuristic Evaluation		
Tasks	**Heuristics Violated**	**Comment**
T1	No heuristic violated	No usability problem was found. The process was successfully completed.
T2	1. Match between system and the real world.	The word "widget" is a technical and not plain language. It is known as block or sometimes module.
T3	1. Consistency and standard 2. Recognition rather than recall	Page and post is bit confusion for less technical user. Post is used normally for blog post. Image button in the creation page area is not visible.
T4	1. Recognition rather than recall	Image button in the creation page area is not visible
T5	1. Flexibility and efficiency of use	New add-ons and plug-ins is needed. Short code is needed to add for form activation. Non-technical user needs extra help.
T6	1. Flexibility and efficiency of use 2. Match between system and the real world. 3. Aesthetic and minimalist design	New add-ons are needed to install. Capability is used instead of permission. Capability is not a plain language. Overly information in the capability sections.

As it's shown from the table five different heuristics were violated "consistency and standard", "recognition rather than recall", "match between system and the real world" and "flexibility and efficiency of use". Consistent and standard deals with terms that is not standard among all systems. Terms that is not known in everywhere, but rarely used by specific system. For instance, the usability of terms post and page create more confusion. The term page is more standard therefore it is used extensively. Recognition rather than recall deals with minimizing user's memory load by designing object and options that are visible and recognizable. For instance image button in the creation page is not appropriately labeled and not noticeably visible. The other important heuristic that was violated is match between system and the real world. The system should be used by different users; therefore it should speak a common language, instead of speaking a technical language. For instance term "widget" is more technical rather than familiar language to the user. Flexibility and efficiency of use is also violated. For instance Task five took more time to implement due to installing and enabling extra plug-ins. This decreases the efficiency of non-technical user to complete the task. In addition to that "plug-in" is more technical word which violates "match between system and the real world". More heuristics were violated by task six. Flexibility and efficiency of use were violated, because plug-ins are to be installed and activated. This process of extending core functionalities will take more time and extra effort. Match between system and the real world was also violated. The capability term is more of technical word, whereas permission is more obvious term regarding technical and no-technical user. Aesthetic and minimalist design is also one of the violated Heuristics in Task 6. There is a lot of information in the capability section, and sometimes irrelevant information that increase confusion of the users.

7.2 Joomla

Joomla provides more functionality than WordPress. It was designed to provide full cms functionality that mid-sized and large-sized organizations prefer to use rather than WordPress. Joomla provides a well-structured administrative panel that persuades users to vigorously utilize the rich components of it.

During implementation of the tasks, a lot of technical problems were faced such as creating database tables in the installation process. The meaning of some terms in Joomla are also confusing such as article which implies the system is designed for building news websites, but in reality the Joomla is multipurpose cms. Another confusing area is about add-on terms. Joomla uses four different terms for add-ons template, Modules, plug-ins and components.

7.2.1 Joomla: Heuristics Evaluation

As Joomla has more problem than WordPress, more heuristic violations were expected. Joomla is more sophisticated than WordPress; some of the tasks were implemented with struggling. Most of the heuristics violated related to non-standard terms and more technical terms. Term confusion entails that some time is needed to learn the odd words. Some of the area in the interface contains excessive information that would demotivate the users to go forward. The following table illustrates the heuristics violated by each tasks.

Table 8: Joomla Heuristic Evaluation

Joomla Heuristics Evaluation		
Tasks	**Heuristics Violated**	**Comments**
T1	1. Help user recognize, diagnose, and recover from errors 2. Help documentation 3. Error prevention	Error message was not plain, just path of system file is exposed. Short coding was mandatory. I have not got enough help and documentation which is specific to the task.
T2	1. Match between the system and the real world. 2. Flexibility and efficiency of use	Other comparing system uses appearance term which is less technical. Everything is under extension manager which less technical user suffers more, and needs time to learn. More technical words are used such as plug-in, module and template. It took more time to complete for novice user.

T3	1. Match between system and the real world 2. Aesthetic and minimalist design	The term page is more obvious and standard than article. Too much irrelevant information in the content creation area.
T4	1. Recognition rather than recall	The media button is not clearly seen, it is under content section. Not easily retrievable.
T5	1. Recognition rather than recall	Contact button is hidden under component button. Not easily perceivable
T6	1. Aesthetic and minimalist design 2. Match between system and the real world	Irrelevant fields that is impossible to fill such as last visited date was in place. The terms group and Access level is more technical. Term confusion, group and access level are rarely used terms. Role and permission are less technical and more standard terms.

During the implementation of the tasks it was found match between system and the real world, and recognition rather than recall are the most violated heuristics. Match between system and real world deals with the language used by a system should be familiar to users. For instance article is not familiar to all users; it is only known in some specific system such as Joomla. Recognition rather than recall means lessening user's memory load by recognizing actions, objects and options. For instance media option in Joomla is not visible; it is hidden under the content option, whereas media option of WordPress is easily retrievable in the administrative panel. The other remarkable heuristic that was violated by Joomla interface was aesthetic and minimalist design which avoids irrelevant and rarely used information in the interface. For instance too much irrelevant and rarely used information are composed in the content area of Joomla. Two different heuristic were violated by task six. This indicates that creating a new user and assigning a role is not easily attainable in Joomla. Joomla uses more technical and non-standard terms that increase the confusion. Too much irrelevant information is in the permission area.

7.3 Drupal

Drupal is the most sophisticated system and has more functionality than other systems. The negatively remarkable point is that there is no separation between sites, the administration site and the actual site. Less technical users get confusion of where they are. Therefore it would be brilliant to improve usability of the system so that there could be a clear separation between the sites. It's astonishing that the create content option is observable in the actual site area before you get in to the administration area. This is unnecessary choice which increase user's confusion for amalgamation of the two sites (administration and actual). Drupal has more choices for content creation that would not be familiar to all users. Some of the terms are excessively duplicated which increases the unfamiliarity such as content creation terms like article, basic page, story and book. Therefore the novice user can't grasp quickly the difference between these content types.

Specific Problems and their violated heuristics are discussed in the following subsections.

7.3.1 Drupal: Heuristics Evaluation

Table 9: Drupal Heuristic evaluation

Drupal Heuristic Evaluation		
Tasks	**Heuristics Violated**	**Comments**
T1	1. Help documentation 2. Error prevention	More help was needed for technical errors
T2	1. Recognition rather than recall	Plus sign for add new theme is not recognizable.
T3	1. Match between system and the real world 2. Consistency and standard	For page creation terms article, book, story and blog entry are very excessive for new users. Too much irrelevant information was in the article area.

	3. Aesthetic and minimalist design	
T4	1. Recognition rather than recall	Image button is not visible.
T5	No Heuristics violated.	No usability Problem was found. The process was successfully completed.
T6	1. Recognition rather than recall 2. Aesthetic and minimalist design	Plus sign for add new user is so small and not in standard location. Add role is not retrievable easily, the button is hidden under permission tab. Too much information in the permission area, some of them are irrelevant.

In Drupal recognition rather than recall is the most violated heuristic. For instance the plus sign for add new theme is not easily recognizable by users. And save button in the new article area is not also clearly seen. In task six this problem has come three times, therefore this is a significant heuristic that Drupal interface has violated iteratively. Aesthetic and minimalist design is another heuristic violated by Drupal user interface. For instance too many confusions and overly information are in the content creation area. Match between system and the real world was also violated by Drupal interface, because there are too many technical words in the interface. For instance "weight" is technical word, therefore it would be good to use the term "order" instead. Moreover the url path setting is also too technical. In order to make it simpler, it would be better to use everyday language.

7.4 Comparison of the systems

In this section the results found from the experiment will be analytically compared. The figures in section 6.4 illustrate the share of each interface for the problems found according to the level of severity and time spent. In addition to that we will refer some previously done researches that mainly confirm with the results.

As it was mentioned in the "chosen method" section, the problem is considered major if it has serious problem that may evade the completion of the task or brings more errors.

From the figures in section 6.4 Drupal took the highest share of the problems designated to major. Drupal got the major score four times out of six tasks which indicates Drupal interface is more complex than other comparing cms. This shows that more than 50% of the problems that come up during the implementation of the tasks were scored a major. Some of important areas were so complicated for the novice user. Content creation area which is important for every user, it provides overwhelming options that may hinder users to achieve results with reasonable time. Article, basic page, book page and blog entry are the available content types in Drupal 7. Task three was rated as a major due to the variety of contents related terms, which also added to other difficulties such as WYSIWYG editors are not out of the box in Drupal 7. It is obvious that WYSIWYG editors are so important for systems like cms where users are constantly modifying the format of texts. This will increase the confusion for the new users in interpreting the enormous content creation options. Contrary, the professional user can enjoy the flexibility of content creation area, whereas a novice user doesn't care about the capability of a system that diminishes the usability. Typically less technical users prefer a system that is easily learned and used. In addition to that some other areas are also scored as a major such as image insertion process and assigning roles to the newly created users. As it is obvious authentic and anonyms users are out of the box in Drupal 7, other users are to be created by the privileged users. The structure and layout of the user's area in the Drupal's administrative panel are very messy. For instance updated options are concealed under dropdown box, and also permission and role tabs are not clearly visible. However The Heuristic evaluation proves that professional user can manage the Drupal interface while non-specialist can learn and use through struggle.

Joomla has taken the second highest share of problems rated as major. Joomla has three major score out of six tasks which is about 50%. The task one has taken more time to implement due to the technical problems occurred during the installation. This is not counted a common problem for every user. Some other users may install Joomla as quickly as possible without any trouble. Joomla has also big share of the problems rated as moderate and falls in second position. Joomla has provided the biggest challenge in task two with the layout and appearance change. Appearance change in Joomla is not really intuitive. It was expected for Joomla interface to have appearance and theme button like the way WordPress and Drupal had. In Joomla there is no single position where

you can control appearance for the site. It is dispersed into template manager, Module manager and plug-in manager. Each component devotes extra work for installing and activating the add-ons.

Joomla has bigger capacity according to cms functionalities than WordPress, but less capacity in terms of functionalities comparing to Drupal. Despite Joomla shows easiness of use in some areas, it is more complex than WordPress. As the figures in section 6.4 shows Joomla doesn't have any task rated as a no issues. Task rated as a no issues means no problem and no heuristics violated. Joomla provides huge number of plug-ins out of the box, whereas Drupal needs additional plug-ins to be installed and activated. Joomla is relatively easy according to the experience of the user. However the novice user can complete some of tasks without struggling. The heuristic evaluation proofs that a professional user can handle Joomla without worries, but non-technical user may hinder the overwhelming options in the Joomla user interface. Despite some of the tasks are to be executed by the novice users without any help, but extra help and documentation is needed for some other tasks.

As it is evident in the figures 6.4 WordPress is much easier than other systems. WordPress has least score of problems rated as major. On the other hand WordPress has the highest share of problems rated moderate which is the second grade in terms of severity. WordPress has less capacity and functionality than other comparing cms, instead usability aspect is more focused in WordPress. It provides a very fascinating user interface. There is no panic for the new user in the first time. Some of the area is like using word document. For instance content creation area was very easy and provides WYSIWYG editors that allow editing and modifying text formats. Moreover WordPress provides extra tools that it is not available in the other comparing systems. Image formatting tools which allows changing the format and the scale of the image without utilizing graphical applications such as Photoshop. On the other hand creating a new user and assigning roles is not a simple task in WordPress. Extra work for extending the core functionality of WordPress is very much needed. The term capability is not standard for every cms, permission is more common. Excessive information is in the user section, which may restrict new users. Eventually the heuristic evaluation proofs that the

WordPress is the most usable of all. WordPress is a system that technical and non-technical users enjoy working on it.

There are also a lot of researches done for comparing cms, but most of the researches were focused on the capability, functionalities and flexibilities of the systems. The usability aspects of open source cms systems were less concentrated by the researchers. Easiness of use of a system means to construct straightforward website quickly without technical expertise and no matter how feature-rich the cms is (Quinn, 2010). Idealware has done a very valuable comparison for Open source cms (WordPress, Joomla, Drupal and Plone) in 2010. The focus of the research was comparing both capability and usability of the system. Despite the comparing versions were different than the versions used in this thesis, specifically WordPress and Joomla has updated a lot since 2010, but the information in the report is still valid. Similar research has been done by Ghrecha and Bhatt in 2013. Ghrecha and Bhatt have found same result as Idealware (Ghrech & Bhatt, 2013). The table below shows the comparisons done by Idealware about usability. Idealware has rated the systems excellent, solid, fair and none. Excellent has the highest score for the easiness of use and none has the least score.

Table 10: Idealware usability comparison

Features	WordPress	Joomla	Drupal
Ease of Hosting and Installation	Excellent	Excellent	Excellent
Ease of Setup: Simple Site	Excellent	Solid	Solid
Ease of Setup: Complex Site	Excellent	Excellent	Solid
Ease of Use: Content Editors	Excellent	Solid	Solid
Ease of Use: Site Administrator	Excellent	Solid	Solid

As it is evident from the table WordPress has out-performed in every comparing feature. The other systems also performed well. It is remarkable that hosting and installation

process is designated excellent to all systems, whereas Joomla and Drupal installation were problematic during the installation on my laptop. Therefore, it is not fair to say installation process of Joomla is so complicated, rather than considering many issues such as experience of user, platforms and version of servers (MySQL and apache). For setting up simple site WordPress has performed well than other systems. Creating simple site doesn't matter how feature-rich system is (Quinn, 2010). This includes installing themes, creating contents, adding images and other tasks. Some systems make site administration tasks so easy while others demand more technical expertise or learning curve (Quinn, 2010). Therefore WordPress has designed a well-structured interface that is easily administered by everyone.

There are also some other researches that mainly confirms with the results found from the heuristic evaluation. These include the comparisons made by the Rackspace Support Network in April 2013. Rackspace has concluded their research in terms of easiness of use that WordPress is the most intuitiveness of use, and no need technical experience (Rackspace, 2013). Despite both other systems are more complex than WordPress, Joomla is less complex than Drupal (Rackspace, 2013). Joomla needs some effort for understanding the structures of the interface and terminologies (Rackspace, 2013). Related research has been conducted by Mark Janes, and concluded "WordPress is committed to serving non-technical users who want to communicate easily and effectively" (Mark, 2011). On the Other hand, Mark pointed out that Joomla and Drupal are more complex than WordPress, "Ease of use is an issue that both Joomla and Drupal are working on. But it doesn't come naturally to them; evidenced by the slow progress they're making and the fact that their ships are still being sailed by technologists" (Mark, 2011). W3Techs has conducted a survey about ranking websites according to the cms technologies they use. WordPress has taken the biggest share, whereas Joomla and Drupal have been second and third position respectively (W3Techs, no date). Similarly Water and stone has conducted surveys in 2010 and 2011 in which more than 2500 participants responded to the survey (Water & Stone, 2011). The Participants were asked "what system are you using now?". Then the result shows that WordPress is still in the leading position, whereas Drupal is the second leading and Joomla is the fourth (Water & Stone, 2011). Lastly Builtwith is another group that made a valuable survey about cms technology behind today's website. The same results were revealed, WordPress and

Drupal have maintained their positions while Joomla has descended in to the fourth position (Builtwith, 2014). In my point of view, WordPress has maintained the leading position throughout, and the only reason for this adoption is easiness of use. On the other hand Joomla and Drupal are bit complicated for a non-technical user, though they present usable interface in some areas.

7.5 Further Work

The role of usability is mainly overlooked in the process of development of open source software (Hall & Duin, 2014; Andreasen *et al*., 2006). Open source software is always criticized to poor usability (Hall & Duin, 2014). End users share their comments about software such as " is a great program once you figure out how to use it", "You will like using_...after you learn the awkward menus" (Hall & Duin, 2014). All these statements indicate that OSS frustrates users in the first time due to the lack of usability. As it is common the program should be usable by different level of users and follow the 'Law of least Astonishment' (James, 1984). This law simply defines that the program should always respond to the user in the way that astonishes him least (James, 1984). As the developers of open source software inclined to give much thought to functionalities rather than usability, the comparing products lack many aspect of usability. Therefore the improvement of usability of the comparing products is mandatory for process of product development. To improve usability, developers must adopt usability testing for improving their product (Hall & Duin, 2014). In addition to that, users should have full involvement in the process of product development.

The aim of employing usability evaluation methods is to reveal issues that hinder general users from using software successfully (Hall & Duin, 2014). Therefore relying on a single method is not productive. Different evaluation methods examine different part of the interface. However, combining multiple approaches is the best practice that uncovers more errors in the program. Formative evaluation which is to implement the evaluation in the earlier stage of product design and development associated with summative evaluation which is applicable when design is completed by assessing the design against quantitative goals and competitive product would improve usability of any open source software.

8 Conclusions

The aim of this master thesis is to study, investigate and compare usability aspect of different open source content management systems. The selection and comparison process of an open source content management system represent one of the challenged tasks undertaken by many companies and organizations. Content management system is an important area in the IT arena due to the massive volume of data needed to be stored and managed in a dynamic manner. Despite the fact that the number of available open source content management systems is very large, the most prominent products were selected (WordPress, Joomla and Drupal). Different usability evaluation methods were presented and classified into usability inspection methods and usability testing methods. Although various usability inspection methods were available, heuristic evaluation method were employed. Heuristic evaluation method is valuable when resource and time is limited. Moreover, a single evaluator can use heuristic evaluation method to measure problems in the interfaces as it is depicted in table 1.

After installation of the selected software, tasks were implemented to gauge defects in the interface. Then the information collected by the observation was analyzed and translated into meaningful results. The findings of the research shed light on the major problems in the UI and heuristic principles violated.

However, the results of the research proved that WordPress, Joomla and Drupal have performed well for providing interfaces that can be easily used by technical and non-technical users. WordPress has provided the most usable interface, whereas UI of Joomla and Drupal provided some kind of difficulties in implementing some of the tasks. The research also identified that all these products have overwhelmingly gained leading position in open source content management systems' competition and their developers are keen to maintain consistently that position. The research also proved that the most violated heuristic principles were recognition rather than recall and match between system and real world. Recognition rather than recall means lessening user's memory load by recognizing actions, objects and options. Match between system and real world deals with the language used by a system should be familiar to all different

level of users. In addition to that the results of previous researches were mainly confirmed in my own conclusion.

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