

Business Intelligence (BI) Application in Open-source Content Management System (CMS): A Review

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Abstract: *This paper reviews the development of the business intelligence (BI) platform in the web application system based on the open-source content management system (CMS): WordPress, Joomla, and Drupal. The open-source CMS mostly used by companies for their websites and web application systems, while the BI application used by companies to analyze the information needed for decision-making. The BI application involves data visualization (DV) techniques that displayed in a visual chart or dashboard, which can effectively improve the interpretation capabilities of data. However, the open-source CMS cannot easily be integrated with commercial BI software, and most commercial BI tools are expensive and require the purchase of copyright. In this study, the existing DV plugins, extensions, and modules in WordPress, Joomla, and Drupal are reviewed and analyzed for developing the BI application in the system. The aimed result for this study is to find out which open-source CMS between WordPress, Joomla, and Drupal is the best used for developing the BI platform in the web application system by using their DV plugins, extensions, and modules.*

Keywords: *Business Intelligence (BI), Data Visualization, Content Management System (CMS), WordPress, Joomla, Drupal.*

1. INTRODUCTION

In a dynamic and competitive business environment, open-source content management systems (CMS) are mostly used by companies for their websites and web application systems. Companies use business intelligence (BI) to analyze the information needed for their decision-making. CMS is an application that allows for publishing and organizing large amounts of web information. Advancements in open-source technology have led to the adoption of open-source CMS like WordPress, Joomla, and Drupal in significant establishments to manage vital assets like data analysis and visualization. Meanwhile, the application of BI for businesses can help companies to combine information technology and business management practices to make strategic decision-making for companies' performance [1]. Today, many BI tools such as SAS, Tableau, QlikSense, and PowerBI are used to develop BI applications to analyze business data and are appropriate for different types of visualization projects. However, these commercial BI tools cannot easily be integrated with open-source CMS. Most BI tools have been designed either as stand-alone single-user applications or as purely collaborative systems [2]. These tools are mostly implemented as heavy stand-alone systems and difficult to

integrate into existing systems with multiple data sources [3]. Besides, some of these tools are complex for the most complex of tasks, and the cost of purchasing, learning, and using these tools is mostly very high and expensive and requires the purchase of copyright [4].

Nevertheless, among the most popular open-source CMS used by companies, WordPress, Joomla, and Drupal offered data visualization (DV) plugins, extensions, and modules. Hence, could the BI platform be developed in the web application system based on open-source CMS such as WordPress, Joomla, and Drupal just by using their DV plugins, extensions, or modules? Which one of the open-source CMS has the best DV plugins, extensions, or modules? And which one is the best use for developing the BI platform? There is no research yet to analyze and compare the DV plugins, extensions, or modules in WordPress, Joomla, and Drupal to develop the BI application. Selecting the right open-source CMS that has the best DV options is a big decision to develop the best performance of the BI platform in the web application system.

This paper analyzes and compares the DV plugins, extensions, and modules between three popular open-source CMS: WordPress, Joomla, and Drupal, for developing the BI application. This study will help companies develop the BI application just by using open-source CMS without the need to purchase commercial BI software. The BI application in the open-source CMS will enable companies to explore data visually with ease and dynamically and save costs. Besides, it could be used widely in any business industry, even for small businesses, as the open-source CMS is freely available and does not require costly licensing and the purchase of copyright. Additionally, companies will have benefited from the use of the BI to analyze their business data and increase the quality of their business decision-making.

Literature Review

Open Source Content Management System (CMS)

A content management system (CMS) is an application that allows for publishing and organizing large amounts of web-based information. It is a software tool designed to facilitate the management of website content without the technical knowledge of web programming. CMS enables people to create, edit, publish, and manage the content of a website without needing technical knowledge [5]. WordPress, Joomla, and Drupal are open-source CMS that allows publishing, managing, editing, deleting, and modifying content effectively and dynamically. They are often used for running websites, blogs, e-commerce, and web applications. They also provide excellent user support, security, and documentation [6,7]. The open-source CMS can freely be used and modified [8], in which users are allowed to change and improve the software with spurs creativity and innovation.

Much literature is available about CMS as software built to keep track of every piece of content on a website, in which the visual appearance, layout, and structure of the websites can be changed quickly and conveniently [9]. According to [8], an open-source CMS has many advantages because of its dynamic structure in which the web content is organized and maintained through a backend system that allows users to manage templates, content, images, and more. The previous study reveals that the more adapted and used open-source CMS are Joomla, WordPress, and Drupal. [10]. WordPress, Joomla, and Drupal are the most popular open-source CMS built on PHP and MySQL [11]. Most of the comparative studies by [11,12,13,14,15] analyze these open-source CMS on the features, design and functionalities, user-friendliness, search engine optimization (SEO), security, and support. Table 1 below shows the comparative studies of these open-source CMS.

Table 1 Comparative Studies of Open-Source CMS			
Year & Author	Popular Open-Source CMS		
	<i>WordPress</i>	<i>Joomla</i>	<i>Drupal</i>
2020 [11]	WordPress is very easy to write content or blogs on the Internet and most useful for their plugins.	Joomla enables users to develop websites in a more structural way than WordPress.	Drupal gives a systematic approach to the complex site.
2018 [12]	WordPress provides functionalities from its backend. It was the best in SEO positioning and was not as complex as Drupal.	Joomla is the most intuitive CMS as it had more extensive options for functionalities. It also had the largest and most active user community.	Drupal is the most complex CMS in terms of management but seemed more robust in terms of users' roles and security.
2017 [13]	WordPress is a suitable CMS for simple and easy to use blogging solution. It is not as powerful or capable as Drupal or Joomla but is easy enough for any lay user.	Joomla enables users to build a site with more structural stability and content and has a fairly intuitive interface. It is very useful for a standard website with standard capabilities.	Drupal is suitable for building a much more complex site. Even though Drupal is harder to learn, it has much more flexibility to scale a site in terms of complexity.
2017 [14]	WordPress is suitable for users with low knowledge and serious requests as it was extremely user friendly.	Joomla is suitable for semi-professionals and serious requests.	Drupal is suitable for the request of professionals who involved in challenging projects.
2016 [15]	WordPress is widely used as it has ever-increasing themes, plugins, and widgets, and its blogging platform is easy to use.	Joomla offers a middle ground between WordPress and Drupal and builds more complex sites than WordPress.	Drupal is a powerful tool for building complex sites, but it requires some expertise and experience.

Based on comparative studies in Table 1, WordPress is a user-friendly platform focusing simplicity while Joomla is a platform somewhat beginner-friendly with a more structural way than WordPress, and Drupal is more to the developer-focused standard platform. In terms of

user-friendliness, WordPress is a perfect choice and a fast, feature-rich, and excellent solution to create a website for companies that have low knowledge technical person in web development. Joomla also can be the right choice as it has plenty of features and flexibility, but it just needs some time and patience to learn. Drupal also can be a choice if the company has a person mastered in web development. In terms of design and functionality, WordPress is perfect for users who want flexibility as it offers a highly customizable design along with ease of use. Joomla has fewer design options for a complete website but plenty enough for users who need a framework and a quick selection of templates and extensions. Drupal is the perfect choice for web developers with higher custom design needs, but the learning curve may once again be the limitation. In terms of SEO, WordPress has an SEO friendly framework with tags, categories, and plenty of SEO plugins. Joomla and Drupal also have various modules and extensions for SEO and marketing. With regards to support and security, nowadays, all three platforms have been created using certain security standards and are community-based platforms in which users can get plenty of support and resources. The community is consisting of developers, designers, trainers, users, and volunteers, which aimed to make the platform a better CMS by supporting the users, sharing knowledge, solving the issues, organizing events, and more.

WordPress is found as the easiest and most powerful blogging platform. However, today, WordPress is used for blogging solutions, but it is also the most widely used CMS for designing websites. Joomla is also great for designing websites, but it requires a basic understanding of technical skills. In terms of complexity, Joomla comes somewhere between simple WordPress and comprehensive and advanced Drupal. However, Joomla allows users to build a website with more content and structure flexibility than WordPress offers. Joomla also has to retain the user-friendliness and intuition that WordPress excels at while also combining Drupal's flexibility and power, making it a perfect middle ground in a crowded marketplace. Drupal is the most difficult but powerful as it requires an understanding of coding skills. The comparison of the open-source CMS is shown in Table 2 below.

CMS	WordPress	Joomla	Drupal
Usage statistics [43]	37.8% of all the websites	2.4% of all the websites	1.6% of all the websites
CMS Market share [43]	63.6%	4.0%	2.6%
Language	PHP	PHP	PHP
Database	MySQL	MySQL	MySQL
Ease of use	Beginner-friendly	Somewhat beginner-friendly	Requires coding skills
Design (themes/templates)	More than 4500 official free themes and 9500 premium themes	More than 950 premium templates, but there is no official template directory	More than 2000 official themes and 450 premium themes
Functions (plugins/)	More than 50,000 official plugins	More than 7500 official extensions	More than 37,000 modules at official

extensions/ modules)			directory
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Based on Table 2, all the three open-source CMS are based on PHP and MySQL and use themes or templates for the design and plugins/ extensions/ modules for adding functionality and features. As for today, WordPress is widely used by 37.8% of all the websites [43] and has a CMS market share of 63.6% [43]. By comparing the market share, WordPress seems to be far ahead of Joomla and Drupal; however, there are also multiple aspects in which WordPress falls behind. WordPress could be considered to be the all-rounder CMS for businesses if the company wants to build a website that gets most of the features in handy and business required. WordPress is the simplest open-source CMS platform ever, which can be handled by a non-tech person even without having proper knowledge of HTML, CSS, and PHP. With WordPress, users get access to thousands of templates and thousands of plugins that enhance the simple website functionality. Drupal could be the first choice for businesses to create a website with too many custom functionality or to give first priority to website security. A website with Drupal can be created if the company has an expert or knows technical stuff as is not best for the beginner users that lack in technical code. Also, some code for doing custom work should be known for improving the functionality that Drupal provides. Joomla can be chosen if the company wants to create the most powerful online application as its functionality lies between WordPress and Drupal. Most of the top-level organizers and website developers prefer the Joomla platform than others as it is the best used for user management scheme if the website should handle by multiple users.

Business Intelligence (BI)

Business intelligence (BI) transforms business data into business information to make well-informed decisions. BI has become an essential concept of Big Data [16] for analyzing data to help managerial decision-making. BI is an application or tool to extract Big Data faster to make the right decisions. According to [17,18], BI is considered a powerful tool to improve operational capability. The BI dimensions include data integration, analytical capabilities, content quality in business processes, and decision-making culture [19]. A study by [20] presented a systematic literature review to determine the factors related to successful BI system implementation. Another study by [21] presented a model for examining the relationship between BI functions that provide practical and useful insights for business owners to utilize more appropriate BI tools to reach more idealistic organizational advantages. BI plays an essential role in the strategic planning process and the analysis of information to optimize decision-making. It also enables process performance measurement and management, which allows the initiative to become more business-focused [22]. The successful implementation of a BI application should include the core components and address operational issues while also providing meaningful output to the organization [23]. It also must be embedded within organizational processes and be adaptable to changing technologies. Furthermore, BI has a positive and meaningful effect on organizational innovation as BI provides data, knowledge, and information [19].

Today, many commercial BI software and tools are used to analyze business data [24], such as SAS, Tableau, QlikSense, and PowerBI. Each of them is appropriate for different types of visualization projects. However, these commercial BI tools cannot easily be integrated with open-source CMS. According to [2], most BI tools have been designed either as stand-alone single-user applications or as purely collaborative systems. These tools are mostly implemented as heavy stand-alone systems and difficult to integrate into existing

systems with complex data sources [3]. Furthermore, commercial BI software and tools are costly to acquire and maintain [25]. The cost of purchasing, learning, and using these tools are mostly very high and expensive [4]. According to [26], these commercial BI tools generally require costly licensing, and the licensing fees vary drastically. The investment in BI technologies is expensive because its implementation includes infrastructure, software, licenses, training, and wages [27]. Even though these tools offer customer support, they tend to be expensive compared to open-source tools [28]. Moreover, these commercial BI tools require the purchase of copyright [4]. Therefore, instead of using these commercial BI tools, the solution idea is to use the DV plugins, extensions, and modules to create the BI platform in the web application system based on open-source CMS.

Data Visualization (DV)

The BI is also known as business data visualization or business information visualization [29]. Data visualization (DV) is the presentation of data in a pictorial or graphical format that can effectively improve data processing and interpretation capabilities. Most companies used intuitive graphs, pie-charts, and other forms of visualizations to make sense of sales, revenue, and other aspects of company operations. According to [29], the BI process typically consists of data management, data analysis, and data presentation. The DV in BI is the data presentation which is presenting the form of business information analysis [30]. DV is the graphical or visual method of data presentation, and its techniques are used extensively in the BI application [31]. DV has increasing importance in the complete BI process and is becoming an integral part of any BI system. It is a key component of business and data analytics, which allows businesses to create tools such as dashboards for business executives [32]. The BI application involves DV techniques displayed in a visual chart or dashboard, which can improve the data processing and interpretation capabilities effectively. The DV techniques are applied as part of BI techniques [33] for enabling users to see patterns, trends, and any other relationships that can provide actionable intelligence. DV is not only helping people understand the significance of data by placing it in a visual context [34], but it also enables the decision-makers to see analytics presented visually. According to [35], DV provides stakeholders with a comprehensive report and incorporates effective data representation strategies to integrate, unify, and standardize data coming from different sources. DV has a vital practical significance as it can show the results of data analysis intuitively and helps people extract information from the enormous amount of information [36]. Besides, DV represents a way to overcome the managers' dilemma as they are confronted with pressure and the increased information overload for efficient and effective decision making, which affects the decision quality and decision confidence [37]. Therefore, DV has become an essential means of test data processing as it can effectively improve data processing and interpretation capabilities [38]. The right DV presentation makes it easy to organize and understand the information. There are many different kinds of graphics used in the DV techniques to transform data into information for the BI application. The most common DV techniques used for the BI application, such as bar charts, histograms, pie charts, scatter plots, heat maps, line charts, bubble charts, candlestick charts, waterfall charts, radar charts, and area charts.

2. REVIEW AND ANALYSIS

In this section, the DV plugins, extensions, and modules in WordPress, Joomla, and Drupal are reviewed and analyzed based on the functions and the DV techniques used.

DV Plugins/Extensions/Modules

Currently, WordPress has over 50,000 plugins available [39,40], including DV plugins. Joomla has more than 7,800 active extensions available [41], including DV extensions. In contrast, Drupal has more than 37,000 modules to extend and customize its functionality [42]. Most of them are free and premium versions. Sometimes, there are limited features in free versions, which are offered only in the premium versions. The premium versions mostly use for a lifetime license and are not too expensive. The costs are based on the chosen support duration for the premium versions. The suitable DV plugins/ extensions/ modules can be used for the proposed BI application shown in Table 3 below.

Open-Source CMS	Plugin/Extension/Module	Functionality	Last Updated
WordPress	Visualizer	This plugin is easy to use for creating interactive, responsive charts and tables. This plugin also uses Google Visualization API, DataTables.net, and ChartJS, and users can import the data from Excel, CSV, etc.	July 2020
	wpData Tables	This plugin allows users to quickly create tables and charts from Excel, CSV, PHP, and other data sources. It also uses Google Visualization API.	July 2020
	Data Tables Generator	This plugin allows users to create responsive data tables, easy-to-use charts, and data management. The table can be export and import from CSV, Excel, etc.	July 2020
	iChart	This plugin allows users to build responsive charts and graphs easily with shortcode generator.	June 2020
	M Chart	This plugin allows users to manage data sets via a spreadsheet interface and present that data in chart form via the Chart.js or Highcharts chart libraries.	October 2019

	WP Charts & Graphs	This plugin allows users to create charts using a chart generator on the WordPress backend and frontend.	July 2020
	Charts Ninja	This plugin is a chart maker that allows users to create and add beautiful graphs and charts to the website.	May 2020
	Easy Chart	This plugin is easy to use to generate charts to show on the website page and posts.	July 2019
Joomla	vChart	This extension is an advanced charting Joomla component that fulfills data visualization needs as it contains many customizing options and a simple and intuitive data input option.	November 2019
	Art Data	This extension allows users to populate charts using a built-in dataset spreadsheet, or users can load a dataset from SQL Query, HTML, or CSV file.	June 2020
	Plotalot	This extension allows users to write the SQL for extract data using the Google Visualization API to draw various charts with numerous formatting options.	July 2020
	JA Google Chart	This extension supports multiple chart types and enables users to customize charts easily using the Google Visualization API.	August 2018
	JModules Charts	This extension is based on Charts.js and allows for the fast deployment of charts.	March 2020
	POWr Graphs	This extension allows users to create charts and graphs for any data set just by copy paste data from Excel or any spreadsheet and instantly generate a beautiful, responsive display.	July 2018
	Artio Fusion Charts	This extension is a charting and graph plotting extension that allows users to create	June 2020

		JavaScript charts and easily integrate them into the websites.	
Drupal	Views Chart Tools	This module integrates with the Google Visualization API for generating image charts from database data.	December 2014
	Charts	This module transforms data into information through simple-to-create charts using users' choice charting libraries such as Chart.js or Highcharts.	July 2020
	Chart Suite	This module supports a variety of file formats, including CSV, TSV, HTML, and JSON, to chart file data for tables, trees, and graphs.	May 2020
	Data Visualization Wizard	This module provides a fast way to get data visualizations online after a quick upload of a spreadsheet.	November 2014

Based on Table 3, WordPress has eight (8) suitable DV plugins, while Joomla has seven (7) suitable DV extensions, and Drupal has four (4) suitable DV modules that can be used for the proposed BI application. Most of the DV plugins in WordPress are up-to-date in the current year 2020, while two of them are last updated in 2019. All the DV extensions in Joomla are up-to-date in the current year 2020, except three of them, in which two are last updated in 2018, and one is last updated in 2019. Only two modules in Drupal are up-to-date in the current year 2020, and the other two do not update since 2014. Some plugins, extensions, and modules in WordPress, Joomla, and Drupal use Google Visualization API, such as Visualizer and wpDataTables in WordPress, Plotalot, and JA Google Chart in Joomla and Views Charts Tools in Drupal. With Google Visualization API, there are so many DV techniques that can be chosen and work dynamically, which will keep changing as per the changes in the data collection and present the results accordingly. However, Google Visualization API requires a continuous network connection for all of its functions to work properly and requires JavaScript coding to customize it. There are plugins, extensions, and modules in WordPress, Joomla, and Drupal that allow users to upload spreadsheets from Excel, CSV, and other data sources quickly, such as Visualizer, wpDataTables, and Data Tables Generator in WordPress, Art Data, and POWr Graphs in Joomla, and Chart Suite and Data Visualization Wizards in WordPress. By uploading data, it could be saving hours; however, the plugins, extensions, and modules must allow users to create tables linked to the data source, in which case users will upload the file and initialize the table, whereupon it will be read every time on page load, and then users can overwrite this file to update the data. Such tables will not be editable, and if they are larger than 3000 to 5000 rows, the page load and generation time will be slow. There are also plugins, extensions, and modules that depend on the other charting libraries such as Chart.js or Highcharts. These include M Chart in WordPress, J Modules Chart in Joomla, and Charts in Drupal. The charting libraries offer

the ability to create light and simple charts quickly with low impact on page loading. However, these charting libraries do not offer much flexibility, and there are limited graph and customization options. Some plugins and extensions in WordPress and Joomla have their own charts or DV techniques design, such as Data Tables Generator, iChart, WP Charts & Graphs, Charts Ninja, and Easy Chart in WordPress, VChart, and Artio Fusion Charts in Joomla. These plugins and extensions could contain many customizing options and a straightforward and intuitive data input option in the back end.

DV Techniques in the Plugins/Extensions/Modules

In the context of BI, the DV techniques should cover a complete theory of how to represent data visually so the concepts and systems can be applied in the design of visual interfaces for communicating information. For developing the best performance of the BI platform in the web application system based on open-source CMS of WordPress, Joomla, or Drupal, these plugins, extensions, or modules should support the most common DV techniques. Table 4 below shows the DV techniques used by the DV plugins, extensions, and modules in WordPress, Joomla, and Drupal.

Open - Source CMS	Plug in/ Extension/ Module	DV Techniques												Total
		<i>B</i> <i>a</i> <i>r</i> <i>c</i> <i>h</i> <i>a</i> <i>r</i> <i>t</i>	<i>H</i> <i>i</i> <i>s</i> <i>t</i> <i>o</i> <i>g</i> <i>r</i> <i>a</i> <i>m</i> <i>c</i> <i>h</i> <i>a</i> <i>r</i> <i>t</i>	<i>P</i> <i>e</i> <i>c</i> <i>h</i> <i>a</i> <i>r</i> <i>t</i>	<i>S</i> <i>c</i> <i>a</i> <i>t</i> <i>t</i> <i>e</i> <i>r</i> <i>p</i> <i>l</i> <i>o</i> <i>t</i>	<i>H</i> <i>e</i> <i>a</i> <i>t</i> <i>m</i> <i>a</i> <i>p</i> <i>s</i>	<i>L</i> <i>i</i> <i>n</i> <i>e</i> <i>c</i> <i>h</i> <i>a</i> <i>r</i> <i>t</i>	<i>B</i> <i>u</i> <i>b</i> <i>b</i> <i>l</i> <i>e</i> <i>c</i> <i>h</i> <i>a</i> <i>r</i> <i>t</i>	<i>C</i> <i>a</i> <i>n</i> <i>d</i> <i>l</i> <i>e</i> <i>s</i> <i>t</i> <i>i</i> <i>c</i> <i>k</i> <i>c</i> <i>h</i> <i>a</i> <i>r</i> <i>t</i>	<i>W</i> <i>a</i> <i>t</i> <i>e</i> <i>r</i> <i>f</i> <i>a</i> <i>l</i> <i>l</i> <i>c</i> <i>h</i> <i>a</i> <i>r</i> <i>t</i>	<i>R</i> <i>a</i> <i>d</i> <i>a</i> <i>r</i> <i>c</i> <i>h</i> <i>a</i> <i>r</i> <i>t</i>	<i>A</i> <i>r</i> <i>e</i> <i>a</i> <i>c</i> <i>h</i> <i>a</i> <i>r</i> <i>t</i>	<i>A</i> <i>d</i> <i>d</i> <i>i</i> <i>t</i> <i>i</i> <i>o</i> <i>n</i> <i>a</i> <i>l</i>	
WordPress	Visualizer	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	<ul style="list-style-type: none"> • gauge chart • omb chart • imeline chart • olar area chart • D chart 	15

													s	
	wpData Tables	✓	✓	✓	✓		✓	✓	✓	✓		✓	• gauge chart	10
	Data Tables Generator	✓	✓	✓			✓	✓				✓	• 3D chart • Pyramid chart	8
	iChart	✓		✓		✓	✓						• polar area chart	5
	M Chart	✓	✓	✓	✓		✓	✓				✓		7
	WP Charts & Graphs	✓		✓			✓				✓		• polar area chart	5
	Charts Ninja	✓	✓	✓			✓				✓	✓	• pyramid chart • funnel chart • D charts	9
	Easy Chart	✓	✓	✓			✓			✓		✓	• polar area chart	7
Joomla	vChart	✓	✓	✓	✓	✓	✓	✓	✓			✓	• timeline chart • notation chart	12

													• auge chart	
	Art Data	✓		✓			✓			✓		✓	• olar area chart	6
	Plota lot	✓		✓	✓	✓	✓	✓	✓			✓	• auge chart • imeli ne chart • reem aps	11
	JA Goo gle Char t	✓	✓	✓	✓	✓	✓			✓		✓	• rendl ines chart	9
	JMo dule s Char ts	✓		✓			✓							3
	PO Wr Grap hs	✓		✓	✓		✓							4
	Arti o Fusi on Char ts	✓	✓	✓										3
Drupal	Vie ws Char t Tool s	✓	✓	✓	✓	✓	✓	✓	✓			✓	• nnot ation chart • imeli ne chart • omb	13

													o chart • reem aps	
Char ts	✓	✓	✓	✓		✓						✓		6
Char t Suite	✓		✓	✓		✓						✓	• reem aps	6
Data Visu aliza tion Wiz ard	✓		✓		✓	✓								4

Based on Table 4, WordPress’s plugins support all the eleven (11) most common DV techniques. WordPress also supports seven (7) additional DV techniques: gauge chart, combo chart, timeline chart, polar area chart, 3D charts, pyramid chart, and funnel chart. The extensions in Joomla support all the most common DV techniques except for radar chart, and there are six (6) additional DV techniques: timeline chart, treemaps, annotation chart, gauge chart, polar area chart, and trendlines chart. The modules in Drupal support only nine (9) most common DV techniques, and four (4) additional DV techniques: annotation chart, timeline chart, combo chart, and treemaps. Therefore, the DV plugins in WordPress support 18 DV techniques, while DV extensions in Joomla support 16 DV techniques, and the DV modules in Drupal support only 13 techniques.

Every plugin, extension, and module in WordPress, Joomla, and Drupal has pros and cons and have been listed in Table 5 below.

Table 5 DV Plugins/Extensions/Modules Pros and Cons		
Plugin/ Extension/ Module	Pros	Cons
WordPress		
Visualizer	<ul style="list-style-type: none"> • Multiple DV techniques • Cross-browser compatibility • Flexible and customizable 	<ul style="list-style-type: none"> • Limited features on the free version
wpData Tables	<ul style="list-style-type: none"> • Multiple DV techniques • Fully customizable • No complicated configuration • No coding knowledge required 	<ul style="list-style-type: none"> • Limited features on the free version
Data Tables Generator	<ul style="list-style-type: none"> • Responsive modes and large tables support • Frontend editing 	<ul style="list-style-type: none"> • Limited features on the free version

	<ul style="list-style-type: none"> • Formulas and HTML support 	
iChart	<ul style="list-style-type: none"> • Use the shortcode to embed charts on any page quickly • Customizable and responsive 	<ul style="list-style-type: none"> • Limited DV techniques • Limited features on the free version
M Chart	<ul style="list-style-type: none"> • Import and export CSV files • Add charts from Media panel 	<ul style="list-style-type: none"> • Limited DV techniques • Depends on charting libraries • Last updated on last year
WP Charts & Graphs	<ul style="list-style-type: none"> • Cross-browser compatibility • Live preview generator 	<ul style="list-style-type: none"> • Limited DV techniques
Charts Ninja	<ul style="list-style-type: none"> • Responsive and cross-browser compatibility 	<ul style="list-style-type: none"> • Need to use embeddable code
Easy Chart	<ul style="list-style-type: none"> • Users can switch to any chart type without making any changes in data • Customizable display 	<ul style="list-style-type: none"> • Limited DV techniques • Lack of support • Last updated in last year
Joomla		
vChart	<ul style="list-style-type: none"> • Multiple DV techniques • Cross-browser compatibility • Input Charts data in various ways • Great support and documentation 	<ul style="list-style-type: none"> • No free version • Last updated on last year
Art Data	<ul style="list-style-type: none"> • Custom templates can be created to control the look of tables and charts • Responsive 	<ul style="list-style-type: none"> • Limited DV techniques
Plotlot	<ul style="list-style-type: none"> • Multiple DV techniques • Responsive and cross-browser compatibility • Can be built into users own code to add charts 	<ul style="list-style-type: none"> • Totally depends on Google chart
JA Google Chart	<ul style="list-style-type: none"> • Data can be imported manually or from a CSV files and Google spreadsheets 	<ul style="list-style-type: none"> • Also totally depends on Google chart • Last updated two years ago
JModules Charts	<ul style="list-style-type: none"> • Responsive • Single and group data options 	<ul style="list-style-type: none"> • Limited DV techniques • Depends on charting libraries
POWr Graphs	<ul style="list-style-type: none"> • Interactive controls to remove/show data • Responsive 	<ul style="list-style-type: none"> • Limited DV techniques • Limited data set size on the free version • Last updated two years ago
Artio Fusion Charts	<ul style="list-style-type: none"> • Animated and interactive JavaScript charts • Intuitive UI with easy customization 	<ul style="list-style-type: none"> • Limited DV techniques
Drupal		

Views Chart Tools	<ul style="list-style-type: none"> • Multiple DV techniques 	<ul style="list-style-type: none"> • Not updated since 2014 • Require coding skills • Dependent on other Drupal modules: Views and Google Charts Tools API
Charts	<ul style="list-style-type: none"> • Block plugin features fields for data input 	<ul style="list-style-type: none"> • Limited DV techniques • Require coding skills • Depends on Google Chart API and charting libraries
Chart Suite	<ul style="list-style-type: none"> • Can download a set of CSV, htm and JSON files for testing 	<ul style="list-style-type: none"> • Limited DV techniques • Require coding skills • Depends on Google Chart API and structured Data API from the San Diego Supercomputer Center (SDSC)
Data Visualization Wizard	<ul style="list-style-type: none"> • Data can be offered to the user in CSV, JSON, GeoJSON and XML formats 	<ul style="list-style-type: none"> • Limited DV techniques • Require coding skills • Not updated since 2014 • Dependent on other Drupal modules: Content Construction Kit, Schema, Importer

Developing the BI Platform

The combination of plugins/ extensions or modules can be used for developing the BI platform in a web application system based on open-source CMS. In WordPress, the combination of the three plugins in WordPress can be used for all 18 DV techniques, which are Visualizer, wpDataTables, and Charts Ninja. Figure 1 below shows an example of the BI platform in WordPress that has a total of 18 DV techniques by using the combination of the three plugins: Visualizer, wpDataTables, and Charts Ninja.



Figure 1 Example of the BI platform in WordPress

For developing the BI platform in the web application system based on Joomla, 16 DV techniques can be used using the four extensions: vChart, Plotatol, JA Google Chart, and Art Data. Figure 2 below shows an example of the BI platform in Joomla that has a total of 16 DV techniques by using the combination of the four DV extensions: vChart, Plotatol, JA Google Chart, and Art Data.



Figure 2 Example of the BI platform in Joomla

In Drupal, the BI platform can only be used for 13 DV techniques by using the combination of Views Chart Tools and Charts, or can only by using the Views Chart Tools only. Fig. 3 below shows an example of the BI platform in Drupal that has a total of 13 DV techniques by using the combination of both DV modules: Views Chart Tools and Charts.



Figure 3 Example of the BI platform in Drupal

3. DISCUSSION

The BI platform can be developed in the web application system based on open-source CMS such as WordPress, Joomla, and Drupal just by using their DV plugins, extensions, and modules. Based on Fig. 1, 2, and 3, the DV techniques used in the BI platform for all these three open-source CMS are very interactive and can be used to analyze and transform business data into business information to make well-informed decisions. The DV plugins, extensions, and modules also can be chosen or combined to create a BI platform that provides all the DV techniques required. However, developing the BI platform in WordPress and Joomla much easier than Drupal because the DV modules in Drupal require more coding skills and dependent on a few other Drupal modules. Compared to Joomla and Drupal, WordPress has more DV plugins that can be chosen for developing the BI platform. Besides, most of the DV plugins in WordPress are up-to-date in the current year, while some DV extensions in Joomla are last updated one to two years ago, and some modules in Drupal did not update since 2014. Every plugin, extension, and module in WordPress, Joomla, and Drupal has its pros and cons. Some plugins, extensions, and modules in WordPress, Joomla, and Drupal use Google Visualization API, which provides multiple DV techniques but requires a continuous network connection. Some plugins, extensions, and modules in WordPress, Joomla, and Drupal allow users to quickly upload spreadsheets from Excel, CSV, and other data sources, which could be saving hours to enter data but may impact page load and generation time. There are also plugins, extensions, and modules that depend on the other charting libraries, such as Chart.js or Highcharts, which able to create light and simple charts quickly with low impact on page loading, but there are limited graph and customization options and not much flexible. Some plugins and extensions in WordPress and Joomla have their own charts or DV techniques design, containing many customizing options and an intuitive data input option in the back end.

WordPress not only has more plugins to choose from but also can support 18 DV techniques, while the DV extensions in Joomla and DV modules in Drupal can support 16 and 13 DV techniques only. When comparing the three of them for developing the BI platform, WordPress could be the best choice as it offered more DV techniques and very friendly for non-developers. Most of the DV plugins in WordPress are not only responsive and cross-browser compatibility but also offer customizability and flexibility. Joomla also could be the best choice as it also has some DV extensions that offer responsiveness, great features, and support. However, not all of the DV extensions in Joomla are up-to-date, and some of them depend on Google Chart and charting libraries. Nevertheless, Drupal is not recommended for the BI platform. Besides require more coding skills, there only four (4) DV modules that found suitable can be chosen, and two (2) of them are not up-to-date since 2014. Moreover, some of the DV modules in Drupal are not only dependent on Google Chart API and charting libraries but also dependent on a few other Drupal modules, which have to be installed before the installation of the DV modules.

4. CONCLUSIONS

Companies or businesses can use the BI application just by using open-source CMS without purchasing commercial BI software. The existing DV plugins, extensions, and modules in WordPress, Joomla, and Drupal can be used to develop the BI application in the web application system based on open-source CMS. WordPress could be the best choice as it offered more DV techniques, very friendly for non-developers, cross-browser compatibility,

customizability, and flexibility. Plus, users can choose more DV plugins in WordPress that can handle pretty much DV techniques. Joomla could also be the best choice as it has many DV extensions that also offer responsiveness, great features, and support. On the one hand, Joomla does deliver many user-facing features and expects users to custom-code the non-standard elements. Drupal is not recommended for the BI platform, as its modules are mostly not up-to-date and dependent on the installation of a few other modules. Drupal is more geared toward developers as it requires a lot of custom work and coding.

REFERENCES

- [1] G Richards, W Yeoh, AYL Chong and A Popović. Business intelligence effectiveness and corporate performance management: an empirical analysis. *Journal of Computer Information Systems*. 2019; **59(2)**, 188-196.
- [2] DH Jeong, S Ji, EA Suma, B Yu and R Chang. Designing a collaborative visual analytics system to support users' continuous analytical processes. *Human-centric Computing and Information Sciences*. 2015; **5(5)**.
- [3] P Järvinen, K Puolamäki, P Siltaanen and M Ylikerälä. *Visual analytics: Final report*. VTT, Finland: VTT Technical Research Centre of Finland, 2009.
- [4] L Chou, Nine data visualization tools that you cannot miss in 2019, Available at <https://towardsdatascience.com/9-data-visualization-tools-that-you-cannot-miss-in-2019>, accessed September 11, 2019.
- [5] S McManus. *Web design in easy steps* (6th ed.), In Easy Steps Limited. Warwickshire, United Kingdom, 2014.
- [6] SK Patel, V Rathod and S Parikh. Joomla, Drupal, and WordPress - a statistical comparison of open source CMS. *3rd International Conference on Trends in Information Sciences & Computing (TISC2011)*, 2011.
- [7] SK Patel, V Rathod and JB Prajapati. Performance analysis of content management systems - Joomla, Drupal, and WordPress. *International Journal of Computer Applications*. 2011; **21(4)**, 39-43.
- [8] R Severdia and J Gress. *Using Joomla! efficiently build and manage custom websites*. 2nd ed. Sebastopol, CA: O'Reilly Media, Inc, 2014.
- [9] A Mirdha, A Jain and K Shah. Comparative analysis of open source content management systems. *2014 IEEE International Conference on Computational Intelligence and Computing Research*. 2014.
- [10] NA Khan and H Ahangar. Use of Open Content Management Systems in Government Sector. *2018 5th International Symposium on Emerging Trends and Technologies in Libraries and Information Services (ETTLIS)*. 2018.
- [11] VA Sindekar, YK Sharma and DP Sharma. A Guide for Selecting CMS Tools: Wordpress, Joomla, Drupal. *Studies in Indian Place Names*. 2020; **40(35)**, 621-626.
- [12] J Martinez-Caro, A Aledo-Hernandez, A Guillen-Perez, R Sanchez-Iborra and M Cano. A comparative study of web content management systems. *Information*. 2018; **9(2)**, 27.
- [13] MB Roy and N Kumar. A comparative study of content management systems: Joomla, Drupal, and WordPress for web application development. *International Journal of Information Movement*. 2017; **1(7)**, 12-17.
- [14] I Lavrnić. Analyzing the Potential Mechanism for Measurements-The Most Popular Open Source Web Content Management System. *In Sinteza 2017-International Scientific Conference on Information Technology and Data Related Research*. Singidunum University. 2017; 85-89.

- [15] J Vivekavardhan and MK Verma. Open Source Content Management System for Content Development. *Library Waves-A Biannual Peer Reviewed Journal*. 2016; **2(1)**, 6-14.
- [16] B Puklavec, T Oliveira and A Popovič. Understanding the determinants of business intelligence system adoption stages. *Industrial Management & Data Systems*. 2018; **118(1)**, 236-261.
- [17] C Lin and A Kunnathur. Strategic orientations, developmental culture, and big data capability. *Journal of Business Research*. 2019; **105**, 49-60.
- [18] V Trieu. Getting value from business intelligence systems: A review and research agenda. *Decision Support Systems*. 2017; **93**, 111-124.
- [19] R Eidizadeh, R Salehzadeh and A Chitsaz Esfahani. Analysing the role of business intelligence, knowledge sharing and organisational innovation on gaining competitive advantage. *Journal of Workplace Learning*. 2017; **29(4)**, 250-267.
- [20] NA El-Adaileh and S Foster. Successful business intelligence implementation: A systematic literature review. *Journal of Work-Applied Management*. 2019; **11(2)**, 121-132.
- [21] S Rouhani, A Ashrafi, A Zare Ravasan and S Afshari. The impact model of business intelligence on decision support and organizational benefits. *Journal of Enterprise Information Management*. 2016; **29(1)**, 19-50.
- [22] D. Suša Vugec, V Bosilj Vukšić, M Pejić Bach, J Jaklič and M Indihar Štemberger. Business intelligence and organizational performance. *Business Process Management Journal*. 2020.
- [23] R Harrison, A Parker, G Brosas, R Chiong and X Tian. The role of technology in the management and exploitation of internal business intelligence. *Journal of Systems and Information Technology*. 2015; **17(3)**, 247-262.
- [24] B Marr. Comparing data visualization software: Here are the seven best tools for 2018. Available at <https://www.forbes.com/sites/bernardmarr/2018/06/20/comparing-data-visualization-software-here-are-the-7-best-tools-for-2018>, June 20, 2018.
- [25] CR Zamba, G Mahlangu, M Giyane and TG Rebanowako. An investigation of the potential benefits and challenges of business intelligence adoption in the retail sector in Gweru, Zimbabwe. *Journal of Systems Integration*. 2018; **9(2)**, 20-25.
- [26] L Zhang, A Stoffel, M Behrisch, S Mittelstadt, T Schreck, R Pompl and D Keim. Visual analytics for the big data era - A comparative review of state-of-the-art commercial systems. *2012 IEEE Conference on Visual Analytics Science and Technology (VAST)*. 2012.
- [27] R Gaardboe, T Nyvang and N Sandalgaard. Business intelligence success applied to healthcare information systems. *Procedia computer science*. 2017; **121**, 483-490.
- [28] L Nair and S Shetty. Interactive visual analytics on Big Data: Tableau vs. D3.js, *Journal of e-Learning and Knowledge Society*. 2016; **12(4)**, 139-150.
- [29] JG Zheng. Data visualization for business intelligence. *Global Business Intelligence*. 2017; 67-82.
- [30] S Jun. Business Intelligence Visualization Technology and Its Application in Enterprise Management. In *Proceedings of the 2020 2nd International Conference on Big Data Engineering and Technology*. 2020.
- [31] N Bikakis. Big data visualization tools. 2018. *arXiv preprint arXiv:1801.08336*.
- [32] M Diamond and A Mattia. Data visualization: An exploratory study into the software tools used by businesses. *Journal of Instructional Pedagogies*. 2017; 18.

- [33] G Ramesh, T Rajinikanth and D Vasumathi. Explorative Data Visualization Using Business Intelligence and Data Mining Techniques. *International Journal of Applied Engineering Research*. 2017; **12(24)**, 14008-14013.
- [34] J Vaughan. What is Data? - Definition from WhatIs.com. In *SearchDataManagement*. Available at <https://searchdatamanagement.techtarget.com/definition/data>, accessed Nov 2019.
- [35] J Naidoo and K Campbell. Extended abstract: Best practices for data visualization. *2016 IEEE International Professional Communication Conference (IPCC)*. 2016.
- [36] Y Qi, G Shi, X Yu and Y Li. Visualization in Media big data analysis. *2015 IEEE/ACIS 14th International Conference on Computer and Information Science (ICIS)*. 2015.
- [37] B Hirsch, A Seubert and M Sohn. Visualization of data in management accounting reports. *Journal of Applied Accounting Research*. 2015; **16(2)**, 221-239.
- [38] B Lea, W Yu and H Min. Data visualization for assessing the biofuel commercialization potential within the business intelligence framework. *Journal of Cleaner Production*. 2018; **188**, 921-941.
- [39] E Smith. Advantages and disadvantages of using WordPress, Available at <https://www.iblogzone.com/2016/12/advantages-and-disadvantages-of-WordPress.html>, accesses Nov 2019.
- [40] WordPress.org. (n.d.). Blog Tool, Publishing Platform, and CMS, Available at <https://www.wordpress.org>.
- [41] Joomla.org. (n.d.). Joomla Content Management System (CMS), Available at <https://www.joomla.org>.
- [42] Drupal.org. (n.d.). Drupal: Open Source CMS, Available at <https://www.drupal.org>.
- [43] W3Techs. *Usage statistics and market share of content management systems*. W3Techs - extensive and reliable web technology surveys, Available at https://w3techs.com/technologies/overview/content_management, accessed July 2020.