An E-Commerce Model-View-Controller (MVC) Framework For A Cloud Based Environment

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Abstract: *E-Commerce has turned into a need for organizations, especially independent companies hoping to augment benefit by utilizing financially savvy web based marketing strategies. Sufficient framework investigation and plan techniques are required to achieve fully functioning user-friendly and re-scalable e-Commerce systems. Be that as it may, the cost factor embedded in putting up an online presence has been a noteworthy downside for entrepreneurs and this prompted the development of an e-commerce framework (O. Cart). The design of the framework was done using HTML and CSS for the interface, a scripting language (PHP) and MYSQL for the backend. The developed system was implemented on Intel Pentium 64bits using formulated data. The implementation showed that the developed system will be promising.*

Keywords: *Cloud Computing, e-Commerce, Model-view-controller, Business –to- business-commerce.*

I.   Introduction

E-Commerce (e-Commerce) is a popular and growing Web application which enables customers, partners and employees to achieve a variety of purpose and services. According to e-Commerce Association, e-Commercecovers any form of business or administrative transaction or information exchange that is executed using any information and communications technology [1]. Based on the nature of the transactions, the following categories of e-commerce are distinguished: business-to business (B2B), business-to consumer (B2C), consumer-to consumer (C2C), consumer-to-business (C2B), and intra-business ecommerce. E-Commerce systems provide both commercial information (for example,items, costs and available quantities) and encourage various business activities (e.g., buying, selling and negotiation). The increasing use of information technology (IT) in this area has led to fundamental changes in the way business activities are (for example, the rise of dynamic pricing, the ability to easily compare many goods and ability to negotiate contracts much moreas often as possible) and as more advanced information processing techniques are brought to bear so the potential for further changes increases [2]. E-commerce comprehensively envelops all businessactivities occurring over the web. It comprises of electronic retailing, electronic data exchange and electronic fund transfer.

The fundamental objectives of e-Commerce are:

1. Cost reduction
2. Reduction in product cycle time
3. Faster customer response
4. Improved service quality

The e-commerce objectivesabridged above assumes series of fundamental infrastructure services and qualities enduring with a wide architectural framework. This framework allows flexibility, interoperability and directness necessary for effective improvement of e-commerce.

E-commerce models are still at the infancy stages of investigation and applications. There are few issues associated with e-commerce models, for example, platform security, technical standards, regulatory and other services are not well resolved yet in practice. However with the advent of cloud computing, we can tackle a large number of these issues. Cloud computing has been a standout amongst the most blasting innovation among the professionals of information technology (IT) and also the business due to its elasticity in the space occupation and furthermorethe better support for the software and infrastructure. It attracts more technology specialist towards it. Cloud plays the vital role in the smart economy, and the possible regulatory changes required in implementing better applications by using the potential of cloud computing [3, 4].

Cloud computing can be defined as ―A style of computing where massively scalable information technology related capabilities are provided as a service across the internet to multiple external customers‖ [5]. It

is an evolution from distributed computing system, consisting of collection of inter-connected and virtualized computers that provide services dynamically as one or more unified computing resources based on service level agreements (SLA).

Cloud Computing on the other hand is a broad array of web-based services aimed at allowing users to obtain a wide range of functional capabilities on a 'pay-as-you-go' basis that previously required tremendous hardware/software investments and professional skills to acquire. Cloud computing is the realization of the earlier ideals of utility computing without the technical complexities or complicated deployment worries. [6, 7].

The term ―cloud computing refers to a set of large scale Internet-based technology through which information is stored in servers and provided as a service (Software as a Service (SaaS), Platform as a Service (PaaS), Infrastructure as a Service(IaaS)) and on-demand to clients (from the ―clouds). Firms will be able to rent computing power (both hardware and software) and storage from a service provider and to pay on demand, as new generation of network structure is becoming an adoptable technology for many of the organizations and businesses with its dynamic scalability and usage of virtualized resources as a service through the Internet. It defines a new way of delivering computing resources.

The main advantage of cloud computing is the new technology that it gives the low cost implementation for infrastructure (hardware, Software and license for all) and some higher business units like Google and Microsoft which offer the cloud for free of cost for the education systems and business application. The cloud computing as a new service model, with network storage, on-demand access to nature, provides a new information resource sharing and processing mechanisms. In the existing conditions, cloud computing framework allows enterprises with less investment to have access to ecommerce business applications (B2B and B2C). Currently, the combination of e-commerce and cloud computing research focuses on the technical level; therefore, cloud computing based e-commerce application framework will have a high practical value [8,9, 10].

Many business companies do not have the resources and infrastructure needed to run top e- commerce solution. Usually, e-commerce systems are developed as distributed applications, but this is not necessary so. The architecture of a distributed e-commerce system includes software components, like the client application, an application server and database server and the necessary hardware components, client computer, communication infrastructure and servers [11].

Now days, Cloud Computing and e-commerce are two catchwords and are emerged as important technologies. These technologies have received attention from the service industries and research communities.

II.   Related Work
Cloud computing for e-commerce had drawn a significant amount of attention for many researchers for the recent years provided various cloud computing e-commerce models and security challenges related to the sensitive information [12]. Different cloud computing e-business models and security challenges in network were also addressed. The opportunities based on cloud security for IT persons like data theft, damage and leakage were considered.

In [13]'s research was based on trust evaluation model based on cloud model for C2C e-commerce. The work attempted to solve the problem of transaction security in C2C e-commerce. He foreseen an assessment model based on cloud model theory by means of using the algorithm of the merger of the trust cloud and the similarity computing of the trust cloud, sub-attribute valuation and extensive valuation is accomplished. The two sides of transaction got strategic advices. Experiments showed that the technique of valuation model was pragmatic and substantial. This model was not only applied to C2C e-commerce, but also a valuable method was provided for trust valuation in opened network.

In [12]'swork was based on cloud computing e-commerce models and its security. The research presented the ideas, origin and development pattern of cloud computing and based on this issues, analyzing the e-commerce models. To stay coordinated and adaptable in changing business environments, enterprises need to consider Cloud technologies. Cloud offers the coveted versatility and operational readiness for e-commerce platform providers to drive customer loyalty and increase transactions. Be that as it may, business choices are frequently affected by various variables (factors), for example, costs, infrastructure, security, interoperability and compliance.

In [8]'swork presented e-commerce application model based on cloud computing. The work came with the issue of e-commerce and the downtime of resources by establishing the framework of e-commerce application based on cloud computing service model environment.

In [9] an e-commerce model for the cloud computing environment was designed and implemented; he proposed a framework to enhance the web based commerce in the cloud computing environment. He developed

a new model for the problem exploration and parsed related issues on e-commerce development model based on cloud computing. Wang's target was to suggest the essential idea of creating contemporary e-business models based on cloud computing, and investigating corresponding issues and appropriate solutions and show how to use the influence of cloud computing.

In [14], a multi-channel online selling syndicates based on cloud structure was developed. The work designed and implemented an online selling syndicates system with spring framework and several Apache open source projects for market based on Software as a Service (SaaS) model. Analysis of customers' requirement, multi-channel and multi-tenant are bolstered by the system. For IT asset to business idea, a controller cluster mode was designed to decentralise the statue control of cloud computing. Two fast check algorithms were designed to serve the efficient control.

In [15] a cloud based analytics framework for the world's largest B2B e-commerce service provider was engineered; Mindtree engineered a Cloud based analytics framework for a leading provider of B2B e-commerce services globally. The customer works for 30,000+ businesses which includes 70% of Fortune 500 enterprises. They operate a highly reliable and secure global network services platform that makes it possible for these enterprises to conduct business together in real time.

III. Proposed E-Commerce Framework Based On Cloud Computing

Project Design - To build a successful and easy to modify ecommerce framework, accurate and well supported decisions needs to be taken particularly the software and applications to use as the basis for the development activities. Explained below are some of the tools used to complete this project.

Open Cart-The implemented framework is developed using open cart, an online resource that was built to make life easier for merchants and customers to interact. Based in an Open Source environment, OpenCart just like this ecommerce framework uses mysql as the database engine and has very reduced execution cost associated.

Here are a few benefits that come from using Open Cart:

Plugins. The Open Cart system offers you a wide variety of plugins which helps customize your website to meet the needs of your business and your customers' needs as well.

Support. The Open Cart community is pretty substantial. You'll have access to technical support for those sticky questions that you just can't seem to get answered. There are community forums where fellow Open Cart users and some skilled programmers are always happy to give you input, as well.

Cost. Thanks to the Open Source platform from which this program was born, you can download and use Open Cart free of charge. For most small business online stores, the initial out-of-the-box version will work just fine, and that version will cost you nothing.

PHP (Hypertext Preprocessor)- is an open source technology for building dynamic, interactive web content and used to Generate Dynamic Web Content. It is a widely-used general-purpose scripting language that is especially suited for web development and can be embedded into HTML.

PHP is available for free download at its official web site.

The following factors led to the success:

1. PHP is free; especially when combined with Linux server software, PHP can prove to be a very cost-efficient technology to build dynamic web content.
2. PHP has a shorter learning curve than other scripting languages.
3. The PHP community is agile. Many useful helper libraries or new versions of the existing libraries are being developed (such as those you can find in the PEAR repository or at http://www.phpclasses.org), and new features are added frequently.
4. PHP works very well on a variety of web servers and operating systems (Unix-like platforms, Windows, and Mac OS).

Apache Web Server - Apache provides users, developers and web administrators with various advantages, some of these are explained as follow:

1. Features: Apache has various useful features, including implementation of the latest protocols.
2. Customizable: Apache's modular architecture allows you to build a server that is ―made to measure.‖
3. Administration: Apache configuration files are in ASCII, have a simple format, and can be edited using any text editor. They are transferable, so one can effectively clone a server. One can control the server from command line, which makes remote administration very convenient.

4. Extensible: Apache server and API source code are open to public. If there is any feature that you want but does not exist in Apache, you can write your own server module to implement it.
5. Efficient: A lot of effort has been put into optimizing the Apache's C code for performance. As a result, it runs faster and consumes less systems resources than many other servers.
6. Portability: Apache runs on a wide variety of operating systems, including all variants of UNIX, Windows 9x/NT, MacOS (on PowerPC), and various others.
7. Stability/Reliability: Apache's source code is open to public. When any bugs are found, they are often quickly communicated, and rapidly fixed. Updates are made and announced thereafter. This has resulted in Apache becoming more and more stable, and hence reliable, server over the time.

MySQL Database - In this project, MySQL database is deployed as the backend database. It is an open source (i.e. free to use) database management system. The features of MySQL which made it the most suitable for the purpose of this project work are given below:

1. MySQL is a relational database management system. A relational database stores information in different tables, rather than in one giant table. These tables can be referenced to each other, to access and maintain data easily.
2. MySQL is open source database system. The database software can be used and modify by anyone according to their needs.
3. It is fast, reliable and easy to use. To improve the performance, MySQL is multithreaded database engine. A multithreaded application performs many tasks at the same time as if multiple instances of that application were running simultaneously.

In being multithreaded MySQL has many advantages. A separate thread handles each incoming connection with an extra thread that is always running to manage the connections. Multiple clients can perform read operations simultaneously, but while writing, only hold up another client that needs access to the data being updated. Even though the threads share the same process space, they execute individually and because of this separation, multiprocessor machines can spread the thread across many CPUs as long as the host operating system supports multiple CPUs. Multithreading is the key feature to support MySQL performance design goals. It is the core feature around which MySQL is built.
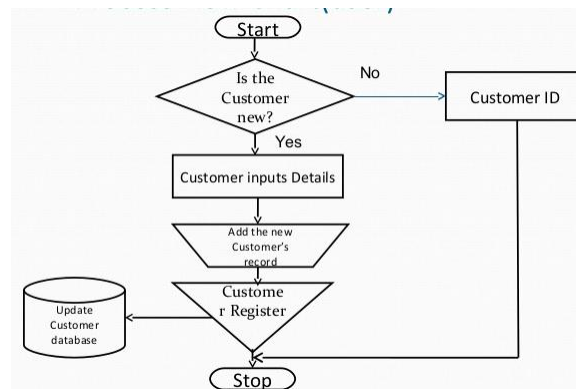
Notepad++ was used for writing codes.

Figure 1: Typical E-commerce Process Flow Chart

IV.   System Detailed Architecture

E-commerce frameworks must be based on a strong architectural model. Usually, they make heavy use of interfaces and design patterns like

1.   Dependency Injection (make components independent of used object implementation)
2.   Factories (create objects at a central place that instantiates the actual implementation)
3.   Decorators (dynamically add functionality to existing objects)

A ―design pattern‖ is re-usable solution that solves similar software design problems in an elegant way. They require programming language templates which enforce public class methods and their signatures called ―interfaces‖.

In general a framework is intended to define and create tools that integrate the information found in today's closed systems and allows the development of e-commerce applications. It is important to understand that the aim of the architectural framework itself is not to build new database management systems, data

repository, computer languages, software agent-based transaction monitors or communication protocols. Rather the architecture should focus on synthesizing the various existing resources like DBMS, data repository, computer languages, software agent based transaction, monitors or communication protocols to facilitate the integration of data and software for better application.

For the purpose of this project, the architecture of the e-commerce framework is based on the Model-View-Controller (MVC) which is a software architecture widely used in the development of web applications or software. The MVC supports efficiency and consistency to a reasonable level. ASP.NET, Django and Ruby on Rails which are the commonly used frameworks adopt the use of MVC architecture.

Following the MVC structure, the main types of functionality in the web application are grouped into three main files: models, views, and controller. This enables for each one of the portion to be designed, implemented and tested independently from one another. It also helps keep the code organized i.e. find a portion easily, make corrections or alterations easily and add new functionality with ease.

MVC is a pattern for the architecture of a software application. It separates an application into the following components:

1. **Models** for handling data and business logic. It is responsible for holding the functions and variables that are involved with what it is representing. It functions more like a class in the OOP.
2. **Controllers** for handling the user interface and application by taking input from the user, sending it to the model to get the appropriate output and then sendingit to the view to display the response to the user
3. **Views** for handling graphical user interface objects and presentation. It will contain the markup, CSS, HTML amongst others used in the creation of the web page.

Figures 2 and 3 represent how the model-view-controller architecture works.This separation results in user requests being processed as follows:

1. The browser (on the client) sends a request for a page to the controller on the server.
2. The controller retrieves the data it needs from the model in order to respond to the request.
3. The controller gives the retrieved data to the view.
4. The view is rendered and sent back to the client for the browser to display.
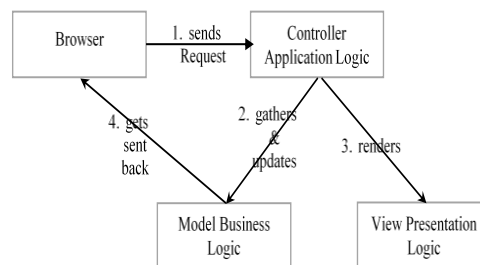

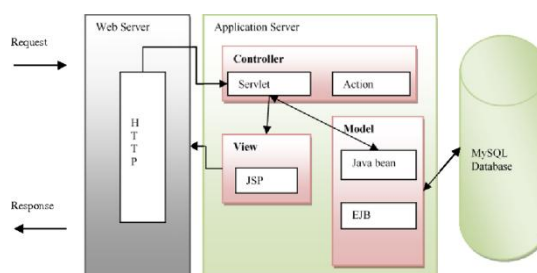**Figure 2: MVCtheory process for the architecture of a software application**

Figure 3: Framework MVC Architecture Pattern (Adopted from [16])

V. Implementation

This framework was developed by building on the existing open cart platform. For unique identification, the system is called O.CART. The O. Cart framework is divided into two (2) broad category phases namely the Admin page (the back end database) and the Store page (front end webpage). The back end database allows the storage of user information, adding and editing product catalogue, and sales amongst others.

The front end on the other hand reflects all the customization made in the back end.The developed system provides the following features: account, shopping cart, featured items, search tool, customer support. The backend database is developed using PHP and MySQL while the frontend webpage runs on HTML and JavaScript.

BASIC FEATURES OF THE SYSTEM

O. Cart is broadly divided into three major phases, they are the:

a.   Installation phase
b.   Admin page
c.   Store page

INSTALLATION PHASE

This phase teaches how to install O. Cart with WAMPP server.

1.   Download the latest version of WAMPP that is best suited with the operating system of your PC (Wamp64 in my case). After download, run the program and WAMPP configuration will start.
     NOTE: Keep everything as default to avoid complications.
2.   Copy the install folder of O. Cart to your clipboard; navigate to local disk where the installed folder of WAMPP server is. Open the folder and again navigate to ―www‖. Create a new folder inside ―www‖ folder and name it whatever name comes to mind for your store. Paste the copied O. Cart installation folder into the newly created project folder. After all said and done, we are almost there.
3.   Open WAMPP server and start all services i.e. MySQL and Apache
4.   Go to your web browser e.g. Mozilla and type in ―localhost‖. This page displays the WAMPP server homepage.
5.   Click on ―phpMyAdmin‖, and then navigate to new for the creation of a new database using your desired username and password preference.
6.   Navigate back to the WAMPP server homepage and under the ―your project‖ tab, click on the name provided in (5) above. Your homepage is displayed.
     "Hurray! You have just installed your ecommerce website using O. Cart framework".

ADMIN PAGE
O. Cart's administration side of the store is where all the work is. All changes made at the administration end are directly reflected in the store front and it determines how easy the customer can interact with the store. Such changes includes, modifying the layout, look, and the displays of the store front, figure 4 is the admin login page.
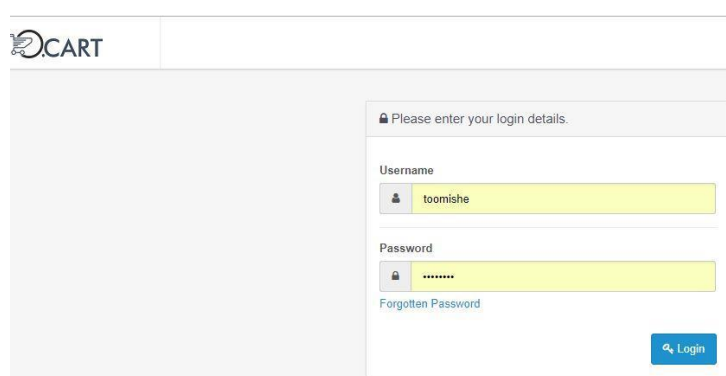

Figure 4:Admin Login Page

Dashboard

Type in the location of the store into the web browser followed by "/admin". In this case, ―localhost/admin‖. Fill in the correct username and password created in Step 5 of the installation process, pressing the "Login" button will direct you to the O. Cart dashboard. The first login attempt to your store, there is no content in your dashboard as shown below because there is no statistical data to be analyzed yet.
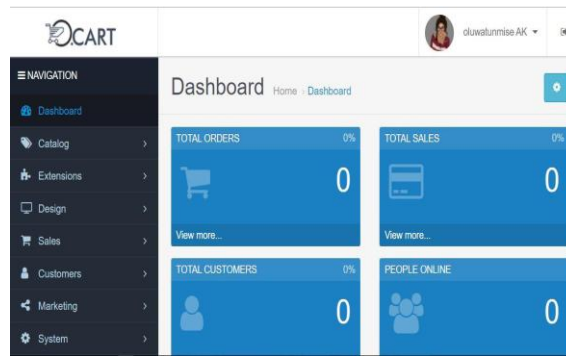
Figure 5:O. Carts Dashboard

The primary function of the dashboard is to give the shop owner an overview of how the shop is performing. Three 3 major sections of the dashboard provides help to understand the statistical data collected by your store. On the leftmost corner is the administration navigation. You can navigate between the "Catalog", "Sales", "System", amongst others.

Catalogue

As shown in figure 6, there are other sub-sections as discussed below in the catalogue page.

Categories – all products with similarities functions are grouped under a compound name such as Laptop or Notebook representing Mac, Windows etc. This feature helps customer identify similar products by placing them under the same category.

Products – all products that are available for sale on the website are displayed with their descriptions, image, cost price, discount price and the remaining quantity up for sale.

Option – it allows merchants to select the products details they want the customers to see under the description of each product

Manufacturer – manufacturers of the product on display are listed and it is advisable to put in the manufacturer details before adding the product so you can link the product correctly.
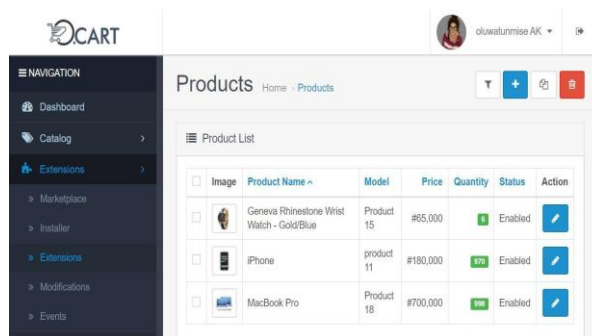

Figure 6: Merchant product list

Search tool

With the design of the web page, all products are not displayed, therefore a user can use the search tool to access products that are not visible.

Featured products

Selected products are displayed on the store front with the cost prices, images, brief descriptions and option to add to cart.
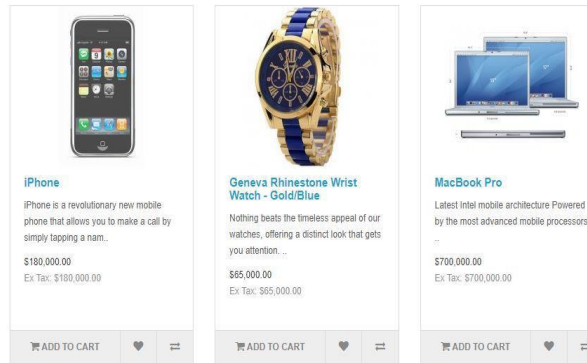
Figure 7: Featured Products

STORE VIEW

The store view is the part that the customer interacts with; it reveals what is displayed to the customer. The default store view for O. Cart before the customer edit it to his/her taste is displayed in figure 8.
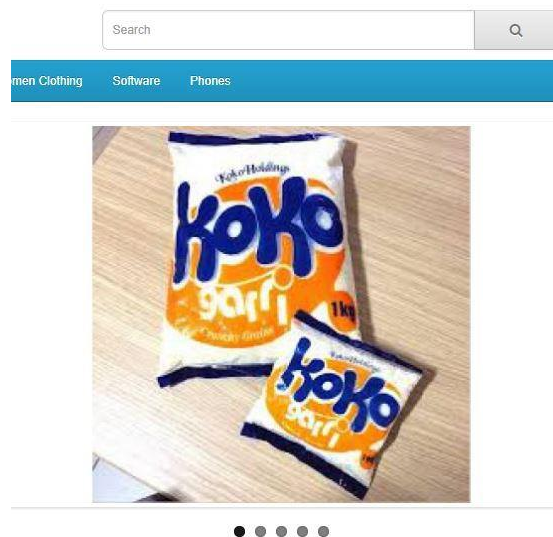

Figure 8:O. Cart Store Front

My Account

On the account page, there are options to login for old users and register for new users. A strong password is required for each users and option to either subscribe to the newsletter. Also, once the user forgets his/her password, the recovery option is made available through the account page.

Shopping Cart

All products selected by the customer is stored in the shopping cart until he/she is ready to checkout i.e. proceed to the final stage of purchase

Footer

1. At the bottom of the page, a block of links that customers will find helpful are listed. Each block has its own category sections:
2. Information: Delivery Service, About Us, Delivery Information, Privacy Policy etc.
3. Customer service: Contact Us
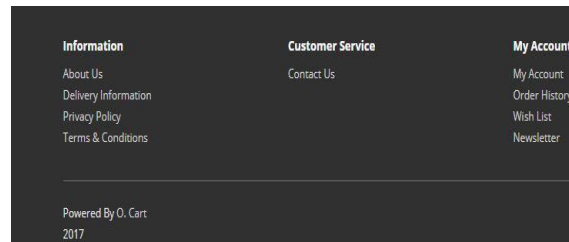4. My Account: My Account, Order History, Wish List, Newsletter

Figure 9: O .Cart Footer

Advantages of an MVC-Based Web Application

1. Easy to manage complexity by dividing an application into the model, the view, and the controller.
2. It provides better support for test-driven development (TDD).
3. MVC framework ideal for developers who want full control over the behavior of an application.
4. It uses view state on server-based forms, which can make managing state information easier.
5. It works glowing for Web applications that are supported by large teams of developers and for Web designers who need a high quantity of control over the application behavior.

VI.   Conclusion

For some years now, e-commerce platforms users' demand for highly personalized products has been on the increase. Considering the extrapolating adoption of Content Management System(CMS) platforms to develop Web solutions (institutional websites, e-commerce and e-business platforms, etc.), a solution for the referred issue is developed. This work has been able to develop a framework (O. Cart) which Small and Medium Enterprises (SMEs) that feels the need of an online presence can use to easily create their e-commerce website with little or no programming knowledge. The performed installation and configuration allowed acknowledging that using this type of approach does not require a significant amount of technical knowledge and might be a fair and adequate solution for the majority of SMEs that want to take the next step and start selling their products online. Finally, O. Cart provides user with more customizable options and quicker delivery of a website.

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