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WOOCOMMERCE IN ECOMMERCE - OVERALL SYSTEM REVIEW AND STRESS TESTS

s. 143-156

ABSTRACT

The ecommerce industry is highly developed, but after COVID-19 it has increased its position even more. The industry consists of huge corporations as well as a large number of small-scale stores. Each of these stores requires a system on which to operate. One popular system for online stores is WooCommerce. This study analyzed this system in terms of popularity, security, usability, among others. Its performance under load was also checked. A test for 4 WooCommerce configurations for different sets of parameters (RAM, processor) was conducted to check the maximum number of users which CMS can handle.

SŁOWA KLUCZOWE

ecommerce, cms, woocommerce, stress test, cybersecurity

1. INTRODUCTION

The rise of e-commerce in the market has revolutionized the way businesses operate, allowing companies to reach a global customer base and improve transactions. Among the various e-commerce platforms, WooCommerce has become a popular choice for creating online stores due to its flexibility, user-friendly interface and wide range of features. E-commerce platforms have not only developed B2C retail, but also B2B and even C2C. Platforms should be flexible enough to handle all these types of commerce. E-commerce websites have become an essential part of modern-day business operations [1].

WooCommerce is built on the CMS Wordpress. Wordpress is a CMS designed for blogs, but due to its high popularity (about 30% of CMS share) [5] the WooCommerce project was opened in 2011 [3]. The founders of WooCommerce declared that their plugin powers more than 3.9 million stores, but Katie Keith in her analysis found that the number of active installations exceeded 5 million, but the exact number cannot be estimated [3]. In terms of overall popularity of CMS, 23.6% of websites were created using those systems in 2011 and that number increased to 48.8% in 2018. The market share for WooCommerce in 2023 is 23% of the top 1 million sites using e-commerce technologies. [5].

It is important to note that the number of active installations does not necessarily correspond to the number of active stores. Those installations can be used for testing, development purposes or simply to be installed as an add-on to the site, but not to be used at all.

The e-commerce industry has been growing steadily for many years. Globally, in 2020, retail e-commerce generated a staggering \$4,280 billion in sales, showing a remarkable annual growth rate of 22 percent over the past five years. In 2020, e-commerce accounted for 18 percent of total worldwide retail sales, a significant increase from its 2016 figure of 8.6 percent, effectively doubling its market share [8]. One of the recent factors that had a significant impact on the sector was covid-19. In Wenchao Ji and Jianing Zhang research [6] was found that the COVID-19 has a positive impact on the E-commerce companies in China. In review [7] Campisi et al said that ecommerce is destined to grow further in all product categories.

Aim of this papers

An analysis of very popular ecommerce systems can be very useful for people whose goal is to start their own online stores, but who lack knowledge and experience in this field. Selecting the right resources is crucial for economic reasons. For example, WooCommerce, despite its low implementation costs, can be very expensive to maintain with very high traffic. On the other hand, custom-built applications are much more costly, but can prove cheaper to maintain in the long term. This study is intended to help estimate the hardware requirements required to maintain the WooCommerce system and assess its good and bad points.

2. RELATED RESEARCH

Studies repeatedly discuss such topics as comparing CMS systems for commerce with each other, or trying to optimize them. Each of the available systems has different characteristics and, consequently, will perform differently in different conditions.

The study [9] revealed that multiple elements, including website design, usability, security, and customer service, are crucial for the success of e-commerce websites. Additionally, effective communication and marketing strategies may be essential for attracting and retaining customers. The research demonstrated the vital role of e-commerce websites in the contemporary business landscape, emphasizing the potential challenges that companies may encounter if they do not adapt to this evolving environment.

Comparing to other frameworks and CMS solutions the paper assumed WooCommerce as:

- Free, easy to use, open-source, numerous plugin (features),
- Fully customizable, SEO friendly, great for small to medium- sized businesses (advantages),
- Limited customer support can be difficult to manage for larger businesses (disadvantages).

Wordpress which is core of Woocommerce could be improved with features like caching. Study [2] of different caching strategies showed that a WordPress with a large number of users can be optimized by utilizing an HTTP accelerator and database caching to efficiently handle high traffic loads from thousands of visitors. According to the paper varnish static cache with redis cache strategy setup brings the best result.

In 2023 a study [10] examined the security of WordPress and highlighted the following that the majority (92%) of vulnerabilities discovered in websites powered by WordPress are a result of third-party plugins and programming errors. The study showed that the DeepRecon tool found the most vulnerabilities (41) eg. XSS, CSRF, privilege escalation vulnerabilities.

In the Martinez-Caro et al paper [5] investigated and compared the possibilities of 3 open-source CMS such as Joomla!, WordPress, and Drupal. For this purpose three independent sites built on different CMS engines were created in uniform appearance. They perform a qualitative comparative analysis to showcase the benefits, limitations, and intricacies associated with each system. The advantages of Wordpress included simplicity, free hosting and the best engine preparation for SEO.

Arafath Y. in his work [11] compared Wordpress with the competing CMS Drupal. Wordpress was found to be better as a blog and easier to install. Drupal, on the other hand, was found to be a more secure system with better security policies for plugins and themes.

3. WOOCOMMERCE IN ECOMMERCE

One of the most popular websites to purchase a professional Woocommerce theme is themeforest website [12]. Total of 1,477 themes are available for the woocommerce platform. Using a scraping method the webpage was analyzed. The cost of purchasing themes starts at \$13 and ends at \$999. The average price is \$58,9, and the median is \$59. The collected data file with prices is available on github [13] and its contribution to this document. On the WordPress repository 11,319 free themes exist [14].

The second component of Wordpress are plugins. For the year, there are 59,727 free plugins in the official Wordpress repository [14]. These plugins are created by third parties, including freelancers and companies. The business model is that developers co-create a paid and more extended version of plugin, which they advertise in the free one.

Due to its popularity, WooCommerce is vulnerable to cyberattacks. In response, there are adequate safeguards as plug-ins from third parties. One method of preventing attacks is Two-factor authentication (2FA) [15]. Przejęcie kontroli nad kontem administratora jest głównym celem atakujących systemy, w tym CMS [16].

4. METHOD AND INFRASTRUCTURE

Stress tests, including simulated high user loads and complex scenarios, were conducted to evaluate the plugin's ability to handle demanding e-commerce environments. By analyzing factors such as response time, resource utilization and system stability, the study aims to provide valuable insights into WooCommerce's limitations and strengths.

The research methodology includes setting up a test environment that resembles real-world e-commerce scenarios, using stress-testing tools to simulate heavy user traffic, and collecting performance metrics to analyze the website behavior. The infrastructure illustrated in Fig. 4.2 was used for the tests. The full specification of the equipment is described in Tab. 4.1.

Taking into consideration commonly used SEO indications for the number of words per page [17], the study used content-filled subpages: posts, pages and products had a minimum of 300 words and 1 image. The principles of SEO are common among online store owners, as it is one of the 2 most popular ways to attract customers, namely through high search engines (eg. Google) positions. The second mentioned strategy is the purchase of advertising.

To create tests, containerization based on the Docker solution was used. Docker is perfect for stress testing web applications, as it allows for easy creation of isolated containers in which to run the application and its dependencies, ensuring a consistent and controlled test environment. With flexible resource management and the ability to scale containers, Docker enables real-time load view (Fig. 4.1), which is crucial when testing application performance. In addition, you can easily replicate the test environment on different platforms, allowing you to comprehensively evaluate the application's behavior under different conditions.

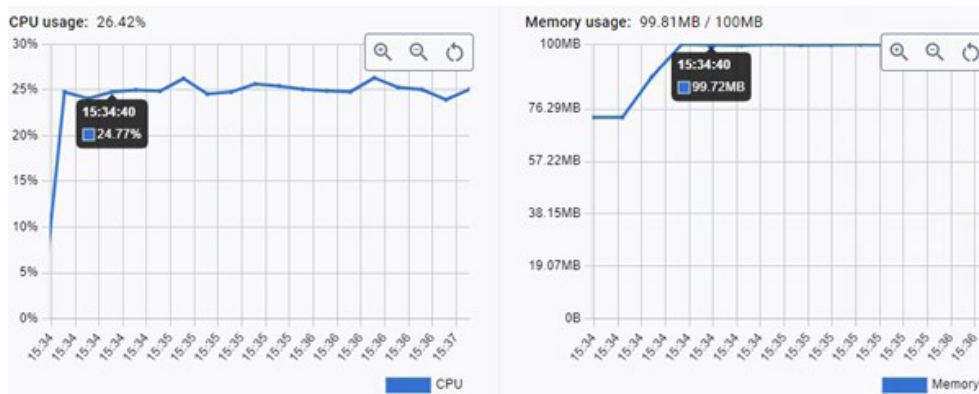


Fig. 4.1. Example of real-time load view (stress tests of Wordpress for 10 users) in Docker Desktop.

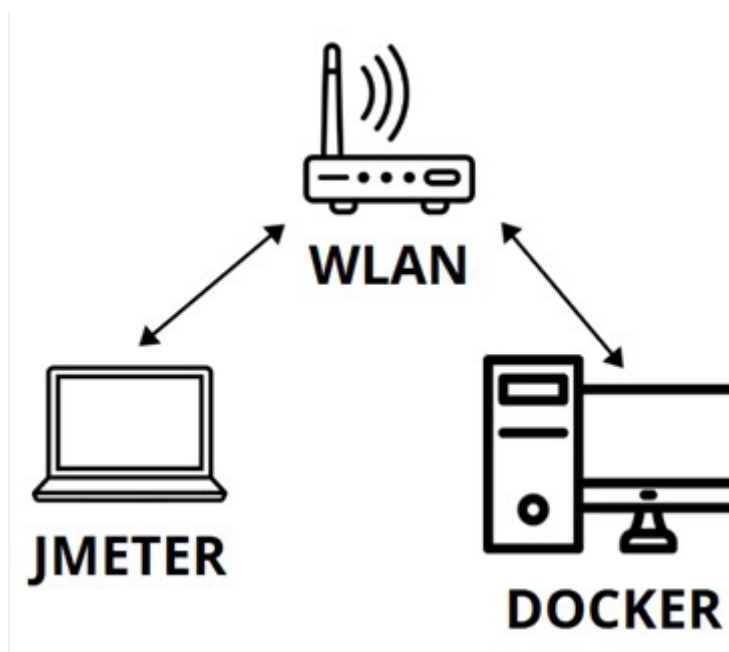


Fig. 4.2. Device connection diagram used in stress tests.

Tab. 4.1. Table of devices used in paper.

	JMETER DEVICE	DOCKER DEVICE
Name	Lenovo Y50	
Processor	Intel® Core™ i5-4200H Processor	Intel(R) Xeon(R) CPU E5-2637 v2 @ 3.50GHz 3.50 GHz (processors: 2)
Memory	8GB	32,0 GB
OS	Windows 10 Pro	Windows 10 Pro to create graphs Debian 12 for stress test

A pre-made publicly available Docker image from the repository was used [18]. The parameters of the CMS installation are as follows:

- **WordPress Version:** 6.3.1,
- **Current WordPress Theme:** Twenty Twenty-Three version 1.2 (default),
- **PHP Version:** 8.0.30,
- **MySQL Version:** 11.1.2-MariaDB-1:11.1.2+maria~ubu2204,
- **Apache Version:** Apache/2.4.56 (Debian).

Table 4.2 shows the tested variants on which tests were performed with JMETER software. The specifications (RAM and processor) of the Docker image are used in determining the minimum needs of Wordpress and stress testing are included in Tab. 4.3 Each type of test was run with the same Docker image [18]. It started with a clean installation of CMS Wordpress, then Wordpress was tested with a pre-configured WooCommerce plugin. Next, WooCommerce was tested with a site running the popular theme named „Free Wocommerce”. The last installation option was Wocommerce built with Elementor builder and 14 very commonly used plugins. Some of plugins were provided with theme. The rest of plugins were selected based on the list of popular wordpress plugins (Fig 4.3). Plugins with low functionality were omitted. List of those plugins are shown in Tab. 5.9.

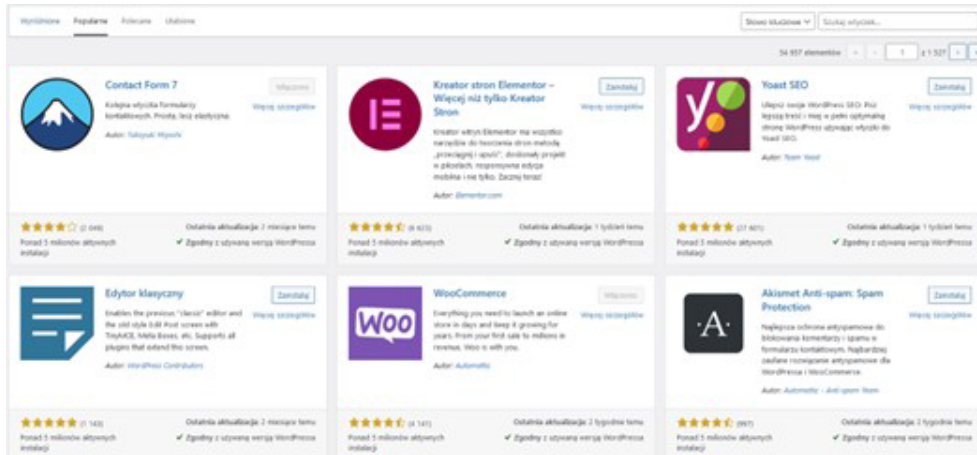


Fig. 4.3. Most popular plugins for wordpress in 2023 among the users.

Tab. 4.2. Examined variants Wordpress and Woocommerce installation

	Type of instance
1.	Clean Wordpress with default template - Variant (I)
2.	Wordpress + Woocommerce (default template) - Variant (II)
3.	Wordpress + Woocommerce + Template (Without Builder) - Variant (III)
4.	Wordpress + Woocommerce + Template (Elementor Builder [19]) + additional plugins - Variant (IV)

Tab. 4.3. Resource configuration variants under study

	Memory [MB]	Processor [%]
1.	100	.25
2.	100	.50
3.	500	50
4.	1000	100

During analysis with the JMETER parameter as „The Ramp-up Period“ is used. The Ramp-up Period parameter is the amount of time in seconds that will take to run all threads to a test execution. For example: 100 threads with 100 seconds ramp-up cause that JMeter will start one thread each second.

5. RESULTS AND DISCUSSION



Fig. 5.1. Wordpress IDLE process in Docker container.

Docker provides relevant information about the status of active containers directly and via plugins (Fig. 5.1.). The test used two factors such as CPU usage and RAM, but disk and network status are also available. In order to get correct results, the container was reset after each measurement, since RAM was not completely released.

5.1. Wordpress Instance

Variant (I) was based on testing a subpage with the type „Post” for a fresh instance of Wordpress. Tab. 5.1 - 5.3 examine the performance of Wordpress on very low resources, among other reasons, to find a reference point for further testing.

Tab. 5.1 Wordpress with 100MB RAM and 25% processor.

Users (Threads)	Ramp up period [s]	Tries	Samples	Average [ms]	Mediana [ms]	Max RAM [MB]	Max proces-sors [%]	Failed [%]
1	1	100	100	1054	815	87,1	24,90	0
2	1	50	100	2619	2593	99,9	26,37	0
10	10	10	100	27652	27514	99,9	26,23	0
100	100	1	100	18372	17063	99,9	27,07	88,00
100	200	1	100	1184	1250	96,8	24,75	0

Tab. 5.2 Wordpress with 100MB RAM and 50% processor.

Users (Threads)	Ramp up period [s]	Tries	Samples	Average [ms]	Mediana [ms]	Max RAM [MB]	Max proces-sors [%]	Failed [%]
1	1	100	100	833	611	88,5	31,64	0
2	1	50	100	1315	1272	99,6	49,60	0
10	10	10	100	14063	14311	99,9	50,98	0
100	100	1	100	25141	264457	98,4	59,02	88
100	200	1	100	1040	1064	96,9	28,37	0

Tab. 5.3 Wordpress with 500 MB RAM and 50% processor.

Users (Threads)	Ramp up period [s]	Tries	Samples	Average [ms]	Mediana [ms]	Max RAM [MB]	Max proces-sors [%]	Failed [%]
1	1	100	100	205	199	66,9	13,4	0
2	1	50	100	451	404	88,9	17,79	0
10	10	10	100	1890	1902	186,4	37,27	0
100	100	1	100	281	231	151,1	30,22	0
100	200	1	100	247	191	125.3	25.06	0

As can be seen in the Tab. 5.1 - 5.3 Wordpress is capable of running on 100MB, but only for a few users. In contrast, 500MB is sufficient. so that the site can be used comfortably by up to a dozen users. A time of 2s seems to be an acceptable time to wait for the page to load when using the site with 10 users running every 1s. Table 5.3 shows that RAM was not used 100%, but the average waiting time increased.

Users (Threads)	Ramp up period [s]	Tries	Samples	Average [ms]	Mediana [ms]	Max RAM [MB]	Max proces-sors [%]	Failed [%]
100	100	1	100	163	150	124,1	12,41	0
100	80	1	100	169	150	130.2	13.02	0
100	50	1	100	166	140	126.4	12.64	0
100	30	1	100	134	129	141.1	14.16	0
100	20	1	100	150	148	185.9	18.51	0
100	10	1	100	5647	7035	549.1	50.66	0
100	1	1	100	11203	13986	806.1	80.61	0
200	1	1	100	25740	31307	999	99.99	0

The next test (Tab. 5.4.) used the maximum resources and increased the load on the machine. With 100 queries in 10s and 1s, the response time increased significantly, but this did not lead to a complete lockdown of the system. Even 200 queries running in a second will not lead to a loss of stability, but the response time was unacceptable for users.

5.2. Wordpress with WooCommerce Instance

For this test (Variant II) a product has been added with the same text and image as page before. The product page was based on the system’s built-in default theme. Example of test are presented on Fig. 5.2 from data collected using command 5.1.

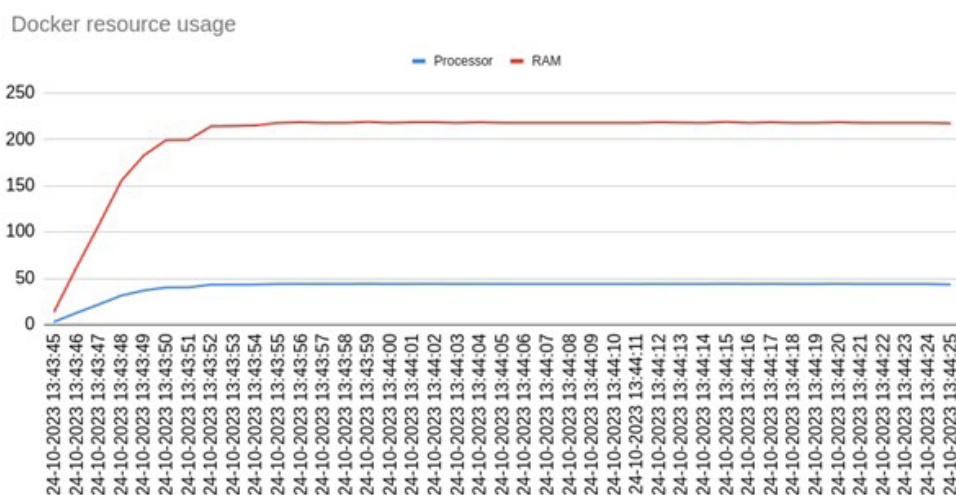


Fig. 5.2. Example of stress tests of Wordpress (1 user per 1 second) from the “docker stats” command.

Command 5.1. Collecting Docker image real-time statistics.

```
docker stats --format $FORMAT $CONTAINER | sed -u ,s/\x1b\[[0-9;]*[a-zA-Z]//g' | tee stats | perl -pe ,use POSIX qw(strftime); my $date = strftime „%d-%m-%Y %H:%M:%S „, localtime; print $date;'
```

Users (Threads)	Ramp up period [s]	Tries	Samples	Average [ms]	Mediana [ms]	Max RAM [MB]	Max proces-sors [%]	Failed [%]
1	1	100	100	372	314	89,4	17,89	0
2	1	50	100	783	704	109,1	21,83	0
10	10	10	100	4293	4505	287,9	57,57	0
100	100	1	100	452	355	230,1	46,02	0
100	200	1	100	353	347	208,5	41,69	0

Comparing Tab. 5.5 (Variant I) to Tab. 5.3 (Variant II), where specification of resources was equal , an increase in resource requirements was observed after expanding the system with WooCommerce. The increase in server response time is noticeable with each test.

Tab. 5.7 Wordpress with 1000 MB RAM and 100% processor.

Users (Threads)	Ramp up period [s]	Tries	Samples	Average [ms]	Mediana [ms]	Max RAM [MB]	Max processors [%]	Failed [%]
100	100	1	100	240	227	181	18.94	0
100	80	1	100	229	221	204.8	22.42	0
100	50	1	100	265	223	226.7	22.64	0
100	30	1	100	226	222	270	27.01	0
100	20	1	100	2984	1407	268.4	26.84	0
100	10	1	100	3901	4675	573.4	100.00	0
100	5	1	100	51808	62217	999	99.99	0
200	1	1	100	25740	31307	999	99.99	0

Compared to Wordpress (Tab. 5.4) with the same parameters working on (Docker instance with 1000 MB RAM and 100% processor), Woocommerce performs much worse. Already with 100 queries in 10 seconds, the application became much slower, but it maintained its performance and handled all queries correctly.

5.3. Wordpress with Woocommerce and Template (Builder)

In this test (Variant III) a free theme shared on Wordpress Gallery named "Open WooCommerce" was chosen. Wordpress has a significant number of damar templates that can be installed directly from the repository of this system. However, not all templates are adapted to the WooCommerce plugin.

Tab. 5.7 Wordpress with 1000 MB RAM and 100% processor.

Users (Threads)	Ramp up period [s]	Tries	Samples	Average [ms]	Mediana [ms]	Max RAM [MB]	Max processors [%]	Failed [%]
100	100	1	100	160	144	145.5	12.34	0
100	80	1	100	157	138	125.9	12.59	0
100	50	1	100	157	134	128.5	12.85	0
100	30	1	100	261	144	196.8	19.81	0
100	20	1	100	1180	175	357.1	35.11	0
100	10	1	100	4143	5197	618.4	63.34	0
100	5	1	100	8342	10468	813.6	81.36	0
200	1	1	100	25740	31307	999	99.99	0

Adding a sample theme for most cases had a positive effect on the response time against the default one (Tab. 5.7). This is a signal that the default theme may be suboptimal or contain errors.

5.4. Wordpress with Woocommerce, Template (Builder) and additional plugins

In this test (Variant IV), outcomes (Tab. 5.7) shows that increasing the number of plugins (Tab. 5.8) and using Builder (Elementor) has a significant impact on slowing down the site. Docker's image requirements have increased as well as the server's response time.

Tab. 5.8 Wordpress with 1000 MB RAM and 100% processor.

Users (Threads)	Ramp up period [s]	Tries	Samples	Average [ms]	Mediana [ms]	Max RAM [MB]	Max proces-sors [%]	Failed [%]
100	100	1	100	242	226	285.5	28.45	0
100	80	1	100	240	232	293.4	28.42	0
100	50	1	100	243	236	287.2	28.73	0
100	30	1	100	3472	3970	529	52.90	0
100	20	1	100	4756	4950	762.12	74.53	0
100	10	1	100	32359	40792	999	99.99	0

Tab. 5.9 List of used plugins in the test.

No.	Plugin name	Plugin description (official)	Plugin version and Prducer
1	Select Advanced Import	Easily import demo data starter site packages or Migrate your site data	Version 1.4.0, By AddonsPress
2	Select All-in-One WP Migration	Migration tool for all your blog data. Import or Export your blog content with a single click.	Version 7.79, By ServMask
3	Select Classic Widgets	Enables the classic widgets settings screens in Appearance - Widgets and the Customizer. Disables the block editor from managing widgets.	Version 0.3, By WordPress
4	Select Contact Form 7	Just another contact form plugin. Simple but flexible.	Version 5.8.1, By Takayuki Miyoshi
5	Select Elementor	The Elementor Website Builder has it all: drag and drop page builder, pixel perfect design, mobile responsive editing, and more. Get started now!	Version 3.16.6, By Elementor.com
6	Select Essential Addons for Elementor	The Essential plugin you install after Elementor! Packed with 40+ stunning free elements including Advanced Data Table, Event Calendar, Filterable Gallery, WooCommerce, and many more.	Version 5.8.12, By WPDeveloper
7	Select Limit Login Attempts Reloaded	Block excessive login attempts and protect your site against brute force attacks. Simple, yet powerful tools to improve site performance.	Version 2.25.25, By Limit Login Attempts Reloaded
8	Select Loco Translate	Translate themes and plugins directly in WordPress	Version 2.6.6, By Tim Whitlock
9	Select Starter Templates by Gradient Themes	Plugin used to install demo data for themes developed and submitted by Gradient Themes.	Version 1.2.0, By gradientthemes
10	Select WooCommerce	An eCommerce toolkit that helps you sell anything. Beautifully.	Version 8.2.1, By Automattic
11	Select YITH WooCommerce Compare	The YITH WooCommerce Compare plugin allow you to compare in a simple and efficient way products on sale in your shop and analyze their main features in a single table. Get more plugins for your e-commerce shop on YITH.	Version 2.32.0, By YITH
12	Select YITH WooCommerce Quick View	The YITH WooCommerce Quick View plugin allows your customers to have a quick look about products. Get more plugins for your e-commerce shop on YITH.	Version 1.32.0, By YITH
13	Select YITH WooCommerce Wishlist	YITH WooCommerce Wishlist gives your users the possibility to create, fill, manage and share their wishlists allowing you to analyze their interests and needs to improve your marketing strategies. Get more plugins for your e-commerce on YITH	Version 3.26.0, By YITH
14	Select Yoast SEO	The first true all-in-one SEO solution for WordPress, including on-page content analysis, XML sitemaps and much more.	Version 21.4, By Team Yoast

6. CONCLUSION

In summary, this study provides a comprehensive review and stress testing analysis of the WooCommerce plugin in an e-commerce context. By evaluating its performance under stress test conditions, this study aims to offer valuable insights for companies and developers who want to use WooCommerce to create robust and efficient online stores.

The tests were conducted in a Docker environment using different configurations of memory and CPU resources. It was tested how the resource requirements would change after applying themes and plugins that are used by hundreds of thousands of people.

In a real environment that may be differently optimized, the results may be different. It is also difficult to estimate how certain data is represented by the Docker application. Docker or the operating system may optimize repeated queries, which also affects the results. In fact, there are cases when users want to get to a single page, because of a product promotion, or to read a news article, but the page may also be loaded more proportionally.

The study does not completely explore the topic of site load testing. For the system under study, there are a number of different plug-ins whose purpose is the same. Their performance could also be compared against each other. Additionally, the results can be compared to other frameworks, tailor-made applications or similar CMS.

Author Contributions

All authors declare equal contribution to this research paper.

Conflicts of Interest

The authors declare there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

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WOOCOMMERCE W BRAŹNY ECOMMERCE - OGÓLNY PRZEGLĄD SYSTEMU I TESTY WARUNKÓW SKRAJNY

STRESZCZENIE

Branża e-commerce jest bardzo rozwinięta, ale po COVID-19 jeszcze bardziej umocniła swoją pozycję. Branża składa się z ogromnych korporacji, a także dużej liczby małych sklepów. Każdy z tych sklepów wymaga systemu, na którym może działać. Jednym z popularnych systemów dla sklepów internetowych jest WooCommerce. W niniejszym badaniu przeanalizowano ten system m.in. pod kątem popularności, bezpieczeństwa i użyteczności. Sprawdzono również jego wydajność pod obciążeniem narzędziem JMETER. Przeprowadzono test dla 4 konfiguracji WooCommerce dla wielu różnych zestawów parametrów (pamięć RAM, procesor), aby sprawdzić maksymalną liczbę użytkowników, którą CMS może obsłużyć.

SŁOWA KLUCZOWE

e-commerce, cms, woocommerce, testy obciążeniowe, cyberbezpieczeństwo



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