USABILITY EVALUATION OF E-COMMERCE WEBSITES

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ABSTRACT
E-commerce is the buying and selling of products and services online. It can also refer to the transmission of funds or data over an electronic network. Usability of the website is a strong predictor of the user satisfaction and intention to use. A good website can enhance user experience tailored to Malaysian commerce preferences. This study aims to evaluate the usability of three leading e-commerce websites in Malaysia, which are Shopee, Lazada and Mudah, by assessing user experience using the Website Analysis and Measurement Inventory (WAMMI). Consequently, Shopee demonstrated the best overall performance across the categories of attractiveness, controllability, efficiency, helpfulness and learnability, indicating that a high level of attractiveness is especially influential in user satisfaction. Lazada, while performing well in controllability, showed room for improvement in other areas. Mudah, on the other hand, showed strengths in efficiency but had lower scores in attractiveness and learnability, suggesting it may benefit from a more user-friendly design and streamlined layout. This study highlights the critical role of usability in optimizing e-commerce platforms and provides insights to improve user satisfaction, contributing to Malaysia's growing digital economy.

Keywords
E-commerce, Electronic Shopping, WAMMI, Website's Evaluation, Shopee, Lazada

1. INTRODUCTION
Online shopping, an application born from advancements in internet technology, has transformed how consumers engage in commerce. Since the emergence of Web 1.0 in the early-to-mid 1990s, traditional commerce methods have reached a turning point. Businesses effectively reached consumers online, driving the rapid growth of online shopping[1]. According to Turban et al. (2015), advancements like Web 2.0 have created new consumer engagement methods, fostering digital consumption and economic benefits[2].

In Malaysia, the e-commerce landscape has experienced rapid growth due to increased internet access and the rise of platforms like Shopee and Lazada, which dominate the market[3]. The popularity of these platforms reflects how normalized online shopping has become, with Malaysian consumers increasingly relying on e-commerce for convenience and variety. This shift positively impacts Malaysia's economy by driving consumer spending and creating opportunities for local businesses. In this context, the MyDIGITAL blueprint by the Malaysian government aims to expand the digital economy's contribution to 22.6% of Malaysia's GDP by 2025, emphasizing the need for improved usability on e-commerce platforms to support this goal[4].

Usability evaluation is a critical step in refining e-commerce platforms, aiming to create websites that are intuitive, efficient, and engaging. A user-friendly website allows consumers to navigate easily, find products quickly, and complete transactions smoothly, ultimately increasing sales[5]. Moreover, good design in e-commerce not only prioritizes aesthetics but also emphasizes functionality and user-centered principles. Norman (2013) highlights that effective design is characterized by clarity, simplicity, and support for user tasks without overwhelming them with unnecessary elements[6]. As Leung (2012) notes, poor web design can deter potential customers, underscoring the importance of investing in user-friendly interfaces to foster customer loyalty[7].

There are several methods for assessing usability, including the Website Analysis and Measurement Inventory (WAMMI) and the System Usability Scale (SUS). WAMMI has 20 questions that focus on five key areas: attractiveness, control, efficiency, helpfulness and learnability, making it ideal for website evaluations. This method provides a comprehensive understanding of user experience, allowing researchers to gather direct feedback on satisfaction levels while employing software-based methods to identify specific usability issues [8][9].

Based on these arguments, this study strives to employ the WAMMI method to evaluate the usability of Malaysia's three leading e-commerce websites: Shopee, Lazada, and Mudah. The focus will be on how these platforms meet user needs and expectations within Malaysia's digital marketplace. By identifying strengths and areas for improvement, this study aims to enhance user satisfaction and contribute to Malaysia's e-commerce growth and overall economic development.

2. METHODOLOGY
There are three e-commerce websites were selected for usability evaluation in this research. The Uniform Resource Locator (URL) of each e-commerce website is shown in Table 1.

Table 1: URL of E-commerce Websites

Website Name	URL of E-commerce Website
Shopee	https://www.shopee.com.my
Lazada	https://www.lazada.com.my
Mudah	https://www.mudah.my

As previously stated, usability is a core principle that affects the effectiveness, efficiency and comfort with which users interact with interfaces[10]. Consequently, this usability study evaluates the commerce website using the five usability dimensions defined by the Website Analysis and Measurement Inventory

(WAMMI): attractiveness, controllability, efficiency, helpfulness and learnability.

2.1 User-based usability evaluation methods

The experiment involved 20 users, comprising both undergraduate and postgraduate students from the UTM library, who completed a Google Form survey to evaluate three e-commerce websites. Participants were allowed to select one or more e-commerce websites for assessment. Before filling out the survey, each user performed six tasks to simulate typical online shopping interactions:

1) Search for a specific product (e.g., a laptop bag).
2) Apply filters to a specific product for a general category(e.g., “Filter laptops by price range, brand and
3) Compare two or more similar products (e.g., "Compare two smartphone models based on specifications and
4) Add Items to the Shopping Cart and Review Cart Contents
5) Check Product Availability by Location
6) Find and access customer support options (e.g., live chat, FAQ or contact information)

Upon task completion, participants answered 20 questions in the WAMMI (Website Analysis and Measurement Inventory) questionnaire. The WAMMI assesses usability across five key dimensions: attractiveness, controllability, efficiency, helpfulness and learnability.

Each question in the WAMMI used a five-point likert scale, ranging from strong agreement (5 points) to strong disagreement (1 point), allowing users to rate their satisfaction based on these five usability factors (listed in Table 2). An ANOVA test will analyze the usability scores across websites, providing a statistical comparison of their performance. The results, along with a discussion of usability differences, will be covered in the Results and Discussion section.

Table 2: Five WAMMI factor

No.	Question
Attractiveness	
1	I find this website pleasant
6	The website is visually appealing.
11	I enjoy using this website.
16	I think the design of this website is attractive.
Controllability	
2	I feel in control when I’m using this website.
7	This website does not let me do what I want. (reverse-scored)
12	The website responds badly when I make a mistake. (reverse-scored)
17	I know where I am at all times when using this website.
Efficiency	
3	It is easy to move around the website.
8	It takes too long to get the information I want. (reverse-scored)
13	This website is fast enough.
18	I can quickly find what I am looking for on this website.
Helpfulness	
4	The help information on this website is useful.
9	When I get stuck, the website helps me.
14	I think this website is easy to learn.
19	The website provides clear information.
Learnability	
5	I understand straight away how to use the website.
10	The navigation makes sense to me.
15	I find the website easy to use.
20	The website layout is simple to understand.

2.2 Software-based usability evaluation Methods

Two software-based usability testing tools, Pingdom and GTmetrix, were utilized to evaluate website performance metrics that affect user experience. These tools are commonly used in usability testing to assess performance, load time, page size and request count, which helps pinpoint areas for improving website speed and user satisfaction.

Table 3: URL for each usability testing tool

Usability Testing Tool	URL of Usability Testing Tool
Pingdom	https://tools.pingdom.com/
GTmetrix	https://gtmetrix.com/

2.2.1 Pingdom

Pingdom, provided by SolarWinds, is a performance monitoring tool that records the time needed for all web resources to load, known as "onload time." This metric stops once every resource on the page has downloaded and processed completely, providing insights ino overall website efficiency. Key metrics tracked by Pingdom include performance grade, page size, load time and the number of requests made by the site. The tool's reports offer suggestions for website optimization, making it highly useful for site administrators aiming to enhance performance[11].

2.2.1 GTmetrix

GTmetrix provides more detailed analytics than Pingdom, capturing additional metrics such as First Contentful Paint, Time to Interactive, Speed Index, and Total Blocking Time. This tool measures "full load time" based on the time it takes for the page to cease all network activity, making its load time slightly longer than Pingdom's but offering a fuller picture of the user experience. GTmetrix is especially useful for identifying complex performance issues that may impact usability[12].

The testing was conducted with Pingdom's server based in Tokyo, Japan, and GTmetrix's server based in Vancouver, Canada. The performance results from both usability tools will be analyzed using an ANOVA test. Comparative findings among the websites are discussed in the Results and Discussion section. Table 3 lists the comparison parameters used by each tool, highlighting the similarities in evaluation criteria between Pingdom and GTmetrix for usability assessment.

Table 4: Parameter for each tool

Tool /Parameter	Performance	Size of Page	Load Time	Number of Requests
Pingdom	/	/	/	/
GTmetrix	/	/	/	/

2.3 Analysis of Variance (ANOVA)

ANOVA (Analysis of Variance) is a statistical method used to test for significant differences between group means, particularly among independent variables. ANOVA can be categorized into one-way and two-way types. One-way ANOVA, which is used in this research, is effective for comparing the means of three or more groups within a single categorical variable to determine if any statistically significant differences exist. Microsoft Excel was utilized to calculate the ANOVA for the purpose of data analysis, providing a streamlined approach to handling statistical comparisons[13][14].

3. RESULTS AND DISCUSSION

3.1 User-based usability evaluation methods

The user-based usability evaluation, as shown in Table 5, highlights key insights into participants' online shopping habits and website usability. Among the 20 participants, 60% were female and 40% male. 80% shop online frequently while 20% rarely shop online. In terms of usage, 75% used platforms like Shopee, Mudah or Lazada over five times in the past month, with only 15% reporting 1-2 uses and 10% using them 3-5 times.

When it comes to time spent shopping, 45% reported sessions under 15 minutes, 20% spent 15-30 minutes, 15% between 30-45 minutes, another 15% between 45-60 minutes, and 5% over an hour. Shopping preferences also varied: 15% preferred household items, 25% electronics, 40% clothing and accessories, and 20% groceries and personal care items.

Table 5: Descriptive statistics

Factor	Category	Percentage(%)
Gender	Female Male	60 40
Often shop online	Yes No	80 20
Time Spent on Online Shopping	Below 15 minutes 15-30 minutes 30-45 minutes 45-60 minutes More than 60 minutes	45 20 15 15 5
Times Used Shopee/Mudah/Lazada (Past Month)	1-2 times 3-5 times More than 5 times	15 10 75
Types of Products Shopped	Household items Electronics Clothing and accessories Groceries and personal care	15 25 40 20

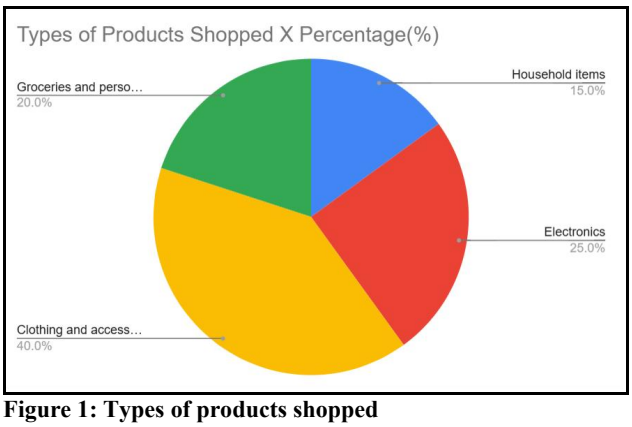

Figure 1: Types of products shopped

For the user-based usability evaluation, an ANOVA test was conducted to determine if there are statistically significant differences in the WAMMI usability factors (Attractiveness,

Control, Efficiency, Helpfulness and Learnability) of Shopee, Lazada and Mudah. The test was performed at a significance level of α=0.05, with the following mean definitions:

μ_1: Mean usability score for Shopee
μ_2: Mean usability score for Lazada
μ_3: Mean usability score for Mudah

The hypotheses for this test are as follows:

Null Hypothesis (H_0): $\mu_1 = \mu_2 = \mu_3$, indicating no significant differences among the websites' usability scores.
Alternative Hypothesis (H_1): At least one website has a different mean usability score.

Each website's usability factor was tested with a sample size of 4, resulting in between-group degrees of freedom (DF) of 2 and within-group DF of 9. The critical F value for this test, based on a 0.05 significance level, was calculated as 4.2565.

3.1.1 Attractiveness

Attractiveness significantly impacts user engagement, as it encompasses the aesthetic and visual appeal that draws users to a website [15][16]. Within this study, attractiveness was evaluated through specific WAMMI questions, including question 1, question 6, question 11, and question 16. Based on the analysis, Shopee displayed the highest attractiveness, with a mean score of 4.29, a standard deviation of 0.7559. Lazada followed with a mean score of 4.0 and a standard deviation of 0.8165, indicating a favorable level of attractiveness. Mudah had the lowest attractiveness rating, with a mean of 3.5 and a higher standard deviation of 1.0488, which suggests a varied user experience in this factor. The summarized results for attractiveness are shown in Table 6.

Table 6: Summary of attractiveness

Website	Mean	Standard Deviation	Standard Error
Shopee	4.29	0.7559	0.2857
Lazada	4	0.8165	0.3086
Mudah	3.5	1.0488	0.4282

Table 7: ANOVA table for attractiveness

Source	Sum of Square	DF	Mean Square	F-stat	P-value
Between Groups	2.03	2	1.02	1.336	0.28914
Within Groups	12.93	17	0.76		
Total	14.96	19			

Since the p-value is greater than the significance level (0.28914 > 0.05) and the F test statistic is less than the F critical value (1.336 < 4.2565), the null hypothesis cannot be rejected. There is sufficient evidence to conclude that all websites have the same mean of attractiveness.

3.1.2 Controllability

Controllability refers to the ease with which users can navigate a website and accomplish their intended tasks efficiently [17][18]. In this study, controllability was assessed using WAMMI questions 2, 7, 12, and 17. Shopee achieved the highest mean score of 4.14, with a standard deviation of 0.8997, indicating a relatively high level of user control satisfaction. Mudah followed with a mean score of 3.71 and a standard deviation of 1.1127, showing a moderate level of controllability. Besides, Lazada followed with a mean score of 3.5 and a standard deviation of 1.0488. A summary of website's controllability metric is presented in Table 8.

Table 8: Summary of controllability

Website	Mean	Standard Deviation	Standard Error
Shopee	4.14	0.8997	0.3401
Lazada	3.5	1.0488	0.4282
Mudah	3.71	1.1127	0.4206

Table 9: ANOVA table for controllabilty

Source	Sum of Square	DF	Mean Square	F-stat	P-value
Between Groups	1.42	2	0.71	0.678	0.52084
Within Groups	17.79	17	1.05		
Total	19.2	19			

Since the p-value is greater than the significance level (0.52084 > 0.05) and the F test statistic is less than the F critical value (0.678 < 4.2565), the null hypothesis cannot be rejected. This indicates that there is sufficient evidence to conclude that all websites have the same mean of controllability.

3.1.3 Efficiency

Efficiency refers to the ability of users to quickly locate the website they need and accomplish their tasks effectively[19]. In this study, efficiency was assessed using WAMMI questions 3, 8, 13 and 18. Shopee achieved the highest mean score of 4.17, followed closely by Lazada with a mean score of 4.29, indicating that users found both platforms efficient for their tasks. In contrast, Mudah recorded a lower mean score of 3.29, suggesting that users felt less efficient while navigating the site. The standard deviations were 0.9832 for Shopee, 0.7559 for Lazada and 1.1127 for Mudah, reflecting some variability in user experiences. A summary of websites' efficiency is presented in Table 10.

Table 10: Summary of effiecieny

Website	Mean	Standard Deviation	Standard Error
Shopee	4.17	0.9832	0.4014
Lazada	4.29	0.7559	0.2857
Mudah	3.29	1.1127	0.4206

Table 11: ANOVA table for efficiency

Source	Sum of Square	DF	Mean Square	F-stat	P-value

Between Groups	4.11	2	2.06	2.229	0.13814
Within Groups	15.69	17	0.92		
Total	19.8	19			

Since the p-value is greater than the significance level (0.13814 > 0.05) and the F test statistic is less than the F critical value (2.23 < 4.2565), the null hypothesis cannot be rejected. This indicates that there is sufficient evidence to conclude that all websites have the same mean of effiency.

3.1.4 Helpfulness

Helpfulness is defined as the degree to which a website meets user expectations in terms of content and structure[20]. In this study, helpfulness was assessed using WAMMI questions 4, 9, 14, and 19. Shopee achieved the highest mean score of 3.14, indicating a relatively high level of user satisfaction with the helpfulness of the site. Mudah had a mean score of 3.00, suggesting a moderate perception of helpfulness among users while Lazada followed with a mean score of 2.43. The standard deviations were 0.8997 for Shopee, 0.9759 for Lazada and 1.4142 for Mudah, highlighting some variability in user experiences. A summary of websites' helpfulness is presented in Table 12.

Table 12: Summary of helpfulness

Website	Mean	Standard Deviation	Standard Error
Shopee	3.14	0.8997	0.3401
Lazada	2.43	0.9759	0.3689
Mudah	3	1.4142	0.5773

Table 13: ANOVA table for helpfulness

Source	Sum of Square	DF	Mean Square	F-stat	P-value
Between Groups	1.98	2	0.99	0.818	0.45795
Within Groups	20.57	17	1.21		
Total	22.55	19			

Since the p-value is greater than the significance level (0.45795 > 0.05) and the F test statistic is less than the F critical value (0.818< 4.2565), the null hypothesis cannot be rejected. This indicates that there is sufficient evidence to conclude that all websites have the same mean of helpfulness.

3.1.5 Learnability

Learnability refers to how easily users can understand a website's functions and effectively use it[21]. In this study, learnability was assessed using WAMMI questions 5, 10, 15 and 20. Shopee achieved the highest mean score of 4.33, suggesting that users found it very easy to learn how to use the website. Lazada followed closely with a mean score of 4.00, indicating a strong performance in learnability. Mudah, however, received a mean score of 3.57, reflecting a moderate perception of learnability among users. The standard deviations for Shopee, Lazada and Mudah were 0.8165, 0.8165, and 0.5345, respectively, indicating some variability in user experiences. A summary of websites' learnability is presented in Table 14.

Table 14: Summary of learnability

Website	Mean	Standard Deviation	Standard Error
Shopee	4.33	0.8165	0.3333
Lazada	4	0.8165	0.3086
Mudah	3.57	0.5345	0.2020

Table 15: ANOVA table for learnability

Source	Sum of Square	DF	Mean Square	F-stat	P-value
Between Groups	1.91	2	0.96	1.795	0.19622
Within Groups	9.05	17	0.53		
Total	10.96	19			

Since the p-value is greater than the significance level (0.19622 > 0.05) and the F test statistic is less than the F critical value (1.795 < 4.2565), we fail to reject the null hypothesis. This indicates that there is not enough evidence to conclude significant differences in learnability means among the three websites, suggesting that users perceive the learnability of Shopee, Lazada and Mudah similarly.

3.2 Software-based usability evaluation Method

For the usability evaluation, the key performance parameters of each testing tool—page load time, page size, number of page requests, and overall performance score—were analyzed using an ANOVA test to assess whether there is a statistically significant difference in the usability metrics of Shopee, Lazada and Mudah. This test was conducted at a significance level of α=0.05. The following are defined for the test:

$\mu 1$: Mean of Shopee
$\mu 2$: Mean of Lazada
$\mu 3$: Mean of Mudah

The hypotheses for this test are as follows:

Null Hypothesis (H_0): $\mu 1=\mu 2=\mu 3$, indicating no significant difference in mean among the websites.
Alternative Hypothesis (H_1): At least one website has different mean.

The test was carried out with a sample size of 3 for each website, giving a between-group degrees of freedom (DF) of k-1= 3−1=2, and a within-group degrees of freedom (DF) of N-k=9−3=6, where N is the total number of samples. Thus, the total degrees of freedom was 8. Based on these values and a 0.05 significance level, the F critical value was determined to be approximately 5.1433.

3.2.1 Performance

Web performance is defined as the overall speed, responsiveness and smoothness of interactions on a website. The overall performance metric helps identify how quickly content appears and becomes usable for the user, essential in shaping positive user experience on a website[22].

In our study, Mudah achieved the highest mean score of 64.5, followed by Shopee and Lazada, each scoring a mean of 62. The respective standard deviations are 7.7782 for Mudah and 33.9411 for Shopee and Lazada. The smaller standard deviation in Mudah indicates a more consistent performance across trials compared to other websites. The scores are outlined in Table 16.

Table 16: Summary of website performance scores

Website	Mean	Standard Deviation	Standard Error
Shopee	62	33.94	24.01
Lazada	62	33.94	24.01
Mudah	64.5	7.78	5.5

Table 17: ANOVA table for performance

Source	Sum of Square	DF	Mean Square	F-stat	P-value
Between Groups	8.33	2	4.17	0.01	0.99502
Within Groups	2364.5	3	788.17		
Total	2372.83	5			

Since P-value of 0.99502 is greater than significance level of 0.05 while F test statistics of 0.01 is less than F critical value of 5.1433, the null hypothesis cannot be rejected. There is sufficient evidence to proof that all the websites have the same mean of performance.

3.2.2 Page size

Page size refers to the total data weight of a web page, typically measured in megabytes (MB), which directly affects loading speed and overall user experience[23]. Shopee shows the optimal page size among the three websites, with a mean of 2.64, a standard deviation of 0.5091. Lazada has a slightly higher mean page size of 2.65 with a standard deviation of 0.495, indicating moderate loading performance. In comparison, Mudah has the largest page size with a mean of 6.2 and a standard deviation of 0.4313, which may negatively impact loading speed and user experience. Generally, an efficient website typically maintains a lower page size for quicker load times and smoother user interaction. Table 18 presents a summary of page size metrics.

Table 18: Summary of page size metrics

Website	Mean	Standard Deviation	Standard Error
Shopee	2.64	0.5091	0.360
Lazada	2.65	0.4950	0.350
Mudah	6.2	0.4313	0.305

Table 19: ANOVA table for page size

Source	Sum of Square	DF	Mean Square	F-stat	P-value
Between Groups	16.8	2	8.4	36.53	0.00783
Within Groups	0.69	3	0.23		
Total	17.49	5			

Since the P-value of 0.00783 is less than the significance level of 0.05, and the F-statistic of 36.53 is greater than the F-critical value, the null hypothesis is rejected. This indicates that there is sufficient evidence to conclude that there is a significant difference in the mean page sizes among Shopee, Lazada and Mudah. The results suggest that the page size varies significantly across the three websites, with Shopee and Lazada having much lower page sizes compared to Mudah, which may contribute to better loading speed and user experience for Shopee and Lazada.

3.2.3 Load time

Load time is the duration required to fully download and render all resources on a web page, impacting user experience and site performance [24]. In our study, Shopee has the fastest mean load time of 3.6 seconds with a standard deviation of 2.6941, indicating consistent performance. Lazada has a longer mean load time of 10.4 seconds with a standard deviation of 12.1622, showing greater variability in loading speed. Mudah follows with a mean load time of 5.88 seconds and a standard deviation of 6.9579. Generally, shorter load times enhance performance and user satisfaction, making Shopee the most efficient among the three sites. Table 20 summarizes the load time metrics for each website.

Table 20: Summary of website load time

Website	Mean	Standard Deviation	Standard Error
Shopee	3.6	33.1061	23.4095
Lazada	10.4	12.1622	8.6000
Mudah	5.88	6.9579	4.9200

Table 21: ANOVA table for load time

Source	Sum of Square	DF	Mean Square	F-stat	P-value
Between Groups	47.97	2	23.99	0.353	0.72832
Within Groups	203.59	3	67.86		
Total	251.56	5			

Since the P-value of 0.72832 is greater than the significance level of 0.05, and the F-statistic of 0.353 is less than the F-critical value, we fail to reject the null hypothesis. This indicates that there is insufficient evidence to conclude a significant difference in the mean load times among Shopee, Lazada and Mudah. Therefore, we can conclude that all three websites have similar load times on average, although Shopee demonstrates a more consistent performance with a lower mean load time compared to Lazada and Mudah.

3.2.4 Requests

The number of HTTP requests represents the total interactions between a client and the server required to load a web page, impacting load efficiency and performance [25]. In this analysis, Shopee has the best performance with the lowest mean of requests at 97, accompanied by a standard deviation of 8.4853, which reflects stable and efficient request handling. Lazada has a higher mean request count of 332.5 with a standard deviation of 112.43, indicating more variability and potentially slower performance. Mudah's mean request count is 141, with a standard deviation of 12.7279, showing moderate performance. Generally, a lower number of requests correlates with faster load times and better user experience. Shopee's performance is highlighted as the most efficient in terms of request handling in Table 22.

Table 22: Summary of website's requests

Website	Mean	Standard Deviation	Standard Error
Shopee	97	8.4853	6
Lazada	332.5	112.43	79.5
Mudah	141	12.7279	9

Table 23: ANOVA table for page size

Source	Sum of Square	DF	Mean Square	F-stat	P-value
Between Groups	62712.33	2	31356.17	7.307	0.07029
Within Groups	12874.51	3	4291.5		
Total	75586.84	5			

Since the P-value of 0.07029 is greater than the significance level of 0.05, but the F-test statistic of 7.307 is greater than the F critical value of 5.1433, we find sufficient evidence to reject the null hypothesis. This suggests that there are significant differences in the mean number of HTTP requests among Shopee, Lazada and Mudah. Thus, the websites likely do not have the same level of performance in terms of request handling, with Shopee performing more efficiently than the others in this analysis.

4. CONCLUSION

Usability is the most critical feature of e-commerce websites, since it can directly shape users' experience and excitement while shopping. Thus, an intuitively designed keeps users interested in seeing more of the products and making their purchases, hence giving full satisfaction and creating customer loyalty. This study used the Website Analysis and Measurement Inventory(WAMMI) to find out the influence of some usability factors, such as attractiveness, controllability, efficiency, helpfulness and learnability on Malaysia leading e-commerce websites: Shopee, Lazada and Mudah. Despite Malaysia's e-commerce showing rapid growth these days, research regarding usability is still limited locally. The present study therefore fills this information gap, providing the very important insight to bring Malaysian e-commerce websites closer to meeting users' expectations of a more satisfying, efficient and enjoyable shopping experience. This can eventually bring about long-term improvement in customer loyalty, the establishment of Malaysia's digital economy, thus lay a strong foundation for a wider diffusion of user-centered design practices across the nation.

The study has also underlined the fact that usability is very critical in ensuring satisfaction and efficiency in e-commerce. Our detailed evaluations of Shopee, Lazada and Mudah showed important differences concerning the various aspects analyzed, regarding how well the studied portals meet users' needs in main areas such as visual appeal, ease of navigation, speed, and helpfulness.

This WAMMI-based user-centered evaluation thus puts Shopee at the top among the websites tested in particular for aspects of attractiveness, controllability and learnability, hence making it more engaging yet rather easier for users to navigate and learn. Lazada was averagely strong, yielding a good performance in terms of efficiency and controllability but less consistently than Shopee. Mudah shows an almost equal share of strengths and challenges and hence ranks lower in aspects that may affect user satisfaction, such as in attractiveness and learnability.

Furthermore, software-based analyses added to these insights that, while Shopee and Lazada maintain more optimized page sizes, increasing the likelihood of quicker loading times and smoother user experiences, Mudah does not. Thus, these findings put together would suggest that, out of the three platforms under study, Shopee has the friendliest user experience.

Overall, Shopee is the most usable e-commerce platform out of three tested, with the best performance regarding aesthetic and functional dimensions. Such a result underlines the importance of usability improvement policies that should be directed at simplifying the elements of the page, improving both visual appeal and navigation, resulting in a significant increase in e-commerce user engagement. Maybe a future direction could be to lead some specific usability improvements on these platforms, for the good not only of these sites but also serving as an example for other e-commerce platforms.

5. ACKNOWLEDGEMENT

This study was conducted as a part of individual assignment for the Human Computer Interaction (SECV2113) course under Universiti Teknologi Malaysia (UTM) in the 2024/2025 Semester 1.

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