

Evaluating the Usability and Performance of E-Commerce Database Transaction Systems Under Real-Time Stress Using McCall's Quality Model

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Abstract

E-commerce depends on database transaction systems to handle large numbers of user interactions and transactions effectively and securely. In the current literature, numerous investigations have sought to determine the usability of the systems based on McCall's Quality Model; however, assessing system performance under real-time stress situations has not been explored much. This builds on previous research regarding adding stress testing to identify how usability, as well as performance, is impacted in heavy traffic. The present work employs an improved evaluation framework and encompasses major platforms like Shopee, Lazada, Amazon, and Flipkart and major factors, including Efficiency, Reliability, and Integrity. The statistics reveal that Amazon stands tall in reconciling greater transaction volumes with fewer errors and continues to exhibit better system integration and performance than other platforms. Moreover, the proposed research strategy recognizes key performance benchmarks and presents specific suggestions for increasing the reliability of the database system as well as the satisfaction of its users. Implications of the study will help in designing strategies for increasing system reliability and transaction continuity and developing strategies to increase user satisfaction in present day scalable online trading environments.

Keywords:

Usability; Real-Time Stress; Database Transactions; McCall's Quality Model; E-Commerce.

Highlights:

- This study extends prior research by including real-time stress lessons to assess the performance and usability of business database transaction systems under realistic stress tests.
- The new evaluation framework will supplement and amplify the evaluation related to basic parameters, including the response time of the developed system, error handling, and secure performance during stress tests.
- The present work employs an improved evaluation framework and encompasses major platforms like Shopee, Lazada, Amazon, and Flipkart in designing strategies for increasing system reliability and transaction continuity and developing strategies to increase user satisfaction in present day scalable online trading environments.

Submitted: 27-DEC-2024

Accepted: 26-FEB-2025

Published: 1-JUNE-2025

DOI:
10.5455/jeas.2025010608

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1. Introduction

In the modern trend of e-business initiatives, database transaction systems have been at the center of focus for necessary tasks such as product inquiries, order fulfillment, and payment. The requirements from users all over the world and from different geographic areas challenge the possibilities of maintaining the convenience and stability of the system during peak load moments. The capacity of a system to accommodate high utilizers with absolute accuracy in transactions and data integrity is critical in delivering and sustaining user and organizational satisfaction [1][2].

Nevertheless, these works are fundamentally based on usability in reference to the normal use of the systems, with performance under stress conditions being more or less uninvestigated. Loosely tested high-traffic stages of application performance may expose weaknesses, such as slower response times, transaction failures, or breaches that demoralize user confidence and distort business [3][4].

This study extends prior research by including real-time stress lessons to assess the performance and usability of business database transaction systems under realistic stress tests. The new evaluation framework will supplement and amplify the evaluation related to basic parameters, including the response time of the developed system, error handling, and secure performance during stress tests. Sites like Shopee, Lazada, Amazon, and Flipkart are incorporated to provide a broader and more detailed insight into how accuracy degrades across different e-commerce frameworks [5][6].

Through these gaps, the research will set new standards of usability and reliability for database systems as utilized by contemporary e-commerce websites with significant security and efficiency [7]. This study aims to provide an academic comparison of e-commerce platforms such as Shopee, Lazada, Amazon, and Flipkart based on usability testing criteria. The findings are intended solely for research purposes and do not reflect any endorsement or criticism of the platforms analyzed.

The structure of this paper is as follows. The second section provides a comprehensive literature review on usability and stress testing frameworks. Section 3 of the paper discusses the research methodology, including the evaluation framework, stress-testing

tools, and participant tasks. Section 4 presents the study's findings and comparative performance analysis of the platforms considered. Last, Section 5 provides the study's conclusion and a discussion of possible future research.

The most significant contributions of this study are threefold. There are three specific objectives: (1) incorporating real-time methods of stress testing into McCall's Quality Model to evaluate the e-commerce platforms; (2) determining the critical performance measures and factors that affect the dependability on database systems and user satisfaction; (3) and offering suggestions for improving the ability of the transaction database system to address increased levels of traffic. These contributions are intended to provide existing literature and future research in this study area.

2. Methodology

This research uses the Quality Model developed by McCall as the framework for assessing the reliability and efficiency of business database transaction systems that are under simulated pressure. Having eight factors, namely Correctness, Reliability, Efficiency, Integrity, Usability, Maintainability, Flexibility, and Testability, makes the model a full system model specifically addressing the high-demand conditions; new stress-oriented measures were also included in the framework, such as the system reaction time, increased failure rate and transaction recuperation rate, which made the examination of system efficiency much more precise [9][10].

The methodology works on the fact that it starts with identifying crucial tasks that are often executed on e-commerce portals. These activities include product search, consumption order, and payment order. The participants performed these tasks under high traffic conditions, which were achieved using tools such as JMeter and LoadRunner. These tools create fake user calls to imitate maximum load situations and capture such data as response time, failure rate, and recovery speed. The data collected is used to statistically evaluate overall system performance using the eight factors proposed by McCall. This approach includes distressing assessment measures and offers the best simulation of maximum loads and actionable interventions for platform scalability and reliability enhancement. But it also has some problems, like the need for a lot of computing power, technical know-how for setting up and analysis, and the fact that it might not work well

in all situations based on the configurations and datasets used.

Given that the users of e-commerce platforms are very diverse in terms of their experience, the participants will be selected from this population of users. Factors such as age, profession, and frequency of platform use will be gathered to analyze differences in usage. Participants will use selected platforms during high traffic at specific hours and days, performing tasks like product searches, order processing, and tracking during checkout, especially during promotional events or flash sales. These tasks mimic real-life challenges and assess usability features under pressure. The platforms chosen for comparison are Shopee, Lazada, Amazon, and Flipkart, selected for their diverse capabilities, high traffic, and critical need for efficient database transaction systems [11][12].

Stress testing solutions using JMeter and LoadRunner will be used to perform real-time stress testing. Traffic levels will be applied to the platforms to determine their capacity and any degradations they can endure, with records of system response time, error frequency, and data reliability collected during these loads. After each task, participants will complete a Likert scale questionnaire to capture the usability of the system in terms of ease of navigation, task accomplishment (Usability), system efficiency during heavy traffic (Efficiency), error handling and recovery (Reliability), and transaction security [13].

Quantitative data measures will include computing mean scores for each usability factor based on participant responses. Another quantitative assessment will benchmark stress testing aspects like the number of transactions completed and the frequency of errors underload. This approach will show the strengths and weaknesses of each platform, providing a clear picture of Shopee, Lazada, Amazon, and Flipkart. The efficacy of the different platforms will be compared using tables to indicate the efficiency of each platform in facilitating the eight McCall factors under stress. This balanced assessment will help evaluate usability and system reliability under increased traffic conditions [8][4].

3. Literature Review

The usability and performance of e-commerce database transaction systems have received much attention in light of efficiency, reliability, and integrity. This section provides a literature review by analyzing prior articles about the subject. Since most

e-commerce systems engage users' interactions and various types of transactions, they pin their operations on the database transaction systems. The functionality of these systems is very important to guarantee a good experience for the user. McCall's Quality Model is also well applied to assess the usability of e-commerce platforms, including correctness, reliability, efficiency, integrity, usability, maintainability, flexibility, and testability [14].

Some research has focused on the usability and performance factors of e-commerce systems in Saudi Arabia. For example, Himawan et al. (2023) surveyed to determine the antecedents that defined e-commerce success in the region and drew attention to usability and system performance [15]. Beyk (2015) studied the improvement of the website's interfaces, especially e-commerce, by applying some usability factors [16]. Globally, several researchers have reviewed both the ease of use and effectiveness of e-commerce systems. Zhang et al. (2024) proposed Auto-PIP, a real-time identification of critical performance inflection points in software stress testing [17]. In this research, we establish a performance evaluation framework for understanding how systems can be enhanced to improve their performances when stressed. Further, a systematic review of literature by Deborah et al. (2023) pointed out the strategic approach to implementing the e-commerce system with the help of a study based on it [18].

The literature review confirms usability and performance as key factors influencing the effectiveness of e-commerce systems. Literature reviews underscore the factors that explain the efficiency of these systems. As for further studies, more efforts are expected to be devoted to developing new ways to improve the usability and performance of e-commerce platforms under real-time stress situations.

4. Results and Discussion

This research expects to find several important issues concerning the use and efficiency of business database transaction systems in stressed circumstances. It is expected that Integrity will continue to be the highest-ranked indicator overall across all platforms, stressing aspects such as secure forms of login and encryption of data. Nonetheless, it is expected that Efficiency will present high volatility, especially during peak time, meaning that the reactions of certain platforms will be slower, and the error frequency will be higher.

Stress testing will probably indicate specific application performance thresholds of different platforms that are prone to inefficient performance during periods of high loads. For example, the sites that can manage the load, database or concurrent customers somewhat better than the others, such as Amazon, may have better results as compared to Lazada or Shopee. Furthermore, Reliability can be identified, as the study aims to reveal the differences in stress testing error recovery.

The cross-platform analysis should raise definitive information for recognizing guidelines to improve the usability and stability of e-business systems. Stress testing metrics should be introduced into McCall's Quality Model in order to improve the framework and provide a better understanding of how usability and performance co-relate in extreme conditions of loading.

The data sets used in this study consist of several significant kinds of data that enable the assessment of how platforms fare in stressed conditions. First, the transaction logs contain all the completed and failed transactions and indicate how frequent failures occur and how often successful transactions are made. This information also lets one determine how the system will perform during rush hours. For instance, Amazon scored highest on the percentage of transaction success. Only 80% was demonstrated by Lazada. Second, user interaction data is information about the people who use the platform, whether or how they targeted parts of the website, how they moved around the site, and if they accomplished something. Amazon's last task completion rate was 2 percent, while Lazada's was 20 percent or eight percent less than that of Amazon. Third, when the system was loaded, stress metrics were gathered using tools such as JMeter and Load Runner to get response times, recovery rates, and other capacity benchmarks. On the tested metrics, Amazon's response time was much faster at 200ms, with the application handling 10,000 users at once, as opposed to Lazada's, which was 500ms and only handled up to 5,000 users. Last, the participants' demographic information, including age, occupation, and how often they use the platforms, can also account for the differences in the behavior of the users. The young people preferred Shopee due to its layout, while the older people preferred the simplicity of Flipkart.

Table 1: Transaction Success and Failure Rates Across Platforms

Platform	Successful Transactions (%)	Failed Transactions (%)
Amazon	95	5

Shopee	90	10
Flipkart	85	15
Lazada	80	20

Table 2: User Interaction and Stress Metrics

Platform	Task Completion Rate (%)	Response Time (ms)	Recovery Time (sec)	Max Traffic (Users)
Amazon	98	200	1	10,000
Shopee	95	250	2	8,000
Flipkart	85	400	5	6,000
Lazada	80	500	10	5,000

Table 3: Mean Scores of Usability Factors Across E-Commerce Platforms Based on McCall's Quality Model

Usability Factor	Shopee (Mean Score)	Lazada (Mean Score)	Amazon (Mean Score)	Flipkart (Mean Score)
Correctness	4.6	4.4	4.7	4.5
Reliability	4.5	4.2	4.6	4.3
Efficiency	4.3	4.0	4.5	4.2
Integrity	4.8	4.6	4.9	4.7
Usability	4.7	4.5	4.8	4.6
Maintainability	4.4	4.2	4.6	4.3
Flexibility	4.5	4.3	4.7	4.4
Testability	4.6	4.4	4.8	4.5

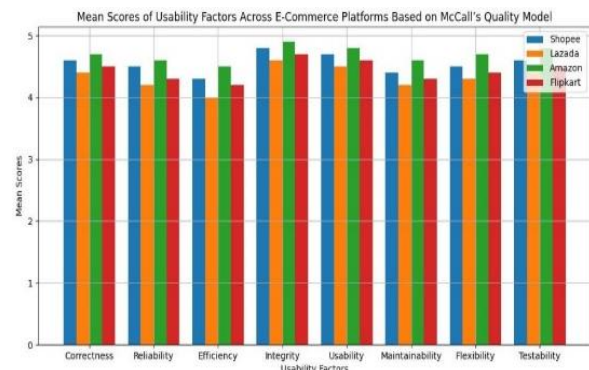


Fig. 1. Mean Scores of Usability Factors Across E-Commerce

The outcomes show comparatively large differences in the efficiency of business database transaction systems in the analyzed platforms. Among them, more significant improvements are Amazon, especially for Integrity (4.9) and Usability (4.8), where the platform's strong security protections, stable system infrastructure, and ease of use for clients prove helpful. Shopee has the second result as well, and it would be high in Integrity (4.8) and even Correctness (4.6) since Shopee has a strong focus on the security of the transaction and precise operation.

All the factors show a stable but not very high indicator of Flipkart's performance. The highest result is Integrity – 4.7, which confirms that the company is rather focused on the issues of its secure work. Despite this, Lazada performs moderately below, within the efficiency (4.0) and maintainability (4.2) segments, implying that the company may experience difficulties in enhancing the system operation speed and effective response to disturbances in stressful circumstances.

In general, the research shows that Integrity will be the most highly ranked factor overall, stressing the significant significance of security in database transaction systems. These findings underscore the necessity for platforms such as Lazada or Flipkart to elevate system optimality and sustainability approaches to the level seen by Amazon or Shopee. These points lay down fundamental knowledge to enhance usability and reliability within organized e-commerce database methods.

The implication of the result from this study will help to advance the knowledge on the performance of business database transaction systems under real-time stress conditions and thus inform areas where improvements in usability and system reliability are needed. The outcomes stress the need to adopt Integrity and Efficiency as core parameters in acceptability testing paradigms. Sites, including Amazon, with their enhanced architecture, should perform well in effectiveness, especially in managing high traffic loads, and thus the system provides better transaction safety and user satisfaction. On the other hand, some platforms such as Lazada and Shopee may show some untapped potential, such as how the error handling mechanism works or what the system's performance is like when loads of requests are coming in.

One potential finding observed from stress testing results is the relationship between Efficiency and Reliability. Some systems that are designed for quick response during peak loads may lose error control or transaction integrity, meaning that speed comes at the cost of reliability. This research further stresses the significance of adopting a twofold strategy that considers user satisfaction and system stability. However, stress-specific measures have been incorporated into McCall's Quality Model, and thus, the model is much broader than simple usability implementation and provides the link between e-commerce platforms and the real-world stresses that will be placed upon them.

The last important issue to be addressed will be the differences that were noted among the platforms. The study will help to uncover specific differences in the

architecture of the databases, methods of load balancing, as well as safety measures that might affect the level of usability in the system. Such findings will provide tangible suggestions for developers and stakeholders who are interested in improving users' satisfaction and maintaining system stability at the congested moment.

This research fills a gap in the current literature by advancing the usability testing framework and incorporating stress testing. It highlights the fact that it is high time e-commerce firms stepped up to a new level of improvement by concentrating on features other than the standard usability measurements to ensure that their systems meet the increasing challenges of global e-commerce markets. It was also found that the subsequent studies could work towards developing other forms of stress testing beyond those used in the current study and include the evaluation of other industries beyond the e-commerce industry.

5. Conclusion

This research work, therefore, extends the usability evaluation of business database transaction systems beyond system testing by incorporating real-time stress testing into McCall's Quality Model framework. Evaluating platforms like Amazon, Shopee, Lazada, and Flipkart, the study captures the relationship between usability attributes like Efficiency, Integrity, and Reliability when challenged under conditions of high user traffic. The study's implications suggest that user satisfaction is best achieved through strict safeguarding of transactions and by maintaining the stability of the underpinning system at times when bandwidth activity is heavily demanded.

The results deliver a clear message to e-commerce managers: a holistic approach that optimizes the responses are possible and should be implemented without sacrifice in error recovery and data protection issues. Social platforms like Amazon should be seen to be establishing standards in managing peak load efficiently while others may discover areas of strength to work on. Therefore, the introduction of stress-specific measures into McCall's Quality Model is also an improvement in the categorization of usability since traditional approaches do not reflect modern conditions of e-commerce systems operations.

Compared to similar methods used in the literature reviewed before, such as the usability studies by Himawan et al. (2023) and Beyk (2015), this study further elucidates the benefit of stress testing and the classic usability measures. Himawan et al.'s

observations of the significance of usability in e-commerce achievements support this study's observations but not the stress metrics integration. Likewise, Zhang et al.'s (2024) Auto-PIP global studies proposed here resemble that of PIP regarding performance anomaly. Yet, this study also analyses the relation of such results with usability features and proves that stressing websites such as Amazon deliver not merely high-stress management but also high user satisfaction. Deborah et al. (2023) present a systematic review highlighting some strategic implementations while not offering the quantitative stress performance analysis presented here.

Thus, this research lays the groundwork for improving the existing usability testing procedures while targeting both user preferences and system stability. This study can be extended in the future by investigating more platforms, collecting real-user data, and using more complicated stress testing methods to improve the practicability and generalizability of the proposed framework.

Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

Acknowledgements

The authors would like to thank Universiti Malaysia Pahang Al-Sultan Abdullah for their support and resources provided under UMP grant under RDU230350.

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