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RESEARCH ARTICLE

Performance efficiency for Spec-Tacular: Laptop recommendation system

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ABSTRACT – The "Spec-Tacular: Laptop Recommendation System" is an advanced solution designed to streamline and enhance the laptop purchasing process for consumers. In an era marked by rapid technological advancements and numerous options, selecting the ideal laptop can be daunting. This system employs sophisticated artificial intelligence (AI) and rule-based algorithms to deliver personalized laptop recommendations tailored to individual user preferences and specifications. By analyzing user input, the system curates a list of suitable laptops to ensure each recommendation aligns with the user's unique needs. Additionally, it integrates recommendations for trusted retailers and a comprehensive comparison tool to address challenges related to finding reliable sellers and comparing different models effectively. With its user-friendly interface and dynamic suggestions, the "Spec-Tacular" system aims to minimize preference uncertainty, bolster decision-making confidence, and elevate overall customer satisfaction. This approach not only simplifies the selection process but also establishes a dependable platform for consumers to make well-informed laptop purchases in a competitive market. Performance efficiency, particularly in terms of response speed and task completion time, has been a focal point of this system, ensuring prompt responses and maintaining seamless performance under varying user demands.

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1. INTRODUCTION

In today's technologically advanced society, selecting an appropriate laptop can be a daunting task. Our "Spec-Tacular: Laptop Recommendation System" addresses this challenge by utilizing sophisticated artificial intelligence (AI) and rule-based algorithms to deliver tailored recommendations. By analyzing user preferences and interactions, the system offers personalized brand suggestions and helps users locate nearby stores via Google Maps integration. Additionally, it enables users to compare laptop specifications side-by-side and engage in forums to connect with peers. This platform is designed to streamline the laptop selection process, making it both user-friendly and informative. The importance of laptops in higher education is well-documented, with these devices being among the most utilized and essential technological tools for students (Kay & Lauricella, 2016). By providing a means for making well-informed purchasing decisions, our system aims to mitigate the risk of post-purchase dissatisfaction. The difficulty of buying a laptop is exacerbated by the overwhelming number of options, differing opinions, and lack of detailed knowledge about features and specifications. Traditional research methods often yield incomplete or inaccurate information, which may lead to confusion and poor decisions. Preference uncertainty further complicates the process, as many consumers are unsure of their specific needs (McShane, Bockenholt, & Chernev, 2024). Moreover, finding trustworthy retailers is a challenge, with online scams on the rise (Mokhsin, Aziz, Zainol, Humaidi, & Zaini, 2018) and the lack of centralized, reliable store recommendations. On top of that, most websites lack comparison tools and only offer products from specific brands, making it hard for users to evaluate and compare laptops from various manufacturers comprehensively.

Our "Spec-Tacular: Laptop Recommendation System" solves these problems by offering a centralized, reliable platform that simplifies the laptop buying process. It uses advanced AI and rule-based algorithms to provide personalized suggestions based on individual preferences, reducing confusion from too many options. The system also helps users find trustworthy nearby stores using Google Maps, reducing the risk of online scams. With robust comparison tools, users can evaluate specifications side-by-side across different brands, helping them make more informed decisions. Additionally, user forums allow for sharing experiences and gaining insights. This ensures a seamless, secure, and informed laptop purchasing experience. Our "Spec-Tacular: Laptop Recommendation System" not only aims to revolutionize the laptop selection process but also adheres to the principles of good governance and integrity emphasized by the Journal of Governance and Integrity (JGI). By embedding ethical guidelines and responsible data management practices, our platform ensures transparency and trustworthiness, essential elements in today's digital marketplace. The system's design and functionality incorporate robust measures for risk management and IT-related governance, ensuring compliance with high standards of security and privacy. This commitment to governance and integrity not only enhances user confidence but also aligns with JGI's dedication to promoting ethical conduct, sustainability, and responsible innovation in technology and business.

Various quality attributes are essential for producing a high-quality software product, one of which is performance efficiency ("ISO 25000 Portal," 2024). Performance efficiency emphasizes how effectively a system uses its resources to achieve desired outcomes. There are three sub-characteristics for calculating performance efficiency: time behavior, resource utilization, and capacity (Yuniasri, Damayanti, & Rochimah, 2020). For the "Spec-Tacular: Laptop

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Recommendation System," the most relevant sub-characteristic is time behavior. Time behavior refers to how quickly the system is able to respond to user requests with timely responses and efficient task processing. These qualities are crucial for ensuring the Spec-Tacular system delivers prompt recommendations and maintains seamless performance under varying user demands.

2. LITERATURE REVIEW

Performance efficiency is a critical quality attribute in software development. Basically, it emphasizes how effectively a system uses its resources to achieve desired outcomes. This review examines the performance efficiency of three prominent websites: NB Plaza, BestBuy IT Mall, and Lenovo's official website. NB Plaza offers a wide range of laptops with detailed specifications but struggles with performance efficiency. Slow response times during peak hours indicate an issue with time behavior, and its limited capacity leads to occasional slowdowns and user frustration. While comprehensive, its lack of optimization for high performance affects the overall user experience. Best Buy IT Mall is known for its extensive inventory and competitive prices. It performs relatively well in terms of time behavior and quick responses. However, during sales events or high-traffic periods, its capacity to handle multiple transactions sometimes results in slower performance. Optimization measures, such as load balancing and caching, have been implemented, but there is still room for improvement. Lenovo's website demonstrates strong time behavior with rapid response times. It is also able to manage high volumes of traffic and transactions well. Advanced infrastructure management and resource allocation techniques allow Lenovo's website to maintain consistent and reliable service even during peak periods, setting a high standard for performance efficiency.

3. RESEARCH METHODOLOGY

A dew method was used to analyze the performance efficiency of the Spec-Tacular: Laptop Recommendation System. The performance efficiency was measured based on ISO/IEC 25010.

A. Block Diagram

This study evaluated the performance efficiency of the Spec-Tacular system. The steps required to conduct this experiment are explained in the experiment block diagram, as shown in Figure 1. Based on the block diagram above, we took a few steps to achieve our goal in this study.

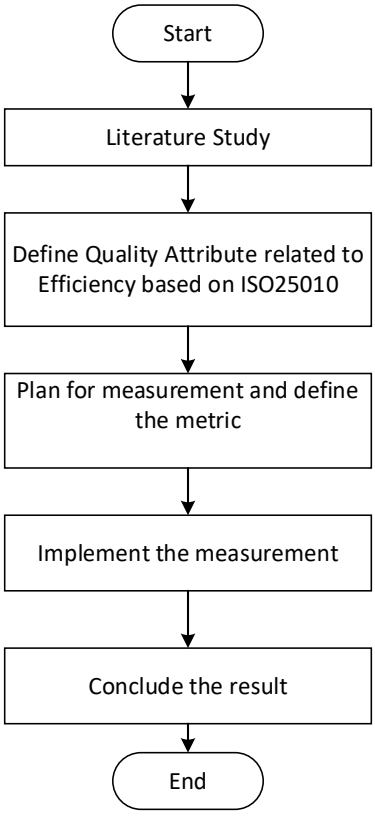

Figure 1. Block diagram

The first step was to conduct a literature review related to existing websites and their performance. Then, we defined a set of sub-characteristics that are related to performance efficiency, which are time behavior, resource utilization, and capacity. However, the most relevant sub-characteristic of the Spec-Tacular system was time behavior. Then, we planned the measurements for the performance efficiency. After we finished the planning, we tested the sub-characteristic to evaluate

the Spec-Tacular system and made the necessary calculations based on the performance efficiency metric. From the evaluation results, the conclusion can be defined and used as a reference for future studies.

B. Time Behaviour

Time behavior measures an application's ability to react to different events over time. It encompasses the duration required for the application to perform particular actions, such as loading a page, running a query, or processing a transaction (Lee, 2023). Time behavior is a crucial aspect of performance testing because it helps identify potential bottlenecks and performance issues within an application. By measuring the application's response time across various scenarios, performance engineers can pinpoint specific areas that cause delays and need improvement. This detailed analysis enables developers to optimize the application's performance, enhancing its overall efficiency and user experience. In this analysis, baseline performance testing and load testing were conducted to determine the system performance under different conditions. Throughout both tests, response times under normal operating conditions were closely monitored. All results were then meticulously recorded and analyzed to draw meaningful conclusions about system behavior under varying load levels.

C. Metric

Some metrics need to be used to evaluate time behavior for performance efficiency, especially to calculate the response time and latency for baseline performance testing. The first metric used was response time. Response time is the total time taken for the system to respond to a user request or action. This parameter was measured in milliseconds (ms) or seconds(s).

$$Response\ Time\ =\ Time\ of\ Response\ -\ Time\ of\ Request \tag{1}$$

The second metric is latency, which measures the delay between the initiation of a request and the beginning of a response. It is measured in milliseconds (ms) or seconds (s).

$$Latency\ =\ Time\ of\ Response\ Start\ -\ Time\ of\ Request\ Sent \tag{2}$$

Average response time represents the mean of all response times measured during a performance test. It serves as a key indicator of the application's response time across simulated user interactions or transactions.

$$Average\ Response\ Time\ =\ \frac{\sum Response\ Time}{Number\ of\ Sample} \tag{3}$$

To measure performance efficiency, test cases that encompass key user interactions with the laptop recommendation module were created. By running these test cases, data to evaluate the system's time behavior and overall performance efficiency was obtained.

Table 1. Test case

Test Case ID	TCON-400
Objective	Evaluate the performance efficiency of the managed laptop module
Quality	Performance Efficiency
Input	Users should be able to view laptops, filter laptops, compare laptops, add laptops to the collections, view laptop collections, and make laptop recommendations.

Table 1 shows the test case to evaluate the system's time behavior. The manage laptop module was used for baseline performance testing and load testing. Each test was closely monitored to obtain accurate data for measurement.

4. RESULTS AND DISCUSSION

The result of the time behavior for managing laptop modules is discussed in this section. The baseline performance testing and load testing were executed, and their response time, average response time, and latency were calculated.

Table 2. Test case

Test Case ID	TCON-400
Objective	Evaluate the performance efficiency of the managed laptop module
Quality	Performance Efficiency
Input	Users should be able to view laptops, filter laptops, compare laptops, add laptops to the collections, view laptop collections, and make laptop recommendations.

Based on the test case, users should use the manage laptop function. Then, the time of response, time of request, time of response start, and time of request sent are recorded. The result of the test case for baseline performance testing, which is the test where the system is in normal condition, is shown in Table 3.

Table 1. Result for baseline performance testing

Test Condition	Element	Time of Request	Time of Request Sent	Time of Response Start	Time of Response	Response Time (ms)	Latency (ms)
TCON-401	View list of Laptop	10:00:00.100	10:00:00.105	10:00:00.350	10:00:00.410	310ms	245ms
TCON-402	View Laptop information	10:01:00.250	10:01:00.255	10:01:00.450	10:01:00.500	250ms	195ms
TCON-403	Filter list of laptops	10:02:00.200	10:02:00.205	10:02:00.500	10:02:00.560	360ms	295ms
TCON-404	Compare laptop	10:03:00.300	10:03:00.305	10:03:00.500	10:03:00.550	250ms	195ms
TCON-405	Add a laptop to the collection	10:04:00.250	10:04:00.255	10:04:00.400	10:04:00.450	200ms	145ms
TCON-406	View laptop collection	10:05:00.150	10:05:00.155	10:05:00.400	10:05:00.460	310ms	245ms
TCON-407	Laptop recommendation	10:06:00.400	10:06:00.405	10:06:00.950	10:06:01.000	600ms	545ms
TCON-408	Cancel laptop recommendation	10:07:00.500	10:07:00.505	10:07:00.750	10:07:00.810	310ms	245ms

Table 2 shows that all users were able to perform all elements in the order management module. Based on the results, the average response time can be calculated using Eq. 3. The figure below shows the calculation process:

$$Average\ Response\ Time\ = \frac{310 + 250 + 360 + 250 + 200 + 310 + 600 + 310}{8}$$
$$Average\ Response\ Time = 323.75 \quad (4)$$

The result of the test case for load testing, which was the test where the load was increased, is shown in Table 4.

Table 2. Result for load testing

Test Condition	Element	Time of Request	Time of Request Sent	Time of Response Start	Time of Response	Response Time (ms)	Latency (ms)
TCON-401	View list of laptop	10:00:00.100	10:00:00.105	10:00:00.450	10:00:00.510	410ms	345ms
TCON-402	View laptop information	10:01:00.250	10:01:00.255	10:01:00.500	10:01:00.550	300ms	245ms
TCON-403	Filter list of laptops	10:02:00.200	10:02:00.205	10:02:00.650	10:02:00.730	530ms	445ms
TCON-404	Compare laptop	10:03:00.300	10:03:00.305	10:03:00.550	10:03:00.600	300ms	245ms
TCON-405	Add a laptop to the collection	10:04:00.250	10:04:00.255	10:04:00.450	10:04:00.500	250ms	195ms
TCON-406	View laptop collection	10:05:00.150	10:05:00.155	10:05:00.500	10:05:00.560	410ms	345ms
TCON-407	Laptop recommendation	10:06:00.400	10:06:00.405	10:06:01.350	10:06:01.400	1000ms	945ms
TCON-408	Cancel laptop recommendation	10:07:00.500	10:07:00.505	10:07:00.850	10:07:00.910	410ms	345ms

Table 4 shows that all users were able to perform all elements in the order management module. Based on the results, the average response time can be calculated using Eq. 3. The figure below shows the calculation process:

$$Average\ Response\ Time = \frac{410 + 300 + 530 + 300 + 250 + 410 + 1000 + 410}{8}$$
$$Average\ Response\ Time = 451.25 \quad (5)$$

Comparison for baseline performance testing and load testing:

Average Response Time (Baseline Testing) = 323.75
Average Response Time (Load Testing) = 451.25

From the average response time, it can be observed that the average response time increased. The calculation below shows that the percentage increase from baseline to load testing:

$$Increase\ Response\ Time = 451.25ms - 323.75ms = 127.50ms$$
$$Percentage\ Increase: \frac{127.50ms}{323.75ms} \times 100 \approx 39.38\% \quad (6)$$

The comparison made showed that the system's average response time increased as it transitioned from baseline testing to load testing. This is expected as load testing simulates real-world usage with multiple concurrent users, which can introduce additional latency and processing time. The increase in response time highlights areas that may need optimization to ensure the system can handle expected loads efficiently.

5. CONCLUSION

The "Spec-Tacular: Laptop Recommendation System" is an innovative solution designed to simplify and enhance the laptop purchasing process for consumers by leveraging AI and rule-based algorithms. The primary objective of this system is to provide personalized and accurate laptop recommendations based on user preferences and specifications, thus addressing the common challenges of selecting the right laptop in a market flooded with numerous options and varying opinions. The system's performance efficiency, particularly in terms of time behavior, has been critically evaluated. Time behavior, a sub-characteristic of performance efficiency, focuses on the system's ability to respond promptly to user requests, which is essential for maintaining a seamless and satisfactory user experience. Through a detailed methodology involving baseline performance testing and load testing, the system's response times under normal and high-load conditions were measured. The results indicated an increase in average response time from 323.75 ms during baseline testing to 451.25 ms during load testing. There are a few ways to improve the response time. One way is to enhance database performance. To achieve noticeable improvements, measures such as query rewriting, schema optimization for efficient object grouping, and ensuring proper database utilization are recommended.

In conclusion, the "Spec-Tacular: Laptop Recommendation System" successfully addresses the complexities of laptop selection by providing a reliable and user-friendly platform. Its ability to deliver personalized recommendations, coupled with its robust performance efficiency, positions it as a valuable tool for consumers looking to make informed laptop purchases. Furthermore, by integrating the principles of good governance and integrity, as emphasized by the JGI, our system ensures ethical practices and transparency in its operations. This alignment with JGI's values enhances user confidence and promotes responsible innovation in technology. Future improvements should focus on optimizing the system's performance, particularly in database efficiency, to maintain its efficacy under varying user demands. These efforts will ensure consistently high-quality user experience while upholding the standards of governance and integrity, reinforcing our commitment to ethical and sustainable technological solutions.

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AUTHORS CONTRIBUTION

Ahmad Kholid Khuzaini (Methodology, Experiment, Writing draft, Resources)

Roslina Mohd Sidek (Conceptualziation, Review and Editing, Supervision)

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