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Meta-Analysis and Investigation of Usability Attributes for Evaluating Operating Systems

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Abstract

This relative study searches into the usability attributes of operating systems (OS) and inspects their severe effect on digital reciprocate and user consultation. The research directed unidentified, prime concern user-friendliness, orderliness, and ease of access as critical elements for a smooth user experience. The all-around evaluation surrounds user interface (UI) design, chart reading easiness, ease of access, orderliness, design evenness, adaptability, user experience curve, fault handling, and task performance. The detection is met through a survey-based approach involving solitary from software houses, providing an integrated understanding of how these attributes collectively donate to the usability of an operating system at first. A questionnaire was used to assess the satisfaction level of usability of an operating system, revealing its effectiveness in allowing users to utilize all modules and answer quiz questions effectively. This study contributes to the continuing discourse on usability, recommended for accessible, methodological, and adaptable operating systems in the energetic digital environment. Secondly, a Meta-analysis will be conducted on the dataset collected after performance-based activity on different university campuses and simulated results will be produced that show relationships between attributes and usability. In the end, specific recommendations for developing operating systems are proposed on behalf of survey-based analysis and Meta-analysis.

Keywords: *Meta-analysis, usability evaluation, Operating system analysis, effectiveness, user-centric OS.*

1. Introduction

Operating systems (OS) are the cornerstone of our digital interactions, profoundly shaping how we engage with our devices. Ensuring the utmost user-friendliness, efficiency, and accessibility in these systems is essential for creating a smooth and enjoyable user experience (Short, n.d.). A comprehensive evaluation of usability attributes within an OS offers invaluable insights into user interactions, guiding the evolution of these foundational systems.

In this exploration, we delve into an exhaustive assessment of usability attributes, each playing a pivotal role in creating a user-centric OS. From the design and aesthetics of the

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user interface (UI) to navigation ease, accessibility, efficiency, and design consistency, these attributes directly impact users' digital interactions. Additionally, we delve into the OS's adaptability, user learning curve, error handling, and task performance capabilities (What Is User Interface (UI) Design?, n.d.).

Efficiency, response time, and the quality of feedback are vital aspects influencing the overall user experience. Moreover, we scrutinize user support and documentation, security measures, multitasking capabilities, and the effectiveness of file management tools. We also assess the ease of installation and updates, resource management, compatibility with various hardware and software, and adaptation to user preferences as essential usability attributes (Bruno & Al-Qaimari, n.d.).

Our examination includes the availability of user feedback mechanisms and customer support, acknowledging the crucial role of user input in OS development. Battery life optimization for portable devices and the usability of data backup and restore features add another layer of complexity to the usability attributes we will explore (Patayon & Mingoc, 2019).

Through this comprehensive analysis, we aim to provide a holistic understanding of how these attributes collectively shape the usability of an operating system. The insights derived from this endeavor offer valuable guidance to users for informed OS decisions and provide developers and designers with essential feedback for enhancing the user experience in the dynamic digital landscape. This contribution advances the ongoing discourse on usability, fostering user-friendly, efficient, and accessible operating systems for all.

1.1. Usability Attributes

Usability attributes are characteristics that define how user-friendly, efficient, and effective a system or interface is, encircle design, accessibility, performance, and support, among other critical factors.

- User Interface (UI) Design: Evaluation of the visible design and intensive of the interface.
- Ease of Navigation: Evaluation of how easily users can negotiate through the system.
- Accessibility: Measurement of the OS's comprehensiveness towards users with disabilities.
- Efficiency: Assessing how quickly users can accomplish everyday tasks.
- Consistency: Assessment of the consistency in design and interaction patterns.
- Customizability: Examination of the degree to which users can personalize the system.
- Learnability: Determination of how quickly new users can become experts with the OS.
- Error Handling: Assessment of the OS's effectiveness in dealing with user errors.
- Task Performance: Measurement of how well the OS supports task completion.
- Response Time: Evaluation of the system's speed in responding to user actions.
- Feedback: Assessing the effectiveness and helpfulness of the system's feedback.
- User Support and Documentation: Evaluation of the availability and quality of assistance resources.
- Security: Assessment of the security features and ease of use in the OS.
- Multitasking: Measurement of the OS's capability to handle concurrent tasks.

- File Management: Evaluation of the effectiveness of the system's file management tools.
- Installation and Updates: Assessment of the ease of system installation and updating processes.
- Resource Management: Evaluation of the way the operating system handles system resources like the CPU and memory.
- Compatibility: Evaluation of the OS's compatibility with various hardware and software.
- User Preferences: Measurement of the degree to which the OS modifies user fondness.
- User Feedback and Support: Assessment of the availability of mechanisms for user feedback and customer support.
- Battery Life Optimization: Evaluation of the OS's efficiency in managing power utilization to maximize battery life for portable devices.
- Backup and Restore Features: Examination of the usability of backup and restore functions for protecting user data.

2. Literature Review

Usability definitions have changed over time and vary among usability researchers. They commonly revolve around users, tasks, technology, and use context. Usability attributes, specific to each application, hold the development process and serve as requirements and specifications. Usability specialists conduct evaluations to ensure the system meets these earmarks (Bruno & Al-Qaimari, n.d.).

As usability testing gains popularity, users often choose operating systems based on price and standard features. This study evaluated Windows 7, 8, and 10 in terms of effectiveness, efficiency, and user satisfaction. Windows 10 had the highest completion rate, but Windows 8 was slower and less satisfying. Future research should explore technical aspects and non-Microsoft operating systems for a broader usability viewpoint (Patayon & Mingoc, 2019).

Usability is important in computer interaction. If we delay it, making a user-friendly system can be costly. This research focuses on designing user-friendly interfaces from the beginning. We incorporate valuable design principles, including Shneiderman's golden rules and Nielsen's heuristics. The Gestalt principle helps organize visuals on the screen for better user experiences (Mazumder, 2014).

Usability evaluation is essential for a good user experience. This research examined multi-platform applications to gauge their efficiency, effectiveness, and user satisfaction. Using the think-aloud method with 50 participants, usability issues were found, and improvements were suggested for better satisfaction, efficiency, and effectiveness. This research guides multi-platform usability evaluations, paving the way for future user interface improvement (Nik Ahmad et al., 2021).

Usability is key in both operating systems and learning apps. Learning apps should encourage holistic development while being user-friendly. Similarly, operating systems must provide efficient and satisfying user experiences through instinctive interfaces and responsive designs. Both domains stress the importance of usability for effective learning and task performance (Ibrahim et al., 2023).

Usability attributes in operating systems have been a major focus in the field of human-computer interaction. Studies highlight the importance of intuitive design, customization,

efficiency, accessibility, security, and compatibility. This research emphasizes the role of usability in ensuring user satisfaction and effectiveness with digital systems (Issa, 2015).

This article tests the user interfaces of mobile devices. It specifically looks at design requirements and usability guidelines. Using the Urban Construction Group's information platform as an example, the article evaluates user-friendliness, content, form, navigation, and aesthetics on Windows, Android, and iOS. The results indicate that the UI design meets the requirements, but there is a need for further exploration in mobile UI design and testing (Wang et al., 2013).

Usability testing reveals that Windows 10 excels in performance, while Windows 8 lags in efficiency, taking more time to complete tasks. Users express a clear preference for the user-friendly interface of Windows 7. The study recommends expanding usability testing to encompass other operating systems and diverse usability factors, providing a broader perspective on user satisfaction and effectiveness (Bevan, 1995).

3. Research Methodology

The research methodology for this assignment is survey-based, aiming to comprehensively investigate the usability attributes of the operating system (Aqeel et al., 2023). Surveys provide a structured and scalable approach to gathering user feedback, preferences, and experiences (Dopp et al., 2019).

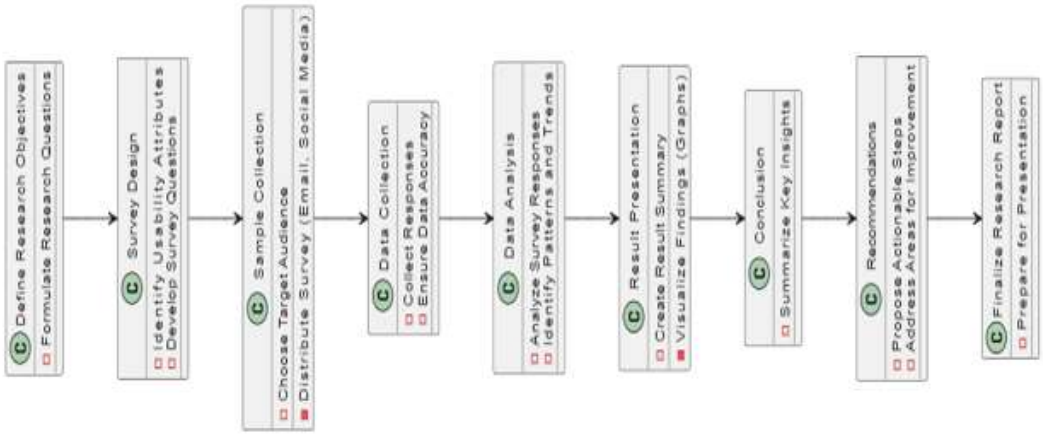

Figure 1. Methodology

Figure 1 throws ample light on a systematic research methodology of usability attributes in three sections: defining research objectives and survey attributes, collecting and analyzing data, and concluding with recommendations. It included activities such as survey design, targeted sample collection, data analysis, and the presentation of results, ultimately leading to summarized insights and actionable recommendations for improving usability attributes in operating systems Peart et al., 2019) (de Oliveira et al., 2022)(Alzahrani & Al-Baity, 2023)(Ba Matraf et al., 2023).

3.1. Sample Collection

A total of 15 multiple-choice questions were allocable among people working at different software houses. These multiple samples were gathered through targeted Outstrip on platforms such as email, online forums, and social media groups (Al-Razgan et al., 2021)(Research with Blind Users on Mobile Devices - Accessibility in Government, 2016)(Kumar et al., 2022)(Khan & Khusro, 2022)(Meenakshi et al., 2022)(Hussain & Omar, 2020).

4. Results and Analysis

4.1 Survey-Based Results

The majority of respondents agree or strongly agree that they regularly interact with operating systems daily. This recommends that daily OS use is common among the surveyed group.

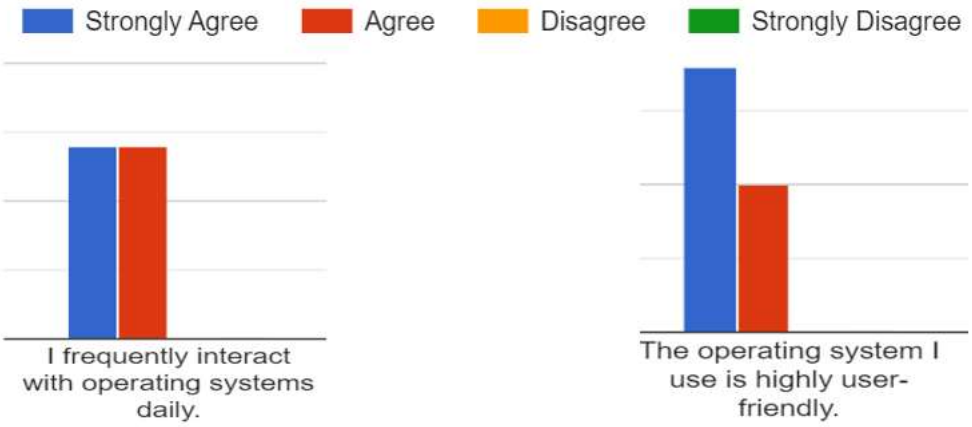

Figure 2. Frequency and User Friendliness of OS

Figure 2 shows that a significant number of respondents strongly agree that the operating system they use is highly user-friendly. This is a positive measure of user satisfaction with the OS's ease of use. The majority of respondents strongly agree that UI design is necessary for their overall satisfaction. This emphasizes the significance of visual design in user experience.

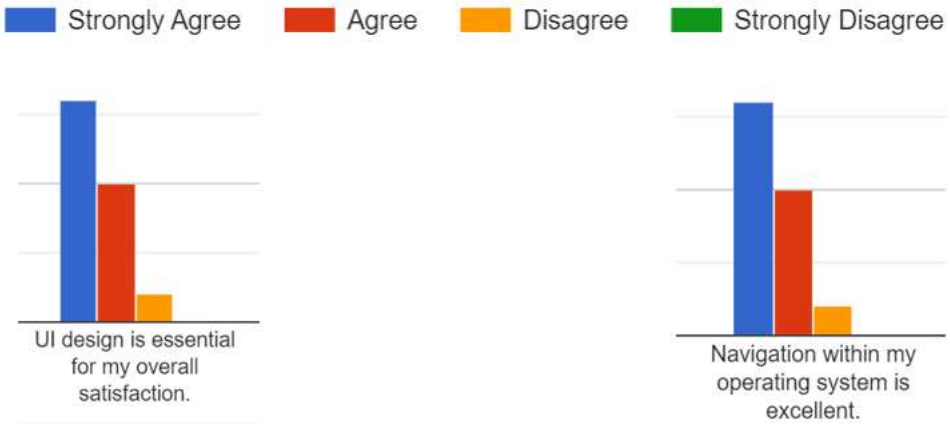

Figure 3. User Design and Navigation Satisfaction

Figure 3 shows that most of the respondents strongly agree that navigation within their operating system is excellent, which indicates a positive user experience in finding their way around the system. While a majority agrees or strongly agrees about effective accessibility features, some have different judgments.

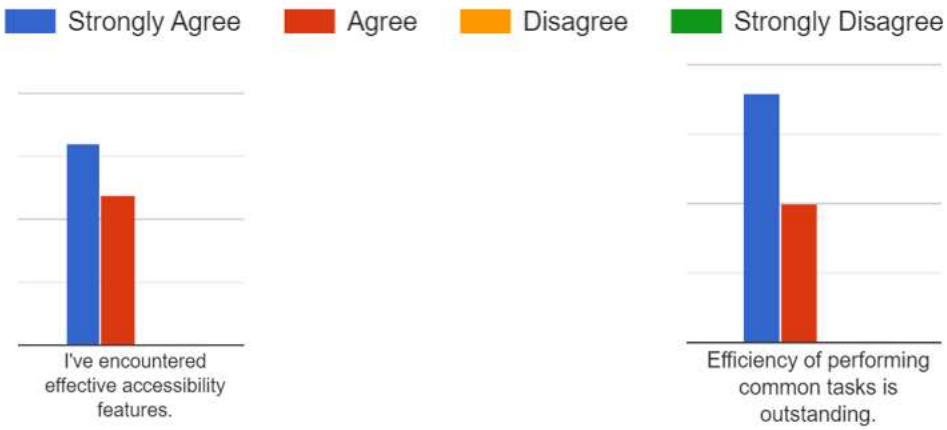

Figure 4. User Accessibility and Efficiency

Figure 4 shows that a remarkable number of respondents strongly agree that they experience outstanding efficiency when performing common tasks, designating high satisfaction with task performance. Most respondents strongly agree that design and interaction patterns are compatible with their operating system, suggesting a consonant user experience.

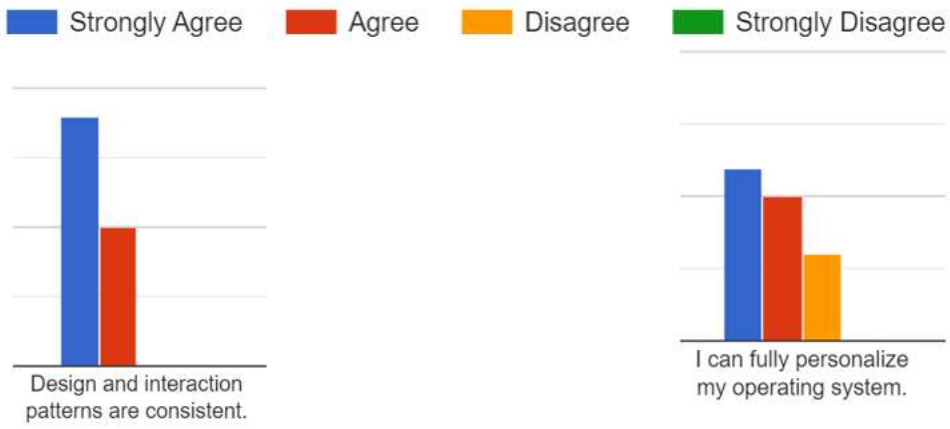

Figure 5. User Interaction Pattern Compatibility and Customizability

Figure 5 shows that while there are strong agreements on customized, there are also several disagreements. It's important to explore what aspects of personalization may not be meeting user expectations. Most respondents agree or strongly agree that they became experts in using their operating system quickly, indicating ease of learning.

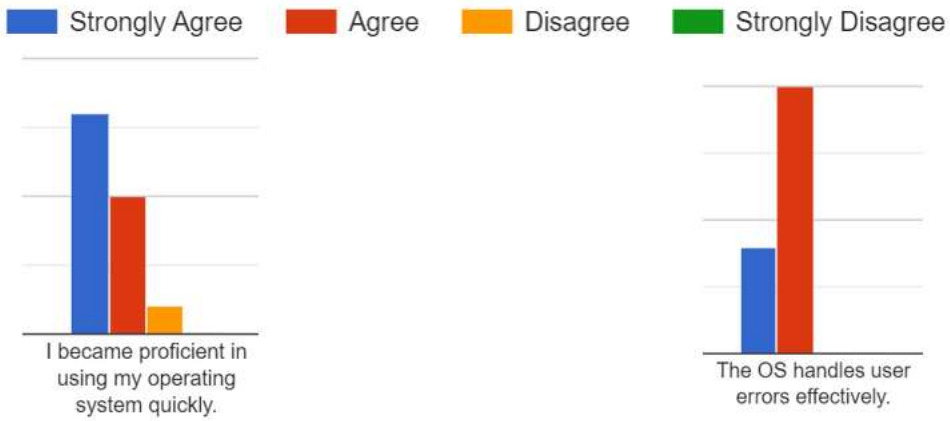

Figure 6. User Learnability and Effectiveness

Figure 6 shows that the majority of the participants agree or strongly agree that the OS handles user errors effectively, which is a positive sign for user satisfaction. Most respondents strongly agree that task performance is highly satisfactory, suggesting that the OS effectively supports various tasks.

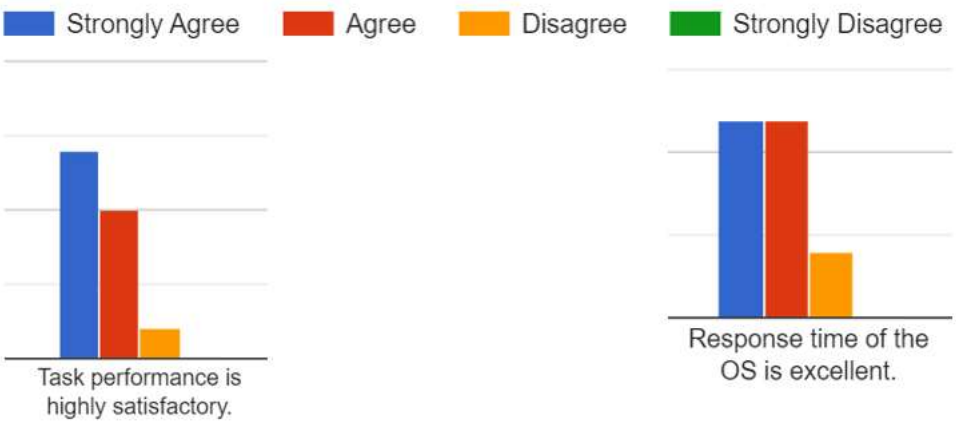

Figure 7. User Satisfaction and Response Time

Figure 7 shows that while the majority agrees or strongly agrees, there are some disagreements, highlighting the importance of further investigation to understand factors affecting response time satisfaction. There are mixed responses regarding feedback quality. It's critical to take a look at what types of feedback may be more effective or need improvement.

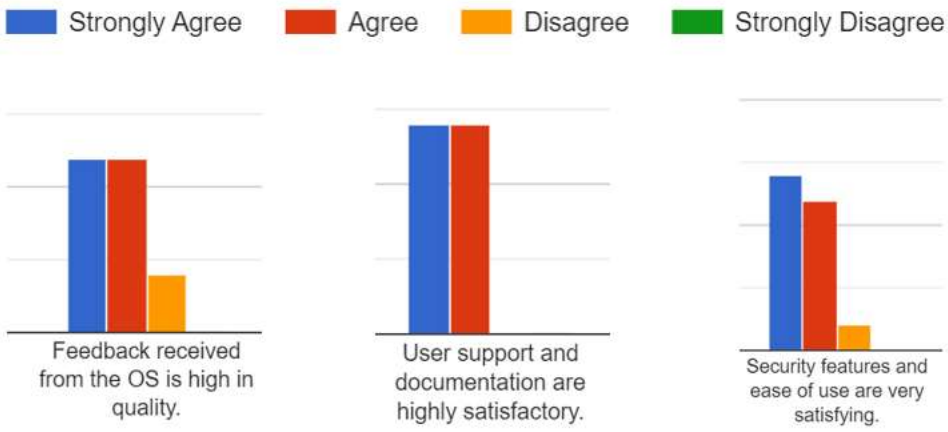

Figure 8. OS Feedback, Support & Documentation and Security Features

Figure 8 shows that most respondents strongly agree or agree about the quality of user support and documentation, which is a positive sign for user cooperation. The majority strongly agrees or agree that security features and ease of use are very satisfying, indicating a high level of satisfaction in these aspects.

4.2 Meta-Analysis of Performance-Based Data

This section evaluates and draws a relationship between different attributes of usability after putting data of ten attributes taken from performance and questionnaire (Hamid, Iqbal, Aqeel, Rana, et al., 2023)(Hamid, Iqbal, Aqeel, Liu, et al., 2023)(Ibrahim et al., 2023).

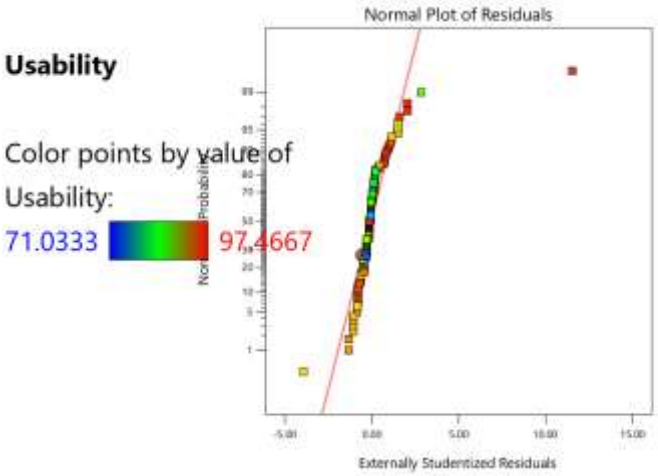

Figure 9. Normal Plot when Applying ANOVA for Meta-Analysis

Figure 9 shows the normal plot with values of usability produced by performance-based and questionnaire-based data of dataset collected from different campuses of university students. Usability value range through these attributes is in between 70 and 98 (Hamid, Muhammad, Iqbal, Nazir, et al., 2023)(Hamid, Muhammad, et al., 2022)(Hamid, Iqbal, et al., 2022).

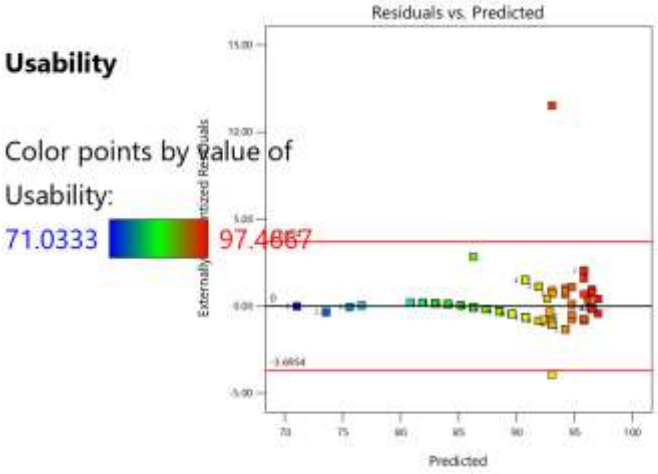

Figure 10. Residual Values vs Predicted Values of Data

Figure 10 shows residual and predictive values of usability produced by performance-based and questionnaire-based data of datasets collected from different campuses of university students. The usability value range through these attributes is between 70 and 98.

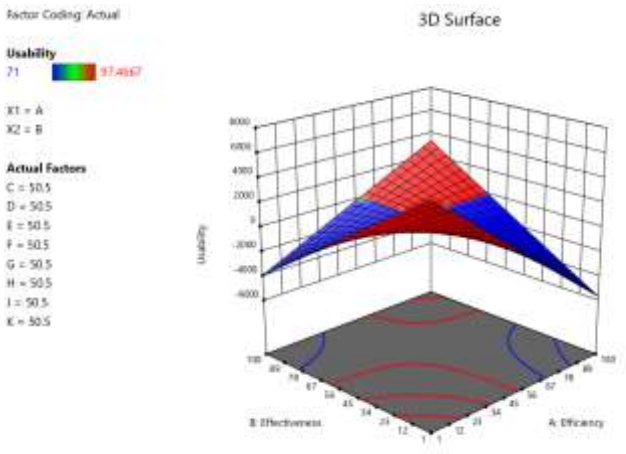

Figure 11. Meta-Analysis Relationships between Effectiveness, Efficiency and Usability

Figure 11 shows the relationship between usability attributes efficiency and effectiveness to the usability produced by performance-based and questionnaire-based data of datasets collected from different campuses of university students. The usability value range through these attributes is between 70 and 98. But at some point showing a reverse relation of effectiveness and efficiency with usability.

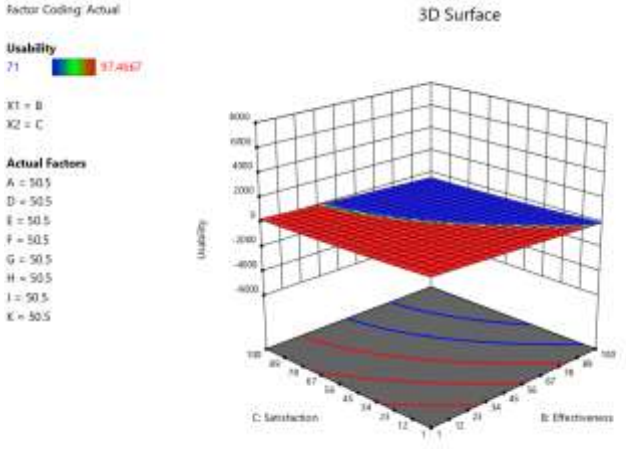

Figure 12. Meta-Analysis Relationships between Effectiveness, Satisfaction and Usability

Figure 12 shows the relationship between usability attributes satisfaction and effectiveness to the usability produced by performance-based and questionnaire-based data of datasets collected from different campuses of university students. The usability value range through these attributes is between 70 and 98.

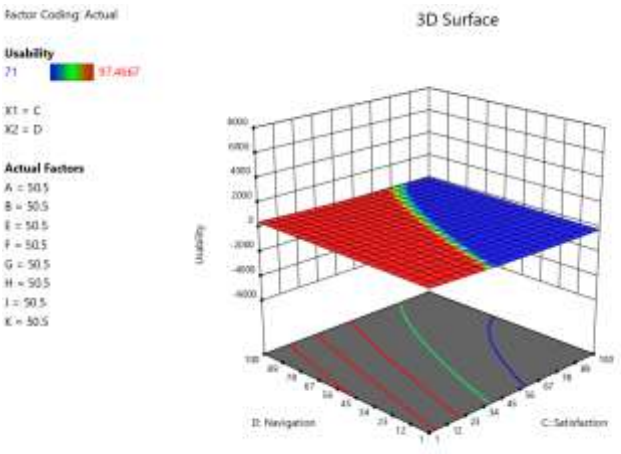

Figure 13. Meta-Analysis Relationships between Navigation, Satisfaction and Usability

Figure 13 shows the relationship between usability attributes satisfaction and navigation to the usability produced by performance-based and questionnaire-based data of datasets collected from different campuses of university students. The usability value range through these attributes is between 70 and 98.

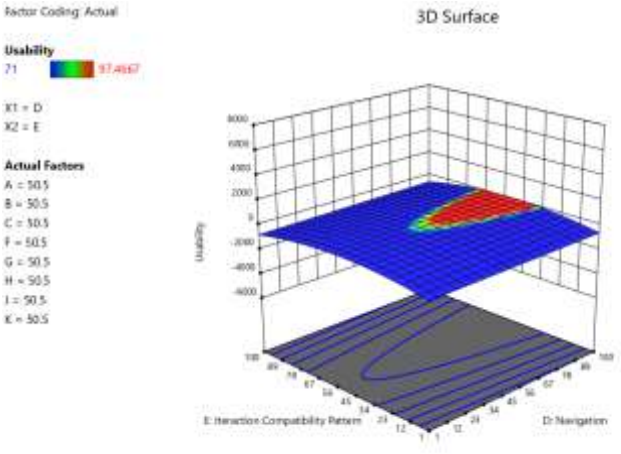

Figure 14. Meta-Analysis Relationships between Navigation, Interaction Compatibility Pattern and Usability

Figure 14 shows the relationship between usability attributes Interaction Compatibility patterns and navigation to the usability produced by performance-based and questionnaire-based data of datasets collected from different campuses of university students. The usability value range through these attributes is between 70 and 98.

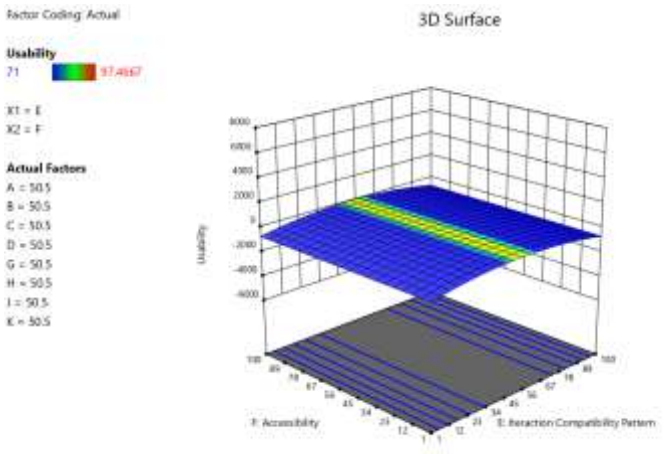

Figure 15. Meta-Analysis Relationships between Accessibility, Interaction Compatibility Pattern and Usability

Figure 15 shows the relationship of usability attributes Interaction Compatibility patterns and accessibility to the usability produced by performance-based and questionnaire-based data of datasets collected from different campuses of university students. The usability value range through these attributes is between 70 and 98.

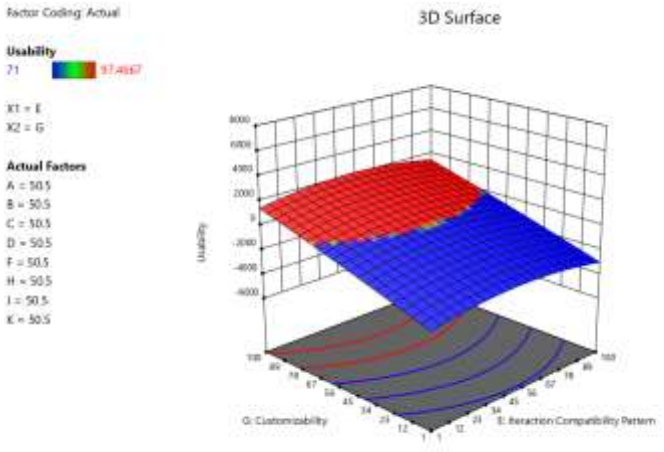

Figure 16. Meta-Analysis Relationships between Customizability, Interaction Compatibility Pattern and Usability

Figure 16 shows the relationship between usability attributes Interaction Compatibility patterns and customizability to the usability produced by performance-based and questionnaire-based data of datasets collected from different campuses of university students. The usability value range through these attributes is between 70 and 98.

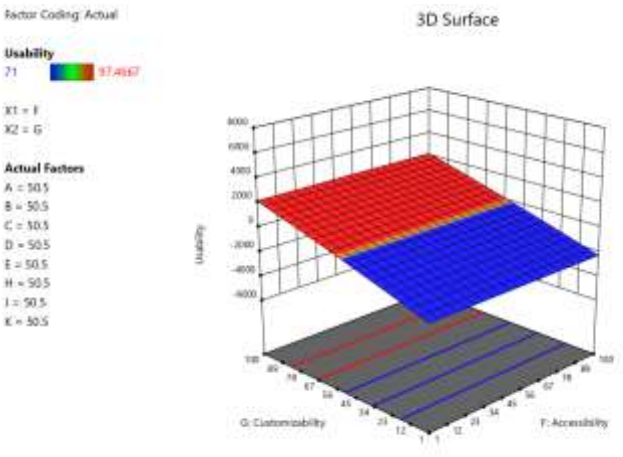

Figure 17. Meta-Analysis Relationships between Customizability, Accessibility and Usability

Figure 17 shows the relationship of usability attributes Accessibility and customizability to the usability produced by performance-based and questionnaire-based data of datasets collected from different campuses of university students. The usability value range through these attributes is between 70 and 98.

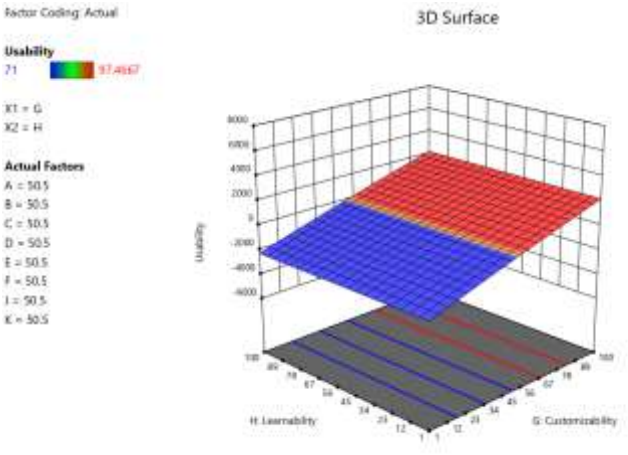

Figure 18. Meta-Analysis Relationships between Customizability, Learnability and Usability

Figure 18 shows the relationship of usability attributes learnability and customizability to the usability produced by performance-based and questionnaire-based data of datasets collected from different campuses of university students. The usability value range through these attributes is between 70 and 98.

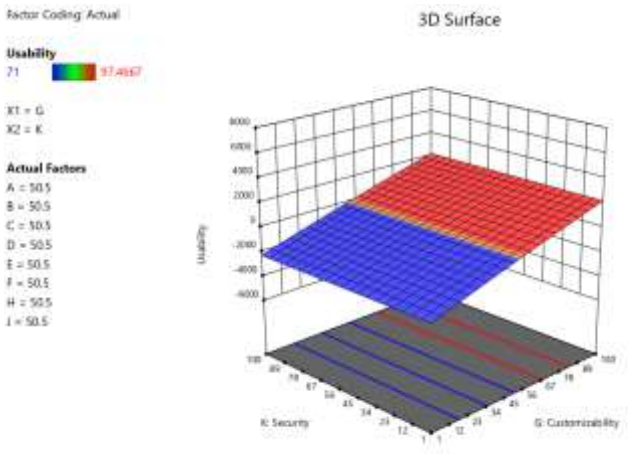

Figure 19. Meta-Analysis Relationships between Security, Learnability and Usability

Figure 19 shows the relationship of usability attributes security and customizability to the usability produced by performance-based and questionnaire-based data of datasets collected from different campuses of university students. The usability value range through these attributes is between 70 and 98.

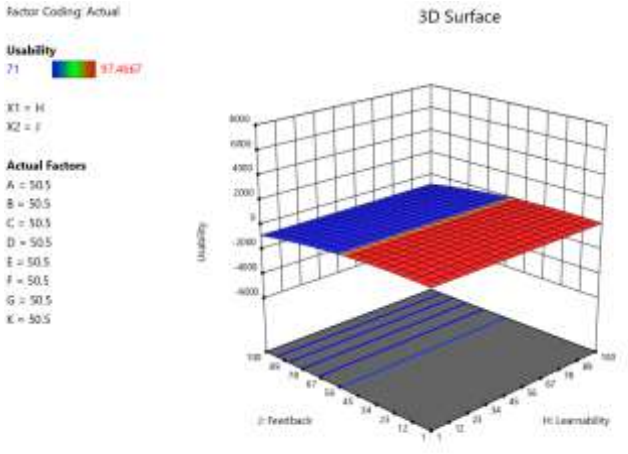

Figure 20. Meta-Analysis Relationships between Feedback, Learnability and Usability

Figure 20 shows the relationship between usability attributes feedback and learnability to the usability produced by performance-based and questionnaire-based data of datasets collected from different campuses of university students. The usability value range through these attributes is between 70 and 98.

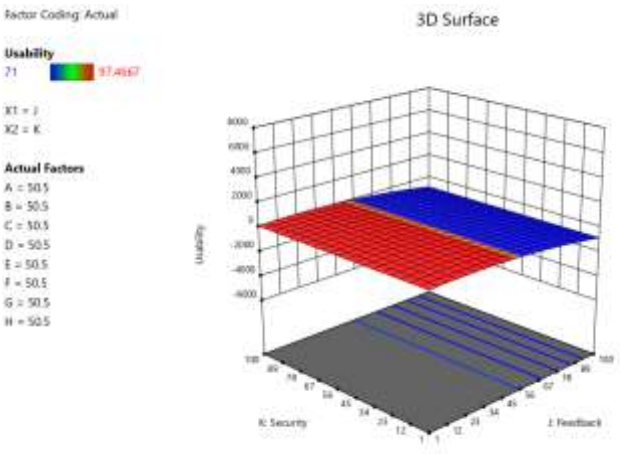

Figure 21. Meta-Analysis Relationships between Security, Feedback and Usability

Figure 21 shows the relationship between usability attributes feedback and security to the usability produced by performance-based and questionnaire-based data of datasets collected from different campuses of university students. The usability value range through these attributes is between 70 and 98.

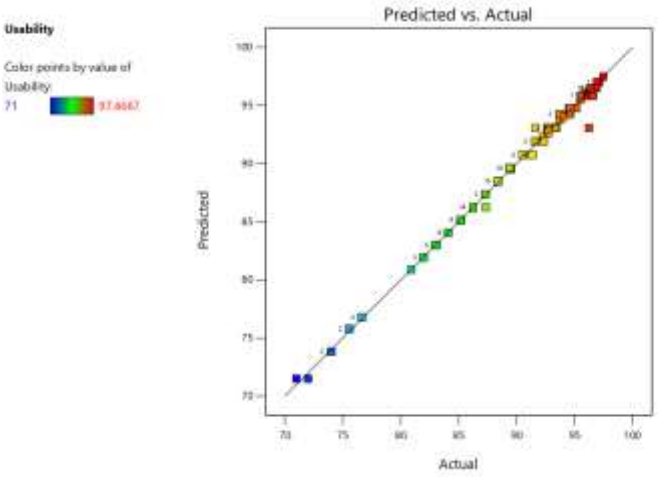

Figure 22. actual and predicted usability

Figure 22 shows the actual and predicted usability produced by performance-based and questionnaire-based data of the dataset collected from different campuses of university students. All values for both actual and predictive sets are in the compatible range between 70 and 98.

Table 1. Fit Statistics

Std. Dev.	0.3988	R^2	0.9959
Mean	90.15	Adjusted R^2	0.9953
C.V. %	0.4423	Predicted R^2	NA(1)
		Adeq Precision	183.0169

Table 1 shows the reasonable standard deviation value, mean value and cumulative variance value. It also presents very close R2, Adjusted R2, and Adequate Precision values. Adeq Precision measures the signal-to-noise ratio. A ratio greater than 4 is desirable. Your ratio of 183.017 indicates an adequate signal. This model can be used to navigate the design space.

4.2.1 Meta-Analysis: ANOVA for Quadratic model

Response 1: Usability

Table 2. ANOVA for Quadratic model

Source	Sum of Squares	df	Mean Square	F-value	p-value	
Model	5315.12	19	279.74	1759.06	< 0.0001	significant
A-Efficiency	0.0407	1	0.0407	0.2562	0.6136	
B-Effectiveness	0.1200	1	0.1200	0.7547	0.3865	
C-Satisfaction	0.0122	1	0.0122	0.0769	0.7819	
D-Navigation	0.0016	1	0.0016	0.0101	0.9201	
E-Interaction Compatibility Pattern	0.0001	1	0.0001	0.0007	0.9791	
F-Accessibility	0.0000	0				
G-Customizability	0.1949	1	0.1949	1.23	0.2702	
H-Learnability	0.0000	0				
J-Feedback	0.0533	1	0.0533	0.3353	0.5635	
K-Security	0.0000	0				
Residual	21.95	138	0.1590			
Lack of Fit	1.15	18	0.0641	0.3699	0.9909	not significant
Pure Error	20.79	120	0.1733			
Cor Total	5337.07	157				

Table 2 shows Factor coding is Coded. The sum of squares is Type III – Partial. The Model F-value of 1759.06 implies the model is significant. There is only a 0.01% chance that an F-value this large could occur due to noise. P-values less than 0.0500 indicate model terms are significant. The Lack of Fit F-value of 0.37 implies the Lack of Fit is not significant.

5. Discussion

These findings provide valuable insights into user satisfaction and highlight areas where the operating system performs well and where improvements may be needed. Further analysis and user feedback can help refine and enhance the user experience.

The meta-analysis model should be significant for accurate data and relationships. It is significant as shown by Meta-Analysis ANOVA for the Quadratic Table. The Lack of Fit should be Insignificant for accurate relationships and datasets. It is insignificant shown by Meta-Analysis in ANOVA for the Quadratic Table. R2 and Adjusted R2 should be close for significant model and it is very close as shown in Fit Statistics.

6. Conclusions

In conclusion, the survey analysis reveals a rich tapestry of user perspectives on various usability attributes in operating systems. Users engage with their OS daily, emphasizing

the integral role these systems play in their digital lives. User-friendliness, efficient navigation, and design aesthetics are highly valued, contributing to overall satisfaction. The study underscores the significance of accessibility features while revealing the need for continued enhancements. Task efficiency, consistency in design, and quick learning curves are evident strengths, making operating systems user-centric. Personalization, response time, and feedback quality are areas where user expectations may not always align with the system's performance, warranting further examination. Despite these nuances, effective error handling, strong task performance, and high-quality support and documentation are commendable. Users find security features and ease of use to be highly satisfying. Furthermore, a Meta-Investigation has been led on the dataset gathered after execution put together action concerning various college grounds and reproduced results have been delivered which show connections among properties and convenience. Eventually, explicit proposals for the improvement of working frameworks are proposed for review-based examination and Meta-Investigation. This research offers valuable insights into user experiences and provides guidance for refining and advancing operating systems to meet the ever-evolving needs of users in the digital landscape.

7. Recommendations

These actionable steps address identified areas for development and are recommended by us for overall usability improvement.

Customized Experience-Provide users with more options to personalize their operating system involvement. Introduce further themes, color choices, and layout options for users to customize the interface to their fondness.

Graceful Installation and Updates-Clarify the process of installing and updating the operating system. Offer clear, user-friendly instructions and compromise automatic updates to make less user effort and guarantee they stay current smoothly.

Improved Response Time-Enlarge the system's speed in acknowledgment of user actions. Identify and address performance congestion to ensure a more instant and smooth user experience.

Optimized Battery Management-Enlarge the regulation of the operating system to expand battery life on portable devices. Execute quick command background processes.

User-Friendly Backup and Restore-Make backup and restore features more accessible and reliable. Make sure to effortlessly execute backups and replace processes.

Real-Time User Support-Implement immediate assistance features for users seeking support. Introduce real-time user support mechanisms like chatbots or virtual assistants that can address queries, offer guidance, and fix issues instantly, contributing to heightened user satisfaction.

These enhancements focus on improving the user experience by making the operating system more adaptable, user-friendly, responsive, and supportive in real time.

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