

Analysis of the SILAT User Experience of the Pamekasan Education Office Using the UEQ Method

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Abstract

The digital transformation of public services has encouraged government institutions to adopt integrated information systems to improve service quality, transparency, and accountability. The Department of Education and Culture of Pamekasan Regency developed SILAT as a web-based platform to digitalize educational administrative services, including diploma data modification, document verification and school transfer services, and digital guest book management. This study aims to evaluate the user experience of SILAT using the User Experience Questionnaire (UEQ) method. A quantitative survey approach was employed involving 185 respondents consisting of school principals or school administrators, Education Office staff, and members of the public who had previously used the system. Data were collected through an online questionnaire using the Indonesian version of UEQ and analyzed using the UEQ Data Analysis Tool. The evaluation results revealed that all UEQ dimensions obtained positive scores, namely attractiveness (1.52), perspicuity (1.66), efficiency (1.64), dependability (1.30), stimulation (1.18), and novelty (1.94). Benchmark analysis indicated that most dimensions were categorized as *Above Average*, while efficiency achieved a *Good* category and novelty reached an *Excellent* category. The high novelty score suggests that users perceive SILAT as an innovative platform, which is likely influenced by the implementation of Dynamic Role Management based on Role-Based Access Control (RBAC). These findings demonstrate that SILAT provides a positive user experience and effectively supports the digitalization of educational administrative services. The study also highlights the potential of dynamic RBAC implementation in enhancing innovation and user experience within e-government systems.

Keywords: User Experience Questionnaire, SILAT, E-Government, RBAC, Digital Public Service

INTRODUCTION

The advancement of digital transformation has prompted government agencies to implement electronic-based services to improve the efficiency, transparency, and accountability of public services (Sukmasetya et al., 2018; Suradi & Purnomo, 2026). In the education sector, the digitization of services has become a key strategy to streamline administrative processes and accelerate access to services for the public and stakeholders (Legi et al., 2020). To support this transformation, the Department of Education and Culture of Pamekasan Regency developed the **Sistem Layanan Terpadu (SILAT)**, a web-based platform designed to facilitate the digitalization of educational administrative services. The system integrates several key services, including diploma data modification, document verification and school transfer management, as well as digital guest book registration.

The success of an information system's implementation is determined not only by the comprehensiveness of its features but also by the user experience (UX) when interacting with the system. A positive user experience can enhance user satisfaction, trust, and acceptance of the digital services provided by the government (Hossain et al., 2025; Suradi & Purnomo, 2026). Conversely, an interface that is difficult to understand, non-intuitive navigation, and low-quality interactions can reduce the effectiveness of the services provided. Previous research indicates that the quality of the user experience is a critical factor in the successful implementation of e-government systems and digital public services, as it influences usage rates and the sustainability of system adoption by the public (Sukmasetya et al., 2018; Wibisono & Tjhin, 2025).

Various studies have been conducted to evaluate user experience in government and education systems using the User Experience Questionnaire (UEQ) method. An evaluation of the portal of the Supreme Audit Agency of the Republic of Indonesia showed that user experience plays a crucial role in improving the quality of government digital services (Nurrizqi & Ramadhan, 2025). Other studies on the website of the Ministry of Health of the Republic of Indonesia (Susanto et al., 2025), the research information management system (Wibawa et al., 2025), the e-Rapor application (Indrawan et al., 2024), the Undiksha PPID website (Sadewa et al., 2024), and the PERKASA digital library application (Adjuah et al., 2026) demonstrate that UEQ can comprehensively identify a system's strengths and weaknesses, thereby serving as a foundation for improving interfaces and services. Nevertheless, research examining user experience in integrated service systems within regional Education Offices remains relatively limited, particularly regarding systems that implement complex access rights management mechanisms.

SILAT differs from most other educational service systems in that it implements Dynamic Role Management based

on Role-Based Access Control (RBAC). This approach allows access rights to be tailored to user roles, ensuring that every actor in the system receives access commensurate with their duties and authority. The implementation of this mechanism is expected to enhance security, streamline service processes, and improve the system's usability. However, research evaluating user experience in public education service systems with dynamic access rights management remains very limited. Furthermore, UX evaluation studies in the government sector are still dominated by aspects of usability and pragmatic quality, while broader dimensions of user experience, such as stimulation and novelty, have not been explored in depth (de Melo & Monteiro, 2026; Hossain et al., 2025).

Given these circumstances, this study aims to analyze the user experience of SILAT using the User Experience Questionnaire (UEQ) method. The UEQ method was selected because it comprehensively measures six dimensions of user experience, namely attractiveness, perspicuity, efficiency, dependability, stimulation, and novelty (Kollmorgen et al., 2025). The findings of this study are expected to provide insights into the quality of the SILAT user experience and serve as a basis for system development recommendations to enhance the quality of digital-based educational services in Pamekasan Regency.

LITERATURE REVIEW

Integrated Service System in Education Governance

Digital transformation is driving government agencies to develop electronic public services to improve the quality of service delivery to the public. The implementation of e-government enables administrative processes to be carried out more quickly, transparently, and accountably compared to conventional procedures (Sukmasetya et al., 2018). In the education sector, the digitization of services plays a crucial role in supporting administrative management, information distribution, and the provision of more effective and efficient educational services (Legi et al., 2020).

SILAT is a digital service initiative developed by the Pamekasan Regency Education and Culture Office. This system integrates various educational administrative services into a single web-based platform, including services for updating diploma information, verifying documents and school transfers, as well as maintaining a digital guestbook. The integration of these services into a single platform is expected to improve ease of access to services while reducing the complexity of administrative processes for users.

In addition to providing integrated services, SILAT also implements a Dynamic Role Management mechanism based on Role-Based Access Control (RBAC). This approach allows access rights to be configured based on user roles, ensuring that each user can only access features that align with their tasks and authority. The implementation of RBAC helps enhance system security, maintain data integrity, and support more structured service governance.

User Experience (UX)

User Experience (UX) refers to the perceptions and responses users have as a result of interacting with a product, system, or service. UX is not limited to the functional aspects of a system; it also encompasses users' perceptions of usability, efficiency, comfort, trust, and satisfaction while using the system (Kollmorgen et al., 2025).

In the context of digital public services, user experience is a key factor influencing the level of acceptance and the success of system implementation. Hossain et al. (2025) explain that evaluating UX in government applications requires more than just focusing on usability; it must also take into account emotional dimensions and the overall user experience. A positive user experience can increase public trust in government digital services and encourage the sustainable use of the system (Suradi & Purnomo, 2026).

Previous studies have shown that UX quality has a significant impact on the success of information systems. Evaluations of the BPK RI portal (Nurizqi & Ramadhan, 2025), the Ministry of Health of the Republic of Indonesia website (Susanto et al., 2025), and a research information management system Wibawa et al. (2025) indicate that improving user experience quality can enhance system usage effectiveness and user satisfaction.

User Experience Questionnaire (UEQ)

The User Experience Questionnaire (UEQ) is one of the most widely used instruments for measuring user experience in interactive systems. The UEQ was developed to comprehensively evaluate the quality of user experience through a combination of pragmatic and hedonic aspects. According to Kollmorgen et al. (2025), the UEQ belongs to a family of UX evaluation instruments that have been widely used across various domains of information systems due to their high levels of validity and reliability.

The UEQ measures six key dimensions of the user experience: Attractiveness, Perspicuity, Efficiency, Dependability, Stimulation, and Novelty. Attractiveness describes the user's overall impression of the system. Perspicuity measures how easily users can understand and learn the system. Efficiency indicates the user's ability to complete tasks effectively and quickly. Dependability relates to the sense of control and security when using the system. Stimulation describes the level of motivation and interest users have in the system. Meanwhile, Novelty measures the level of creativity and innovation users perceive in the system they are using.

The UEQ method has been widely applied in the evaluation of various information systems. Some studies using UEQ include the evaluation of the Ministry of Health of the Republic of Indonesia's website (Susanto et al., 2025), the BPK RI portal (Nurizqi & Ramadhan, 2025), the UM REX research information management system (Wibawa et al.,

2025), the e-Rapor application (Indrawan et al., 2024), the Undiksha PPID website (Sadewa et al., 2024), and the PERKASA digital library application (Adjuah et al., 2026). The results of these studies indicate that UEQ is capable of providing a comprehensive overview of user experience quality while generating useful recommendations for future system development.

METHOD

Type of Research

This study employed a quantitative approach with a survey method to evaluate user experiences with SILAT. The evaluation was conducted using the User Experience Questionnaire (UEQ) to comprehensively measure users' perceptions of the quality of the system's user experience.

Research Object

The object of this research is SILAT, a web-based service platform developed by the Department of Education and Culture of Pamekasan Regency to support the digitalization of educational administration services. The system provides three main services, namely diploma data modification, document verification and school transfer services, and a digital guest book. Furthermore, SILAT implements a Dynamic Role Management mechanism based on Role-Based Access Control (RBAC), which enables access rights to be managed according to users' roles and responsibilities.

Population and Sample

The population of this study consisted of active users of SILAT. The respondents included school principals or school administrators, Education Office operators or staff, and members of the public who had utilized the services provided by the system. A purposive sampling technique was employed, with the criterion that respondents had used SILAT at least once. Based on these criteria, a total of 185 respondents participated in this study.

Research Instrument

The research instrument used was the Indonesian version of the User Experience Questionnaire (UEQ). The UEQ consists of 26 questions grouped into six measurement scales: Attractiveness, Perspicuity, Efficiency, Dependability, Stimulation, and Novelty. Attractiveness describes the user's general impression of the system. Perspicuity measures the system's ease of understanding and learning. Efficiency indicates the system's ability to help users complete tasks effectively and efficiently. Dependability relates to the user's level of control and sense of security when interacting with the system. Stimulation reflects the user's level of motivation and interest in the system, while Novelty measures the user's perceived level of creativity and innovation in the system.

Essentially, the UEQ scales are divided into three aspects: attractiveness, pragmatic quality, and hedonic quality. Pragmatic quality consists of the dimensions of Perspicuity, Efficiency, and Dependability, while hedonic quality consists of the dimensions of Stimulation and Novelty. The UEQ questionnaire is in the form of a semantic differential with seven answer choices that have a value range from -3 (the most negative evaluation) to +3 (the most positive evaluation).

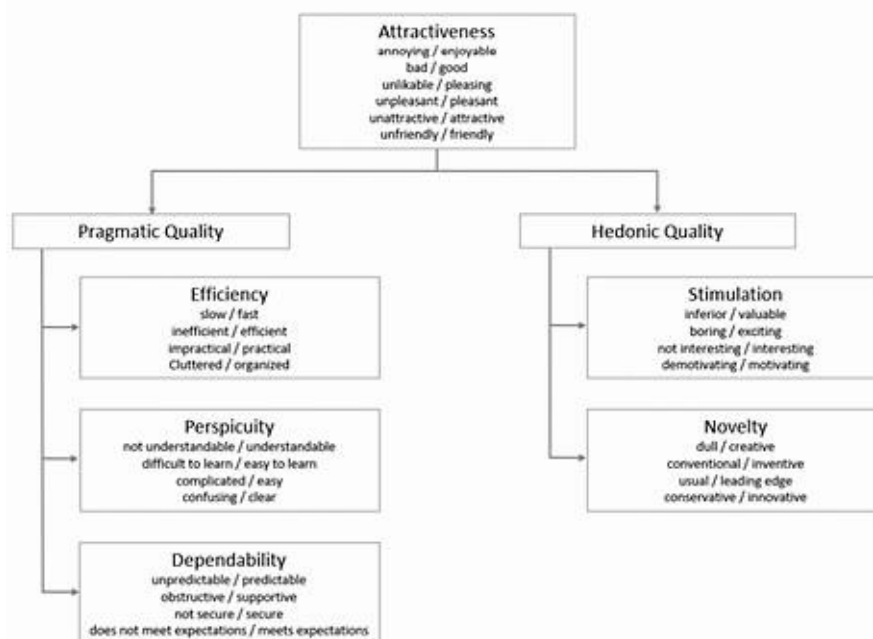


Fig 1. Structure of UEQ Scales
Source: Adapted from (Salsabila et al., 2022).

Data Collection and Analysis

Data were collected through an online questionnaire distributed using Google Forms. The collected data were subsequently analyzed using the UEQ Data Analysis Tool. The analysis process included reliability testing using Cronbach's Alpha, calculation of mean values and standard deviations for each UEQ scale, and benchmark analysis to compare the quality of the SILAT system with other products evaluated using the same method. The mean value for each UEQ scale was calculated using Equation (1).

$$\hat{x} = \frac{\sum_{i=1}^n x_i}{n} \quad (1)$$

Information:

$\hat{x}$ = average value.

x_i = respondent's i score

n = number of respondents.

reliability tests were conducted using the Cronbach's Alpha coefficient as shown in Equation (2).

$$\alpha = \frac{k}{k-1} \left(1 - \frac{\sum S_i^2}{S_t^2} \right) \quad (2)$$

Information:

α = reliability coefficient

k = number of question items

S_i^2 = variance of each item

S_t^2 = total variance

if : $\alpha > 0.70$ then the instrument is declared reliable.

RESULT

Overview of the SILAT System

The Sistem Layanan Terpadu (SILAT) is a web-based platform developed by the Department of Education and Culture of Pamekasan Regency to support the digital transformation of educational administrative services.. The system aims to provide transparent, accessible, and accountable public services by integrating various educational administrative processes into a single platform.

SILAT offers several integrated services, including diploma data modification, document verification and school transfer management, as well as a digital guest book service. In addition, the system implements a Dynamic Role Management mechanism based on Role-Based Access Control (RBAC), which enables access permissions to be assigned according to the roles and responsibilities of each user. This mechanism ensures that users can only access features relevant to their authority, thereby improving system security and service management.

Figure 2 illustrates the main interface of the SILAT system. The homepage provides users with access to various services, including the integrated service portal, news portal, diploma tracking feature, and authentication portal. The user interface is designed to facilitate user interaction by providing intuitive navigation and centralized access to educational administrative services.

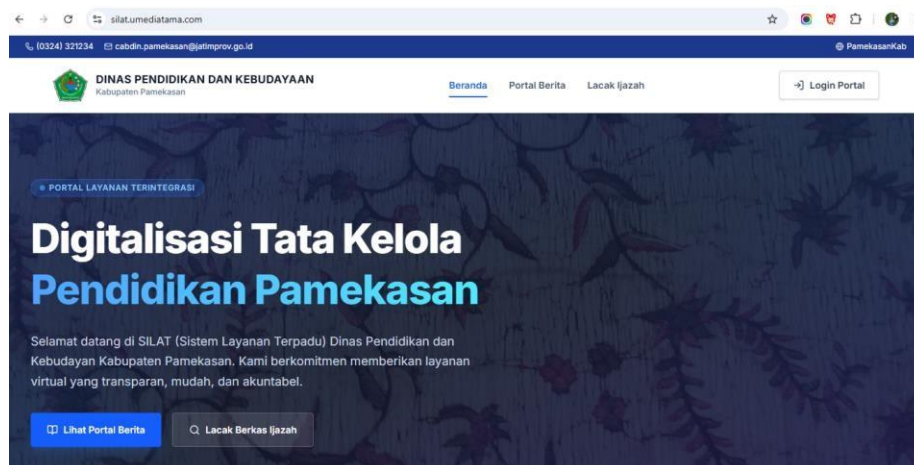
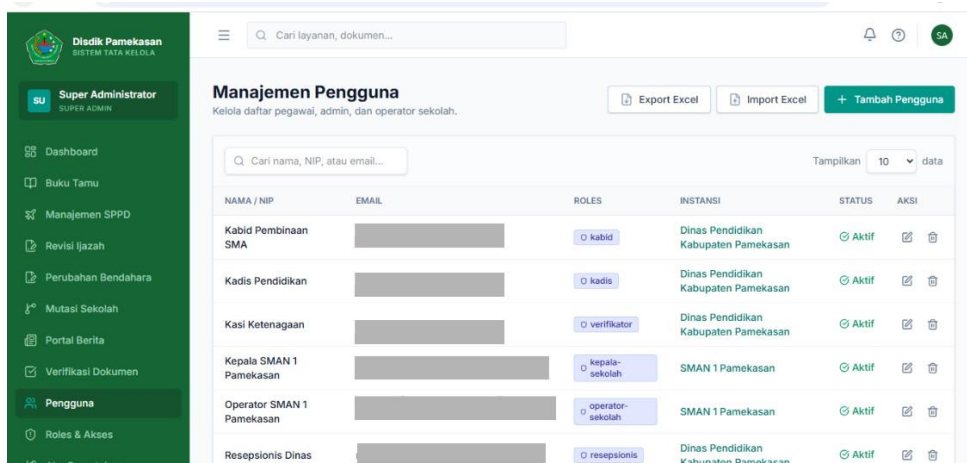


Fig 2. Main Interface of the SILAT System

In addition to providing integrated educational services, SILAT implements a Dynamic Role Management mechanism based on Role-Based Access Control (RBAC). This mechanism enables the system to assign access privileges according to the roles and responsibilities of each user. As a result, users can only access features and functionalities

relevant to their authority, thereby enhancing system security, accountability, and operational efficiency.

Figure 3 illustrates the user management interface implemented in SILAT. The system supports multiple user roles, including super administrator, department officials, school principals, school operators, verifiers, and receptionists. Each role is associated with specific permissions that regulate access to system modules and service workflows. Such a role-based approach facilitates structured administrative processes while minimizing unauthorized access to sensitive information.



**Fig 3. User Management Interface Based
on Dynamic Role Management**

The implementation of Dynamic Role Management is considered one of the key innovations of SILAT, as it allows administrators to dynamically manage user accounts, roles, and permissions according to organizational requirements. This capability is expected to improve users' sense of control and trust while interacting with the system.

Reliability Test Results

Reliability testing was conducted using the Cronbach's Alpha coefficient to determine the level of internal consistency of each UEQ scale. An instrument is considered reliable if its Cronbach's Alpha value is greater than 0.70.

Table 1.

UEQ Instrument Reliability Test Results

Scale	Cronbach's Alpha	Information
Attractiveness	0,91	Reliabel
Perspicuity	0,80	Reliabel
Efficiency	0,76	Reliabel
Dependability	0,61	Quite Reliable
Stimulation	0,76	Reliabel
Novelty	0,28	Less Reliable

Based on Table 1, most UEQ scales have Cronbach's Alpha values above 0.70, thus being considered reliable. The attractiveness scale achieved the highest reliability value at 0.91, while the novelty scale achieved the lowest at 0.28. These values indicate that respondents' perceptions of the novelty aspect tend to be more diverse than the other dimensions.

User Experience Evaluation Results

The user experience evaluation results using the UEQ method yielded average (mean) scores across six measurement scales. The calculation results can be seen in Table 2.

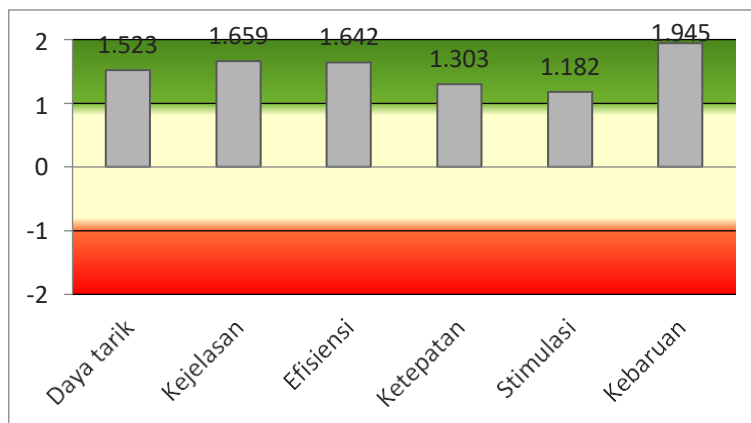
Table 2.

SILAT User Experience Evaluation Results

UEQ Scale	Mean	Variance	Interpretation
Attractiveness	1,523	1,39	Positive
Perspicuity	1,659	1,35	Positive
Efficiency	1,642	1,09	Positive
Dependability	1,303	0,94	Positive
Stimulation	1,182	1,11	Positive

Novelty	1,945	0,41	Positive
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All UEQ dimensions obtained an average value above 0.8, indicating that users gave a positive evaluation of the SILAT system. The novelty dimension obtained the highest value of 1.945, while the stimulation dimension obtained the lowest value of 1.182.



**Fig 4. Results of SILAT User Experience Evaluation Using UEQ
(According to Indonesian UEQ standards)**

UEQ Benchmark Results

A benchmark analysis was conducted to compare the quality of the SILAT system's user experience with other products in the UEQ benchmark database.

**Table 3.
UEQ Benchmark Results**

Scale	Mean	Benchmark Category
Attractiveness	1,52	Above Average
Perspiciuity	1,66	Above Average
Efficiency	1,64	Good
Dependability	1,30	Above Average
Stimulation	1,18	Above Average
Novelty	1,94	Excellent

Based on the benchmark results in Table 3, most dimensions are in the Above Average category, while the efficiency dimension is in the Good category. The novelty dimension received an Excellent category, indicating that SILAT is included in the top 10% of products in the UEQ benchmark database. These results indicate that the SILAT system has a good user experience quality and is able to provide a better user experience than most products in the UEQ benchmark database.

DISCUSSION

Attractiveness

The attractiveness dimension obtained a mean score of 1.52, indicating that users generally had a positive overall impression of SILAT. This result suggests that users perceived the system as pleasant, useful, and appealing during interaction. The positive evaluation may be attributed to the integration of various educational administrative services into a single platform, enabling users to access multiple services without the need to visit the Education Office directly. The centralized service model contributes to improving user convenience and satisfaction. This finding is consistent with previous studies conducted by Nurrizqi and Ramadhan (2025), which reported that positive user experience significantly affects user satisfaction and acceptance of government digital services.

Perspiciuity

The perspiciuity dimension achieved a mean score of 1.66, indicating that SILAT is easy to understand and learn. Users perceived that the system interface and navigation structure were sufficiently clear, allowing them to operate the system with minimal effort. The availability of clearly separated service modules, such as diploma revision, document verification, and guest book services, may have contributed to this positive perception. A clear and understandable interface is essential for public service systems because users often possess different levels of technological literacy. Similar findings were reported by Susanto et al. (2025) and Wibawa et al. (2025), who emphasized that understandable interfaces positively influence users' perceptions of digital government services.

Efficiency

The efficiency dimension obtained a mean score of 1.64 and was categorized as Good according to the UEQ benchmark. This finding indicates that SILAT effectively supports users in completing administrative processes quickly and efficiently. Through digitalization, several conventional administrative procedures have been simplified, reducing processing time and minimizing physical visits to the Education Office. The positive efficiency score demonstrates that the system successfully supports users in accomplishing their tasks with less effort. These results are in line with previous studies that highlighted the importance of efficient digital public services in enhancing organizational performance and service quality.

Dependability

The dependability dimension recorded a mean score of 1.30, reflecting that users experienced an adequate level of control and security while interacting with SILAT. One possible factor contributing to this result is the implementation of Dynamic Role Management based on Role-Based Access Control (RBAC). This mechanism enables the system to assign permissions according to users' organizational roles and responsibilities. Consequently, each stakeholder, including administrators, school operators, and public users, can only access functionalities relevant to their authority. Such a mechanism improves accountability and enhances users' trust in the system.

However, the reliability coefficient for this dimension was relatively moderate (Cronbach's Alpha = 0.61). This finding suggests that users may have different perceptions regarding system predictability and interaction consistency. Therefore, future development should focus on improving system feedback mechanisms and ensuring consistent interaction patterns across all service modules.

Stimulation

The stimulation dimension achieved a mean score of 1.18, indicating that SILAT successfully motivates users to utilize digital educational services. Although this score represents the lowest value among all dimensions, it still falls within the positive evaluation category. This result suggests that users considered SILAT beneficial and sufficiently engaging. Nevertheless, additional enhancements, such as improved visual appearance, interactive features, and personalized services, may further increase users' motivation and long-term engagement with the system.

Novelty

The novelty dimension achieved the highest mean score of 1.94 and was classified as Excellent according to the UEQ benchmark. This result places SILAT among the top 10% of products included in the UEQ benchmark dataset. The high novelty score indicates that users perceived SILAT as an innovative and creative platform for educational administrative services. One major factor contributing to this result is the implementation of Dynamic Role Management based on RBAC. Unlike conventional educational administrative systems, SILAT provides a flexible and comprehensive access management mechanism capable of accommodating multiple stakeholders, including Education Office staff, school administrators, and members of the public. This capability creates a more adaptive, secure, and structured service environment. Therefore, the implementation of Dynamic Role Management can be considered the primary contribution and novelty of this study.

Despite this positive result, the novelty scale exhibited a relatively low reliability coefficient (Cronbach's Alpha = 0.28), indicating that respondents had diverse perceptions regarding the innovativeness of the system. This variation may be influenced by differences in technological experience and the specific features accessed by each user group. Therefore, future research is recommended to incorporate qualitative approaches to explore users' perceptions regarding system innovation in greater depth.

CONCLUSION

This study aimed to analyze user experience in SILAT using the User Experience Questionnaire (UEQ) method. The evaluation results revealed that all UEQ dimensions, namely attractiveness, perspicuity, efficiency, dependability, stimulation, and novelty, obtained positive scores with mean values exceeding 0.8. These findings indicate that SILAT provides a positive user experience and effectively supports the digitalization of educational administrative services in Pamekasan Regency. According to the UEQ benchmark results, most dimensions were categorized as *Above Average*, while the efficiency dimension achieved a *Good* category. The novelty dimension obtained the highest mean score of 1.94 and was classified as *Excellent*, indicating that users perceived SILAT as an innovative system. The high novelty score may be attributed to the implementation of Dynamic Role Management based on Role-Based Access Control (RBAC), which enables flexible access management according to users' roles and responsibilities. Nevertheless, the dependability and novelty dimensions exhibited relatively low reliability coefficients compared to the other dimensions. Therefore, future studies are recommended to employ qualitative approaches to gain a deeper understanding of users' perceptions regarding system security, control, and innovation.

REFERENCES

- Adjuah, T., Qurniawati, M., Bagas, D., & Arifin, F. (2026). *Implementasi Metode UEQ dalam Analisis dan Evaluasi Aplikasi PERKASA (Perpustakaan Kabupaten Pamekasan) Berbasis Mobile*. 7(1).
- de Melo, D. N. A., & Monteiro, I. T. (2026). UX.br: A User Experience Maturity Model for Government Applications. *Lecture Notes in Computer Science*, 16110 LNCS, 289–310. https://doi.org/10.1007/978-3-032-05005-2_15
- Hossain, E., Norowi, N. M., Kamaruddin, A., & Zulzalil, H. (2025). User Experience Evaluation in Government Applications: A Systematic Review. *International Journal of Advanced Computer Science and Applications*, 16(12), 726–735. <https://doi.org/10.14569/IJACSA.2025.0161267>
- Indrawan, G., Studi, P., Komputer, I., Pascasarjana, P., Ganesha, U. P., Studi, P., Program, A., Ganesha, U. P., Studi, P., Informasi, S., & Tabanan, U. (2024). *EVALUASI APLIKASI E-RAPOR MENGGUNAKAN METODE USER EXPERIENCE QUESTIONNAIRE (UEQ)*. 8(1), 10–18.
- Kollmorgen, J., Hinderks, A., & Thomaschewski, J. (2025). Selecting the Appropriate User Experience Questionnaire and Guidance for Interpretation: the UEQ Family. *International Journal of Interactive Multimedia and Artificial Intelligence*, 9(4), 126–139. <https://doi.org/10.9781/ijimai.2024.08.005>
- Legi, H. V., Rawis, J. A. M., Simanjuntak, S., & Oentoe, F. J. A. (2020). *Model Implementasi e-Government di Dinas Pendidikan dan Kebudayaan Kota Manado*. 3(2), 212–228.
- Nurrisqi, A. Z., & Ramadhan, A. W. (2025). User Experience Evaluation of the BPK RI Portal: A Combined UEQ and Heuristic Approach. *2025 5th International Conference on Innovative Research in Applied Science, Engineering and Technology, IRASET 2025*. <https://doi.org/10.1109/IRASET64571.2025.11008067>
- Salsabila, A. R., Lathif, T., Suryanto, M., & Safitri, E. M. (2022). *Evaluasi Pengalaman Pengguna Aplikasi SIMARIS UPN “ Veteran ” Jawa Timur Menggunakan Metode UEQ*. 9(6), 0–7. <https://doi.org/10.30865/jurikom.v9i6.5068>
- Sukmasetya, P., Santoso, H. B., & Sensuse, D. I. (2018). Current E-Government Public Service on User Experience Perspective in Indonesia. *2018 International Conference on Information Technology Systems and Innovation, ICITSI 2018 - Proceedings*, 159–164. <https://doi.org/10.1109/ICITSI.2018.8695962>
- Suradi, A., & Purnomo, H. D. (2026). A User-Centred E-Government Service Design Framework to Enhance Public Trust in Sustainable Policies. *Engineering, Technology and Applied Science Research*, 16(1), 31852–31862. <https://doi.org/10.48084/etasr.14851>
- Susanto, D. H., Purwoko, F. J., Hamada, K. A., & Taufiq, M. (2025). Refining interface of the Indonesian ministry of health's website based on user experience questionnaire (UEQ). *AIP Conference Proceedings*, 3179(1). <https://doi.org/10.1063/5.0268911>
- Wibawa, A. P., Budiarto, L., Herdianto, R., Pradana, I. M. P., & Widiastuti, R. (2025). From Functionality to Adoption: User Experience Evaluation of UM REX Research Management Information System Using UEQ. *2025 7th International Workshop on Artificial Intelligence and Education, WAIE 2025*, 276–281. <https://doi.org/10.1109/WAIE67422.2025.11381055>
- Wibisono, N. Y., & Tjhin, V. U. (2025). Evaluating User Experience in a Public Sector Digital System Through Nielsen's Heuristic Approach. *International Journal of Advanced Computer Science and Applications*, 16(9), 285–295. <https://doi.org/10.14569/IJACSA.2025.0160928>