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The Impact of E-Service Quality on User Loyalty of Digital Farming Applications in Tuban Regency, Jawa Timur Province, Indonesia

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Abstract. The advent of digital technologies has significantly impacted various sectors, including agriculture. The study addresses the impact of e-service quality on digital farming application adoption, which is crucial for agricultural transformation. Utilizing a Structural Equation Model (SEM) analysis through SmartPLS, we examined constructs such as Efficiency, System Availability, Fulfillment, Privacy, User Satisfaction, and User Loyalty. The research was conducted from March to April 2024 with 124 smallholder farmers as respondents, using a purposive sampling technique. The analysis revealed that Efficiency increases user satisfaction by 40%, while System Availability enhances it by 44.3%, ultimately increasing loyalty by 84.5%. Privacy also positively impacts User Satisfaction, albeit marginally. These results underscore the importance of high e-service quality in fostering user satisfaction and long-term loyalty. This study recommends that developers improve system reliability, enhance efficiency with AI-driven support, and strengthen data security measures. Policymakers should support digital literacy programs and foster public-private partnerships to encourage wider adoption of digital technologies. These steps can improve user engagement, retention, and long-term success of digital farming applications. This study highlights the potential of digital farming applications to transform agriculture by promoting sustainable practices and improving farmer livelihoods through enhanced user satisfaction and loyalty.

Keywords: digital farming applications; e-service quality; loyalty; satisfaction

INTRODUCTION

In recent years, the digital transformation of agriculture has emerged as a crucial strategy for enhancing the productivity and sustainability of farming practices. Smallholder farmers, who form the backbone of agricultural sectors in many developing countries, including Indonesia, face significant challenges such as climate change, limited access to modern technology, and insufficient market information (Fanadzo & Ncube, 2018; Leal Filho et al., 2023; Toreti et al., 2022). In this context, digital farming applications have the potential to revolutionize agricultural practices by providing timely information, efficient resource management, and improved market access (El Nahry & Mohamed, 2011; Mesgaran et al., 2017). This breakthrough can help overcome the limitations faced by smallholder farmers with limited land, as land size has proven to be a critical factor in driving overall growth in the agricultural sector (Harahap et al., 2022).

Digital farming applications that have developed in Indonesia, such as PetaniApps, Jiva, Agree, and Agridesa Apps, offer numerous benefits, including real-time weather forecasts, pest management advice, and market price updates, which are critical for smallholder farmers who often operate with limited resources and information. These technologies are particularly vital in addressing the challenges posed by climate change, which has exacerbated the unpredictability of farming conditions. By integrating digital tools into their practices, smallholder farmers can make more informed decisions, optimize resource use, and improve their overall productivity and resilience (Chen et al., 2016; Delgado-Ballester, 2004; Suleman et al., 2022). Tuban Regency, the prominent hub for food production in Jawa Timur, has been targeted for agricultural modernization programs, including government-backed digital initiatives and private-sector investments in precision farming technologies. Tuban had the highest number of farmer users on an agricultural application, a platform owned by PT. XYZ in East Java when the application was first introduced.

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Despite the potential benefits, adopting digital farming applications among smallholder farmers remains limited, particularly among older farmers, those with lower educational levels, and those with lower incomes (Tran et al., 2020). These demographic characteristics pose unique challenges in terms of technology adoption and usage. Older farmers may need to become more familiar with digital tools, while lower educational levels can hinder the understanding and effective use of these technologies (Ayisi et al., 2022; Ronaghi & Forouharfar, 2020). Additionally, financial constraints may limit access to smartphones and internet services, which are prerequisites for using digital farming applications. To address these challenges, it is essential to develop strategies that make digital farming applications more accessible and user-friendly for smallholder farmers.

E-service quality (e-servqual) is a critical factor influencing user satisfaction and loyalty in digital services. In digital farming applications, e-servqual encompasses various dimensions that affect the overall user experience. These dimensions include efficiency, system availability, fulfillment, and privacy. Each variable significantly shapes users' perceptions and attitudes toward the digital service (Parasuraman et al., 2005).

Several studies have examined the relationship between e-service quality and user loyalty in various digital services, including digital farming applications. For instance, a study found that efficiency and system availability were significant predictors of user satisfaction and loyalty among smallholder farmers using digital farming applications in some countries (Chen et al., 2016; Prasetya et al., 2020; Setiawan et al., 2022; Suleman et al., 2022). The study highlighted the importance of designing user-friendly interfaces and ensuring the reliability of the application to enhance user experiences.

Another study focused on the fulfillment dimension of e-servqual, emphasizing the need for accurate and relevant information in digital farming applications (Prasetya et al., 2020; Utami, Yulianto, & Fahrudi, 2024; Utami, Yulianto, & LIF, 2024; Zia & Alzahrani, 2022). The findings suggested that farmers are more likely to trust and continue using the application when they receive timely and valuable information. Additionally, the research explored the privacy concerns of users and their impact on loyalty (Agrawal et al., 2021; Megayani et al., 2023; Shyu et al., 2023; Utami, Yulianto, & LIF, 2024; Wisnel et al., 2022) The study revealed that ensuring data security and privacy is paramount in gaining users' trust, particularly in financial transactions and personal information.

While the existing literature provides valuable insights, gaps must be addressed. One notable gap is the need for more consistent findings regarding the impact of different e-servqual dimensions on user loyalty. For example, some studies have found that efficiency and system availability substantially impact loyalty, while others have highlighted the importance of fulfillment and privacy. This inconsistency suggests the need for further investigation to understand the contextual factors that may influence these relationships.

Moreover, limited research focuses explicitly on smallholder farmers and their unique needs and challenges in adopting digital farming applications. Most prior studies on digital farming adoption have focused on larger-scale commercial farms or general e-commerce platforms, rather than smallholder farmers who constitute the majority of Indonesia's agricultural workforce. Given their significant role in the agricultural sector, it is crucial to conduct more targeted studies to develop tailored strategies that enhance e-service quality and user loyalty among this group.

This study was explored to bridge these gaps by examining the impact of e-service quality on user loyalty to digital farming applications in Tuban Regency, Jawa Timur Province. By understanding smallholder farmers' specific needs and preferences, this

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research will provide valuable insights into how digital farming applications can be improved to serve this vital demographic better and enhance their overall agricultural productivity and sustainability. This study aims to investigate the impact of e-service quality (e-servqual) on user loyalty of digital farming applications in the Jawa Timur Province, explicitly focusing on understanding how these applications can better serve smallholder farmers.

METHODS

The research adopts a quantitative approach to investigate the relationships between e-service quality dimensions and user loyalty. This approach allows for collecting and analyzing numerical data, providing a basis for testing hypotheses and drawing generalizable conclusions. A cross-sectional survey design through purposive sampling was used, as it is well-suited for studying the current state of phenomena and identifying patterns and relationships among variables. The target population for this study comprises smallholder farmers in Tuban Regency who use digital farming applications. Smallholder farmers are defined as those who manage farms of relatively small size (< 2 ha), typically family-run, and rely on traditional farming practices. Given the focus on user loyalty and e-service quality, the study targets farmers who have adopted and regularly used digital farming applications. The challenges faced by Tuban smallholder farmers—low digital literacy, financial constraints, and limited infrastructure—are common across many Indonesian rural areas. Therefore, the findings can inform digital farming strategies in other agricultural hubs, such as Central Java, Sumatra, and Sulawesi.

A total of 124 smallholder farmers were selected to participate in the study based on the purposive sampling technique. This amount was obtained from the participation of target farmers who answered the survey questions during the data collection period from March 2024 to April 2024. The participating farmers represented each village, where out of a total of 320 registered farmers using the application, 214 farmers were willing to answer the questions. The final number obtained consists of those who completed the survey. This sample size was determined based on statistical power analysis, ensuring that the study has sufficient power to detect significant effects and relationships. The sample size also aligns with the requirements for SEM PLS analysis, which recommends a minimum sample size of 100-150 for reliable estimation and hypothesis testing (Hair et al., 2010).

The collected data were analyzed using Structural Equation Modeling (SEM) with Partial Least Squares (PLS). SEM PLS is a powerful multivariate analysis technique that combines factor analysis and regression, allowing for the simultaneous estimation of multiple relationships among observed and latent variables. It is particularly suited for exploratory and confirmatory research with complex models and small to medium sample sizes.

This study's structural model comprises five hypotheses establishing causal relationships among latent variables (**Figure 1**). The hypotheses are presented as follows: H1: Efficiency affects User Satisfaction; H2: Fulfillment affects User Satisfaction; H3: Privacy affects User Satisfaction; H4: System Availability affects User Satisfaction; and H5: User Satisfaction affects User Loyalty. The research model is set up to investigate how e-service quality and user satisfaction affect user loyalty.

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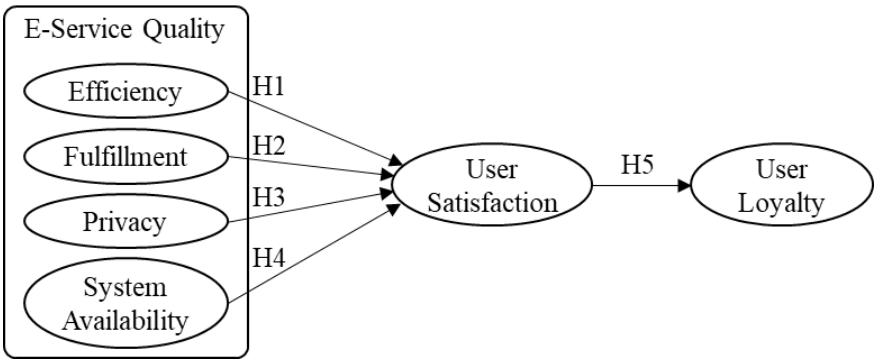

Figure 1. The conceptual framework for the research

RESULTS AND DISCUSSION

The SEM analysis conducted in this program (**Figure 2**) reveals that the e-servqual indicators—Efficiency, Fulfillment, Privacy, and System Availability—jointly significantly influence user loyalty toward digital farming applications, mediated by the satisfaction variable. The coefficient of determination or R^2 for the combined effect of all e-servqual variables on user satisfaction is 0.567 or 56.7% (**Figure 2**), considered moderate to strong (0.33 – 0.67), aligning with studies in digital service quality. This indicates that e-servqual variables in this study explain 56.7% of the variance in user satisfaction, while the remaining 43.3% is attributed to other factors not included in this model. Furthermore, user satisfaction has an effect strength of 0.715 or 71.5% on the user loyalty variable, indicating that user satisfaction highly predicts loyalty (>0.67), similar to results in e-commerce and mobile service studies. Meanwhile, the overall e-servqual indicators have a more moderate effect on user satisfaction, which aligns with the study by Widya and Elisabet (2022), who analyzed the impact of e-servqual on user satisfaction in the e-commerce sector.

Cronbach's Alpha in **Table 1** measures a construct's internal consistency. Values above 0.7 are considered good, indicating high reliability. The constructs' Cronbach's Alpha values are as follows: Efficiency (1.000), Fulfillment (0.808), Privacy (1.000), System availability (1.000), User Loyalty (0.872), and User Satisfaction (0.843). All constructs have Cronbach's Alpha values above 0.7, indicating high reliability and good internal consistency.

Composite reliability measures the reliability of the combined indicators within a construct. Values above 0.7 are deemed acceptable. The composite reliability values for the constructs are Efficiency (1.000), Fulfillment (0.885), Privacy (1.000), System Availability (1.000), User Loyalty (0.921), and User Satisfaction (0.906). All constructs have composite reliability values above 0.7, demonstrating excellent reliability of the indicators within each construct.

Several indicators are used to assess model suitability or fit in SEM analysis using SmartPLS. The following is a detailed discussion based on the model fit and path coefficient results (**Table 2**) provided. The normed Fit Index (NFI) for the saturated model is 0.841, and for the estimated model is 0.806. An NFI value below 0.9 indicates that the model is still within the fit criteria. NFI measures model improvement compared to the base model (null model), with values close to 1 indicating better model fit. The root Mean Square Theta (rms Theta) value is 0.224, which indicates that the overall model fit is good. An rms Theta value below 0.30 indicates a good model fit.

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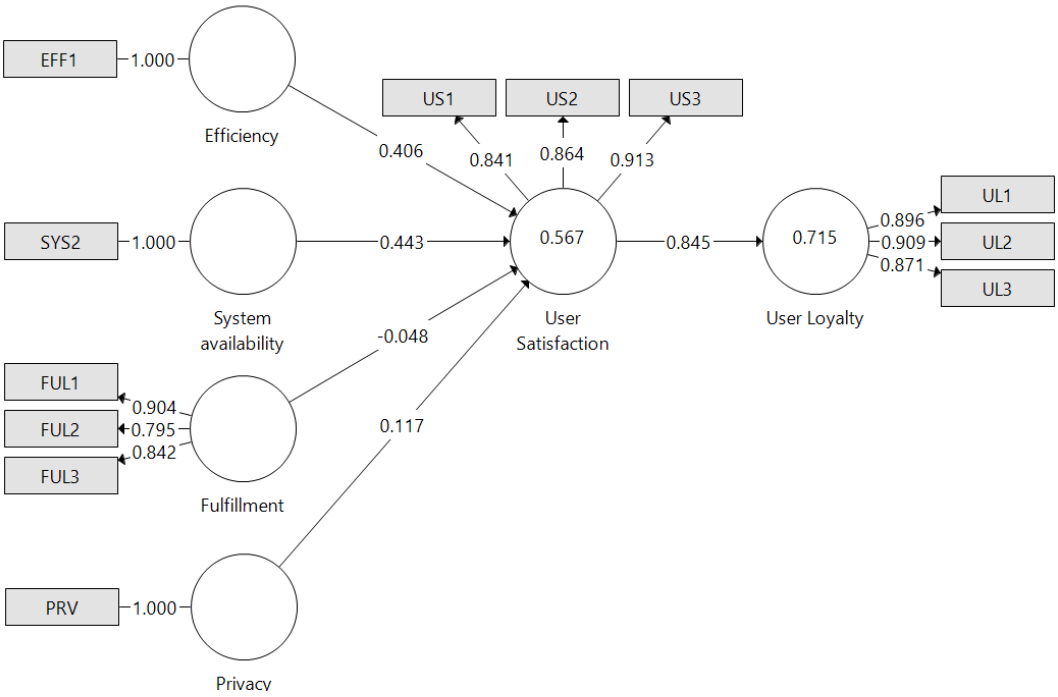

Figure 2. SEM Analysis Model

Table 1. Construct reliability and validity

	Cronbach's Alpha	rho_A	Composite Reliability	Average Variance Extracted (AVE)
Efficiency	1,000	1,000	1,000	1,000
Fulfillment	0,808	0,863	0,885	0,719
Privacy	1,000	1,000	1,000	1,000
System availability	1,000	1,000	1,000	1,000
User Loyalty	0,872	0,875	0,921	0,796
User Satisfaction	0,843	0,847	0,906	0,762

The path coefficients indicate the strength and significance of the relationships between the constructs. Efficiency and System Availability were found to have significant positive effects on User Satisfaction, with path coefficients of 0.406 and 0.443, respectively. This implies that higher efficiency and better system availability enhance user satisfaction with digital farming applications. These findings are consistent with the research by Widya and Elisabet (2022), which concluded that System Availability impacts user satisfaction in e-commerce, although Efficiency does not, due to dissatisfaction among specific e-commerce user segments when accessing the application. Nevertheless, digital farming applications must be designed more efficiently to cater to the user segment within the farming community, which requires a more straightforward system to access the application.

Privacy also positively affected User Satisfaction, though it was marginally significant (p-value = 0.058), meaning that data security and confidentiality matter to users but are not the primary concern. This is consistent with other findings that indicate that Security/Privacy has a significant relationship in enhancing user satisfaction with mobile social media applications (Yum & Yoo, 2023). In digital farming, where sensitive data may be involved, ensuring data privacy can enhance user trust and

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satisfaction. But many smallholder farmers may not be fully aware of potential risks related to personal data protection. Unlike in social media, digital farming applications typically do not handle highly sensitive financial and personal data.

Table 2. Path coefficient and hypothesis

Hypothesis	Original Sample (O)	Sample Mean (M)	Standard Deviation (Stdev)	T Statistics (|O/Stdev|)	P Values
Efficiency -> User Satisfaction	0,406	0,409	0,076	5,349	0,000
Fulfillment -> User Satisfaction	-0,048	-0,031	0,079	0,603	0,547
Privacy -> User Satisfaction	0,117	0,110	0,061	1,900	0,058
System Availability -> User Satisfaction	0,443	0,437	0,075	5,939	0,000
User Satisfaction -> User Loyalty	0,845	0,848	0,027	31,856	0,000

On the other hand, fulfillment had a negative but insignificant effect on User Satisfaction. Unlike other digital services (e.g., mobile banking and e-commerce), where accuracy and completeness of service is a major satisfaction driver (Suleman et al., 2022), it does not significantly impact digital farming application users. Farmers using these applications may not have high expectations for order fulfillment or transactional accuracy, as these apps are primarily used for information access rather than product purchasing. While fulfillment did not significantly impact user satisfaction, it remains a crucial aspect of e-service quality. Future studies could explore other dimensions of fulfillment that may be more relevant to the agricultural context (Cambra Baseca et al., 2019; Gerhardt et al., 2022; Green et al., 2022; Herlitzius et al., 2022; Migende et al., 2022; Paraforos & Griepentrog, 2021; R Shamshiri et al., 2018; Tsolakis et al., 2021; Wheeler et al., 2022).

User Satisfaction was found to have a strong positive effect on User Loyalty, with a path coefficient of 0.845. This indicates that satisfied users are likelier to remain loyal to digital farming applications. These path coefficients' high T-statistics and significant p-values further validate the relationships. This is consistent with other findings that indicate user satisfaction has a significant relationship with loyalty in mobile applications (Saragih, 2019; Suprapti & Suparmi, 2020). The strong relationship between user satisfaction and user loyalty emphasizes the need to improve digital farming applications continuously. Farmers are likely to continue using and recommending an application if it consistently meets their needs, reinforcing the importance of optimizing user satisfaction. This has significant implications for the developers and providers of digital farming applications. Improving e-service quality can increase user retention and positive word-of-mouth, expanding these applications' user base and impact.

Digital farming applications have become increasingly significant in enhancing agricultural productivity and sustainability. These applications provide farmers with essential information, facilitate efficient resource management, and improve agricultural practices. The efficient use of agri-inputs with the help of digital farming applications is expected to increase farmers' income, motivating them to continue participating in agricultural cultivation efforts sustainably (Azrani et al., 2023). In Tuban Regency, adopting digital farming applications has shown the potential to transform the agricultural landscape. However, the effectiveness of these applications largely depends on their e-service quality and the resulting user satisfaction and loyalty (Ammar et al., 2024; Oliveira-Jr et al., 2020; Paraforos & Griepentrog, 2021; Sarangi et al., 2018; Shchutskaya et al., 2020). This study

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examines e-service quality's impact on user loyalty to digital farming applications in Tuban Regency, Jawa Timur Province, Indonesia.

Based on these findings, several recommendations can be proposed. Developers should prioritize making digital farming applications more efficient and reliable. This can be achieved through ongoing technical enhancements, regular updates, and robust customer support. Ensuring minimal downtime and quick resolution of technical issues can significantly boost user satisfaction. Given privacy's positive impact on user satisfaction, it is crucial to implement stringent data protection measures. This includes securing user data against breaches, being transparent about data usage policies, and ensuring compliance with relevant data protection regulations.

Involving users in the development process through regular feedback can help identify areas for improvement. User-centric design principles prioritizing ease of use, accessibility, and intuitive navigation can enhance the overall user experience. Policymakers and developers should collaborate to provide educational programs that improve digital literacy among farmers. Training sessions, workshops, and instructional materials can help users make the most of digital farming applications, increasing their satisfaction and loyalty.

Continuous monitoring and evaluation of the application's performance and user feedback are essential. This can help promptly identify any issues and implement necessary improvements. Regular updates based on user needs and technological advancements can keep the application relevant and efficient. By focusing on these areas, developers and policymakers can enhance the quality and effectiveness of digital farming applications, ensuring they meet the needs of farmers in Jawa Timur Province. This, in turn, can lead to higher user satisfaction and loyalty, fostering sustainable agricultural practices and contributing to the overall development of the agricultural sector in the region.

CONCLUSION

The findings of this study underscore the critical role that e-service quality plays in fostering user loyalty towards digital farming applications in Jawa Timur Province. Specifically, the constructs of efficiency and system availability have been shown to enhance user satisfaction significantly. Though marginally significant, privacy also contributes positively, indicating that secure data practices build user trust. Despite its insignificant impact, fulfillment remains an important facet that warrants further investigation. User satisfaction emerged as a crucial mediator, strongly influencing user loyalty. Satisfied users are more inclined to remain committed to the application, reflecting the importance of maintaining high service standards to ensure continued usage and positive user experiences. The strong path coefficient between user satisfaction and user loyalty highlights the importance of enhancing the overall user experience to cultivate a loyal user base. Developers of digital farming apps should create an AI chatbot to assist farmers with weather updates, information on crop diseases, and current market prices. It is also important for the app to function offline, allowing farmers to access essential data in areas with poor internet connectivity. To enhance data privacy protection, developers should implement end-to-end encryption, enable users to manage their data sharing preferences, and provide clear and understandable privacy policies. Strong regulations from policymakers should support this. Furthermore, to enhance user engagement and foster trust, it is advisable to introduce a feedback feature, integrate gamification techniques to promote continued app usage, and offer educational resources, such as tutorial videos and step-by-step guides, for new users.

Policymakers ought to advocate for subsidized digital training programs that

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include on-ground workshops and mobile-based tutorials, enabling farmers to maximize the advantages of digital farming applications. Promoting public-private partnerships is also crucial; incentivizing technology companies to collaborate with agricultural cooperatives can stimulate innovation and enhance the digital tools available to farmers. While the findings are most directly applicable to Tuban Regency, they offer valuable insights for other rural regions in Indonesia, making this study a relevant model for improving digital farming adoption nationwide. Future studies should consider larger, more diverse samples across multiple provinces with higher or lower digital penetration to further validate the findings.

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