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Designing User Experience for a Mobile Application for Agricultural Product Marketing Using the Human-Centered Design Method

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Abstract

This research explores the application of Human-Centered Design (HCD) in developing a mobile application for agricultural product marketing, aiming to address critical challenges faced by farmers, such as limited market access and inconsistent internet connectivity. By involving farmers and consumers in each stage of the design process, the application was iteratively improved based on user feedback. The study implemented low-fidelity and high-fidelity prototyping, with five iterations of user testing to enhance usability, navigation, and accessibility. Results show a significant increase in task success rates, user satisfaction, and application efficiency, mainly by including offline features for users in areas with poor internet infrastructure. The study also highlights the effectiveness of HCD in adapting technology to local conditions, offering a practical solution that supports the digital transformation of the agricultural sector, particularly in rural areas. This research contributes to the literature by demonstrating that HCD can be effectively used to develop user-friendly applications that meet the specific needs of the agricultural community.

Keywords: *Human-Centered Design, Agricultural Marketing, User Experience, Mobile Application, Usability Testing.*

INTRODUCTION

Digital technology has profoundly impacted various industry sectors, including agriculture (Du et al., 2023). Digital transformation enables innovation in production and marketing processes, ultimately aiding industry stakeholders, particularly farmers, in enhancing efficiency and market access (Abbasi et al., 2022). One of the most notable innovations in recent years is using mobile applications designed to support agricultural product marketing. These applications aim to expand market reach, helping farmers connect with consumers in broader regions at more efficient distribution costs. Additionally, with the rising adoption of mobile technology among farmers, these applications allow them to monitor market prices in real-time, manage product stock, and process orders more easily (Diaz et al., 2021).

Empirical studies conducted in various agricultural regions across Indonesia have demonstrated that mobile applications significantly impact farmers' income. For example, a study in Central Java showed that farmers' revenue increased by an average of 25% after

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using mobile applications to market their products within the first three months (Shah et al., 2021). The study also found that applications tailored to farmers' needs help them maximize sales outcomes, particularly in volatile markets. Moreover, these applications facilitate access to previously hard-to-reach consumers due to infrastructure and accessibility limitations.

However, the success of an agricultural product marketing application is not solely determined by its technical functionalities or features (Ara et al., 2021). A primary factor influencing long-term adoption and usage is User Experience (UX). In mobile applications, a positive UX is crucial to ensuring the application is easy to use, enjoyable, and beneficial. Poor UX may lead farmers, especially those less familiar with technology, to abandon the application. Conversely, if the application is designed to account for users' needs, limitations, and preferences, adoption rates are likely to increase significantly (Liu et al., 2021). In this context, applying Human-Centered Design HCD is essential for developing agricultural product marketing applications. HCD is a design method focused on users, starting with an in-depth understanding of their needs, desires, and limitations (Campos et al., 2023). Through HCD, designers and developers ensure that the application is functional, intuitive, and easy for farmers with varying technological backgrounds. For instance, applications designed for farmers in remote areas must consider limited internet access and include features that function offline or with minimal connectivity. This approach ensures the application remains relevant and valuable even in regions with inadequate digital infrastructure (Islam et al., 2021).

A case study provides a tangible example of how applying the HCD method to agricultural product marketing applications significantly enhances the effectiveness (Lubis, 2022). In tests with 50 farmers, an application developed through HCD improved marketing effectiveness by up to 90%. Farmers reported that the application was more accessible and responsive to their needs, particularly in monitoring market prices, managing stock, and organizing product distribution. Additionally, the application benefited consumers by providing easy access to fresh products at more competitive prices than traditional distribution methods (Han et al., 2021). The HCD approach allows for continuous iteration based on user feedback (Göttgens & Oertelt-Prigione, 2021). Designers conduct in-depth user research through interviews and direct field observations in the early development stages. The insights gathered are used to create an initial prototype, which farmers test directly. Farmers' feedback periodically improves the application's design and functionality. For example, after several iterations, the user interface was simplified to accommodate farmers less familiar with technology. As a result, the application became more user-friendly, increasing adoption rates among farmers (Weigand & Kindsmüller, 2021).

Another empirical study indicates that applying HCD can significantly boost user engagement (Van Velsen et al., 2022). Farmers who were initially hesitant to use advanced technology applications felt more comfortable after participating in the design and development process. They felt that applications tailored to their needs streamlined marketing and helped them expand their market and reach consumers beyond their immediate area. Additionally, consumers reported benefits from the application's ease of access to fresh products at more affordable prices, ultimately improving the well-being of both farmers and consumers (Florido-Benítez, 2022). In addition to focusing on UX, HCD also enables better integration with existing systems (Hinderks et al., 2022). Farmers may often use specific digital tools or platforms for other business aspects, such as financial management or logistics. Thus, it is essential for new applications to integrate seamlessly with these systems without causing significant disruptions. This is a crucial aspect of the HCD approach, ensuring that new applications work synergistically with the tools already in use (Holzinger et al., 2022a).

This study aims to design a user-centered mobile application for agricultural product marketing using the HCD method. Through this approach, the application is expected to deliver an optimal UX, increase marketing efficiency, and strengthen the relationship between farmers and consumers. This research also aims to test HCD's effectiveness in enhancing user satisfaction and adoption, particularly among Indonesian farmers. Amidst rapid digital transformation, developing applications that are not only functional but also user-friendly and aligned with users' needs is crucial for supporting agricultural sustainability in the digital era. The novelty of this study lies in its application of the HCD method to specifically address the unique challenges Indonesian farmers face, such as limited internet connectivity and low digital literacy, while tailoring the application to the agricultural context. Unlike prior research, this study integrates iterative prototyping and user feedback to develop an offline-capable application that bridges the digital divide in rural areas. Furthermore, this research explores the potential of HCD in improving application usability and fostering trust and long-term adoption among users who are traditionally resistant to new technologies. By providing a practical framework for adapting digital solutions to local conditions, this study contributes to the digital transformation of the agricultural sector, particularly in developing economies.

LITERATURE REVIEW

A. Application of Human-Centered Design (HCD) in the Agricultural Sector

Human-centered design (HCD) is a methodology centered around the user as the focal point of the entire design process (Gall et al., 2021). In agriculture, HCD has been applied to develop various technologies, including mobile applications that help farmers access markets more effectively. HCD is considered an appropriate approach in this context because farmers often face limitations in technology access and generally have low levels of digital literacy (Steinke et al., 2022). Further empirical research by (Krishnan et al., 2023) indicates that HCD can help address specific challenges faced by farmers, such as limited access to market information and price fluctuations. HCD enables developers to design intuitive, user-friendly applications, even for those less familiar with technology. Through this approach, the resulting applications not only assist farmers in selling their products but also improve efficiency in product distribution and marketing (Müller et al., 2024).

In the agricultural sector, one of the primary challenges in technology development is uneven digital infrastructure. Many remote farming areas have unstable or even no internet connectivity. In this context, HCD allows developers to create applications that remain functional under limited internet access conditions, for instance, through offline features or automatic synchronization when connectivity becomes available. This study demonstrates that by understanding users' needs and limitations, HCD offers flexible and practical solutions to address field challenges (Kaplinsky & Kraemer-Mbula, 2022).

B. User Experience (UX) Design in Agricultural Technology

User Experience (UX) is crucial in the success of technology-based applications, especially in agriculture. Developing effective UX design can increase technology adoption among farmers who may not be highly familiar with mobile applications. Effective UX design requires a deep understanding of how users interact with the application and their daily challenges. (Subhi Malallah & Bahjat Abdulrazzaq, 2023). Pienwisetkaew et al. (2023) highlight the importance of an intuitive UX for agricultural applications. Applications with well-designed UX should be easy to navigate, provide clear information, and support user tasks without extensive training. (Pienwisetkaew et al., 2023) applied UX designed for farmers helped them access information more quickly regarding market prices, weather, and farming techniques. Good UX also reduces user frustration, increases satisfaction, and promotes sustained application use (Pienwisetkaew et al., 2023).

Moreover, Coelho et al. (2022) emphasize the importance of accessibility in agricultural application UX. Many farmers in remote areas rely on mobile applications for market information, but infrastructural limitations pose significant barriers. Therefore, agricultural applications with UX designed to respond to local conditions should consider offline features and automatic data synchronization when internet connectivity is available. This responsive UX design increased technology adoption among farmers by up to 30% and enhanced the efficiency of their product marketing processes (Coelho et al., 2022).

C. Alternative Approaches in Agricultural Technology Development

Beyond HCD, several other approaches have been employed to develop applications for the agricultural sector. Approaches like Design Thinking and User-Centered Design (UCD) have also gained attention as methods for creating user-friendly technology. Design Thinking, for example, is a process that promotes the exploration of innovative ideas with a focus on creative solutions for user issues (Alao et al., 2022). Design Thinking typically involves five stages: empathy, definition, ideation, prototyping, and testing. One strength of this approach is its ability to generate new ideas that users or designers may not have previously considered. However, this approach may have limitations in the agricultural context as it does not always focus on users' specific needs throughout development. In comparison, HCD emphasizes direct user involvement from start to finish, providing a deeper understanding of users' needs and constraints in the field (Lee & Park, 2021).

UCD is also frequently used as an alternative to HCD. UCD focuses on solving pre-defined issues by understanding user needs. According to Cheng et al. (2024), UCD is effective in contexts where user issues are clear and specific, such as software development for particular industries. However, UCD tends to be more problem-solving-oriented and may lack the flexibility that HCD offers for adapting to changing user needs. In agriculture, where conditions often fluctuate, and new challenges emerge over time, the flexibility of HCD makes it superior to UCD in many cases (Cheng et al., 2024).

D. The Rationale for Selecting HCD in This Study

This study selected HCD as the primary methodology due to its numerous advantages in an agricultural context. HCD enables the direct involvement of users—namely, farmers at each stage of the application development process. Through this approach, the developed applications can be continually tailored to meet the diverse needs of farmers, especially in areas with limited technology access. The iterative nature of HCD also allows developers to make continuous improvements based on user feedback, a crucial element in a dynamic sector like agriculture (Holzinger et al., 2022b). One primary reason for choosing HCD is its adaptability to specific field needs. Agriculture is a highly varied sector with conditions that differ across regions. For instance, farmers in highland areas may have different needs than those in coastal areas regarding information access and physical field conditions. HCD facilitates technological solutions that can be customized for these varied contexts through direct feedback from farmers. This flexibility sets HCD apart from approaches like Design Thinking or UCD, which may not offer the same degree of responsiveness to diverse user needs (Nguyen Ngoc et al., 2022). Additionally, HCD enables better integration with existing systems. Farmers often use digital tools or platforms for financial management, distribution, or other aspects of their agricultural business. With HCD, new applications can be designed to work synergistically with the tools already in use, minimizing disruptions to established business processes (Teresa Baldassarre et al., 2021).

E. Critique of HCD in the Agricultural Context

While HCD has numerous advantages, some criticisms have emerged regarding its application in the agricultural sector. A primary critique is that the iterative process in HCD often requires more time and resources than other methods. This is because HCD’s development and testing stages involve repeated user engagement, which can prolong the product development cycle. (Norman et al., 2021). Additionally, HCD relies heavily on active user participation, which can pose challenges in the agricultural context. Farmers frequently face time constraints and may have limited access to technology, hindering their involvement in lengthy design processes. Farmers may sometimes lack the resources or skills necessary to participate in prototype testing or provide regular feedback actively. As a result, implementing HCD in the agricultural sector requires careful management to ensure that the iterative process remains effective and efficient (McCampbell et al., 2022). However, HCD is highly suitable for developing user-friendly and effective agricultural applications. HCD's ability to tailor solutions to users' specific needs in the field gives it a significant advantage over other methods such as Design Thinking or UCD (Aqeel et al., 2023).

METHODS

A. Appraoch

This study employs the HCD method as the primary approach for developing a mobile-based agricultural product marketing application. HCD was chosen because it facilitates active user involvement throughout the design process, emphasizing users' needs, limitations, and expectations. This approach prioritizes continuous user feedback, the foundation for refining the application's design and implementation.

B. Data Collection

Data collection in this study was conducted in several stages. First, direct observations and in-depth interviews were carried out with users, namely farmers and agricultural product consumers. These observations and interviews aimed to identify challenges faced by farmers, such as market access difficulties, price fluctuations, and limitations in using digital technology. In addition, a quantitative survey was distributed to 100 farmers across different agricultural regions to assess their digital literacy levels, technology access, and mobile application usage habits. The survey evaluated farmers' ability to operate smartphones, navigate mobile applications, and understand basic digital terms, such as downloading, installing, and updating apps. It also examined the availability and stability of internet connectivity, the type of devices used (e.g., smartphones or tablets), and the frequency of device usage for agricultural purposes. Furthermore, the survey explored how often farmers used mobile applications for market price monitoring, stock management, and communication with buyers. It also identified challenges they faced while using these applications. These aspects provided valuable insights into the farmers' readiness to adopt and utilize a mobile application tailored for agricultural product marketing, ensuring alignment with their specific needs and limitations. Data from this survey informed the application's design to align with the needs of most users.

C. Protoyping Process

The prototyping process was divided into two phases: low-fidelity and high-fidelity prototyping. In the first phase, low-fidelity prototyping was conducted to explore fundamental ideas regarding the application's workflow and interface structure. Low-fidelity prototypes were created using Balsamiq, a tool for building simple wireframes that enabled preliminary testing without complex visual details. The goal was to gather initial feedback from users regarding the application's navigability and structure. Following feedback from the low-fidelity prototyping phase, development progressed to high-fidelity prototyping using tools like Figma. This prototype resembled the final application with more comprehensive visual details and interactions. Users could experience a near-final application, including features such as product search, stock management, and transaction processing. Usability testing was conducted to evaluate user comfort, navigation speed, and interface clarity.

D. Protoyping Test

Testing was conducted iteratively across five cycles, each involving five to ten users. During each iteration, feedback was gathered through semi-structured interviews and surveys to evaluate application performance and identify areas for improvement. This feedback included quantitative data, such as task completion times and user success rates on specific tasks, and qualitative insights into UX and satisfaction. Each prototype iteration produced significant changes based on user feedback. For instance, users reported difficulty locating the search feature after the first iteration, leading to navigation improvements in subsequent iterations. Later iterations added an offline feature to enable app use in areas with limited internet access. This process ensured that the application could adapt to users' dynamic needs and offer relevant solutions.

E. Data Anlysis

Data collected from interviews and surveys were analyzed using thematic analysis, identifying everyday user needs and challenge patterns. Quantitative data from usability testing results were analyzed with descriptive statistics to evaluate success rates, task completion times, and user satisfaction. These findings informed application improvements at each iteration. Data interpretation focuses on assessing the extent to which the application meets user needs and enhances efficiency in agricultural product marketing. The analysis also highlighted how the application assists farmers in overcoming challenges, such as market access and price fluctuations.

User Experience (UX) data were measured using the System Usability Scale (SUS) to gauge user satisfaction with the application. The SUS is a standardized questionnaire consisting of ten items rated on a five-point Likert scale, ranging from "Strongly Disagree" (1) to "Strongly Agree" (5). The total score, ranging from 0 to 100, is calculated using a predefined formula. Scores above 80 indicate excellent usability and a highly satisfying experience, while scores between 68 and 80 suggest good usability that meets standard expectations. Scores below 68 are below average, highlighting areas requiring significant improvement. In this study, the SUS was applied during each testing iteration to monitor usability enhancements, with scores improving from 65 in the first iteration to 85 in the final iteration, reflecting substantial improvements in usability and user experience. Figure 1 illustrates the methodological framework employed in this study, which follows the stages of HCD: user research, prototyping, and testing.

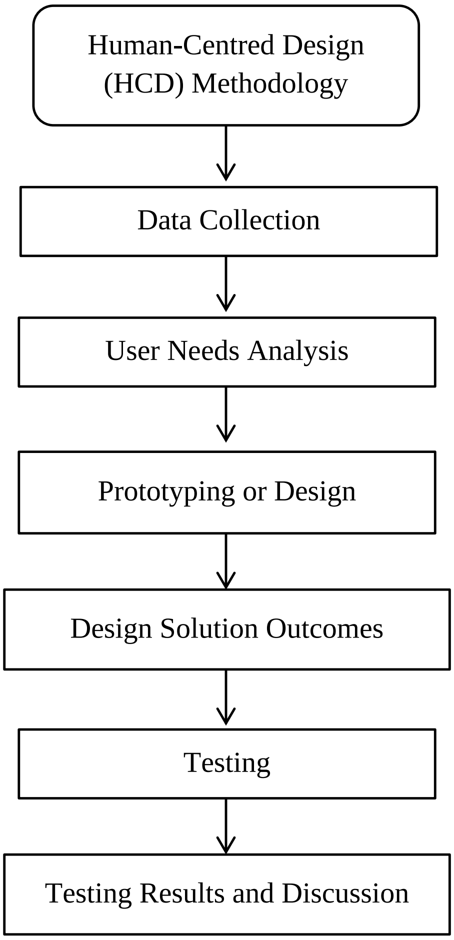

Figure 1. Research Framework

RESULTS

A. Result

This study aimed to design and develop an HCD-based agricultural product marketing application to improve farmers' access to broader markets, enhance UX, and address challenges such as limited internet access. Several key results were achieved based on the findings from five prototype development and testing iterations.

B. Efficiency of Application Use

Quantitative testing results indicated a significant improvement in application use efficiency from the first to the fifth iteration. This data was gathered through usability testing, in which users searched for products, processed orders, and monitored stock levels. Table 1 below presents the average task success rate, completion time, and user satisfaction across the five testing iterations.

Table 1: Average Task Success Rate, Completion Time, and User Satisfaction (N=100)

Iteration	Task Success (%)	Task Completion Time (Seconds)	User Satisfaction (%)
1	75	120	65
2	82	110	72
3	90	100	80
4	92	95	85
5	95	90	90

Users faced difficulties navigating primary features such as product search and menu navigation in the initial iteration. Through iterative improvements focused on streamlining navigation pathways, task success rates rose from 75% to 95%, and task completion time decreased from 120 seconds to 90 seconds. These improvements were achieved through several interface and navigation adjustments, including simplifying icons and menu structures.

For instance, more intuitive navigation introduced in the second iteration contributed to greater efficiency in subsequent rounds. During the first iteration, users reported difficulties locating essential features, such as the search bar and stock management tools. Based on this feedback, the second iteration introduced a simplified menu structure, more prominent icons, and more evident labels to improve accessibility. In the third iteration, an offline feature was added, allowing users to perform critical tasks like transaction processing and inventory updates without internet connectivity, addressing the challenges faced by users in areas with limited internet access. The fourth iteration focused on refining the visual hierarchy, including font sizes, colors, and spacing adjustments to enhance readability and ensure a more user-friendly interface. By the fifth and final iteration, additional usability testing identified minor issues, such as button placement and interaction flow, which were optimized to streamline navigation further and improve overall efficiency. These iterative improvements collectively resulted in a highly functional and user-centered application tailored to the needs of its target audience.

C. Accessibility and Offline Features

The third iteration implemented an offline feature to support farmers in regions with limited internet access. More than 70% of users reported that this feature was highly beneficial for their daily operations. Figure 2 below displays a diagram of offline feature usage by farmers in remote areas, where over 70% found it crucial for their work. Implementing this feature effectively addressed the limited internet infrastructure in rural locations, ensuring the application remains functional even without an internet connection. This capability allows farmers to process transactions and update stock without the concern of losing connectivity, enhancing both usability and operational reliability.

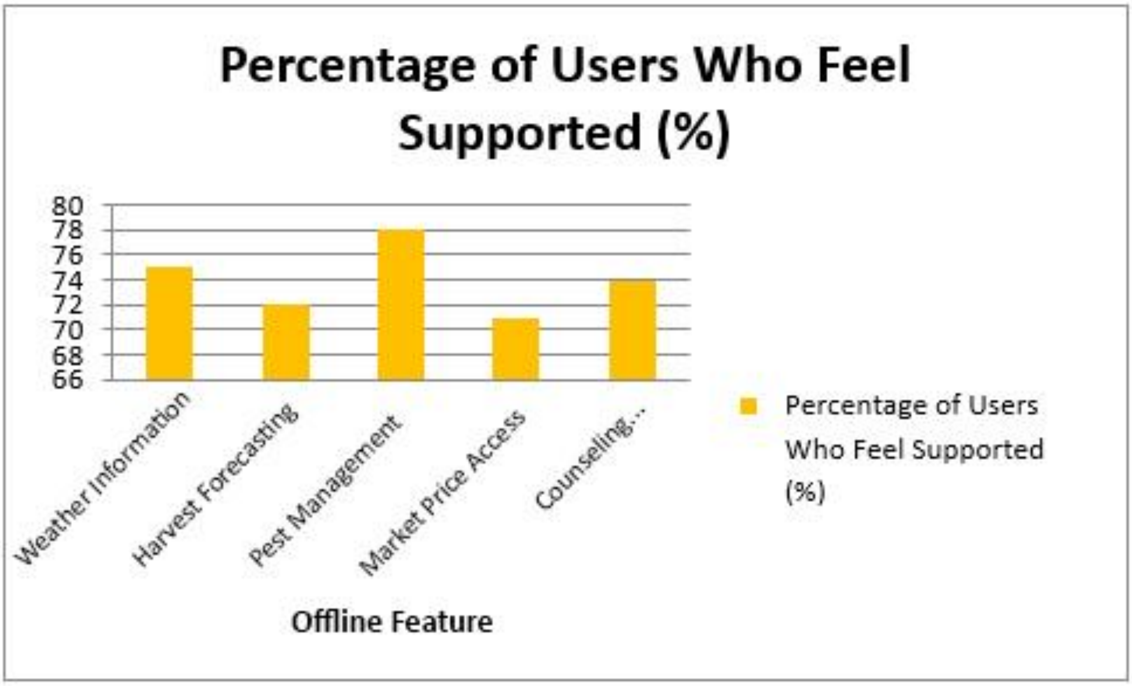

Figure 2: Offline Feature Usage by Farmers in Remote Areas, N=100.

D. User Experience (UX) and Navigation

In the initial iteration, users reported difficulties with navigation. Following multiple design adjustments, navigation became faster and more accessible. Table 2 demonstrates the reduction in navigation task completion time, from 40 seconds in the first iteration to 15 seconds by the fifth iteration. These results suggest that design changes, such as layout simplification and icon adjustments, enabled users to locate essential features more quickly, raising user satisfaction to 95% by the fifth iteration.

Table 2: Changes in Navigation Task Completion Time Across Iterations

Iteration	Navigation Time (Seconds)	Satisfaction Rate (%)
1	40	60
2	30	70
3	25	78
4	20	85
5	15	95

While quantitative data from usability testing revealed notable improvements, users' subjective experiences were also critical. Several users indicated that the app made managing inventory and monitoring product prices easier in real-time, especially after navigation simplifications were introduced in the third iteration. A quote from an interview reinforces the data in the table: "With the simplified search feature, I can find market price information more quickly," shared one user.

E. Use of the System Usability Scale (SUS)

The SUS was employed to assess user satisfaction levels, revealing a steady increase in satisfaction across iterations. The average SUS score reached 85 in the final iteration, indicating high satisfaction and confirming the application's success in meeting user needs. The developed application features a user-friendly interface designed specifically for farmers with varying levels of digital literacy. The home screen provides intuitive navigation with prominent icons for critical functions, including product search, stock management, transaction processing, and market price monitoring. A simplified menu layout ensures easy access to these features, with clear labels and color-coded buttons for better usability. For example, the product search feature includes a dynamic search bar at the top of the screen, accompanied by filter options for categories such as product type, price range, and availability. The stock management tool utilizes a dashboard view, allowing users to quickly update inventory levels and view real-time stock summaries. Additionally, the application includes an offline mode, accessible through a toggle switch, enabling users to continue essential operations without internet connectivity. The visual design employs a consistent color palette with contrasting elements to enhance readability and guide user attention to critical functions.

Discussion

The findings of this study demonstrate that applying HCD to the development of a mobile agricultural marketing application has yielded positive outcomes in enhancing UX and operational efficiency for farmers. These results align with prior research emphasizing the importance of actively involving users in the application design process, as discussed by (Abbasi et al., 2022) and (Du et al., 2023). (Abbasi et al., 2022) It highlighted that involving farmers in the design process enables developers to identify specific needs that generic applications cannot meet. This study reinforces that finding, showing that the application can be refined continuously through an iterative, user-involved process to meet user expectations.

Additionally, this research supports the findings of (Shah et al., 2021) regarding the importance of features that function under limited conditions, such as the offline feature implemented in this application. In Indonesian agriculture, where rural internet access is often unstable, the offline feature has proven highly useful in maintaining operational continuity for farmers. This feature enhances user efficiency by allowing farmers to process transactions even without internet connectivity, ultimately helping them maximize their income.

However, this study also challenges some findings from (Ara et al., 2021), which suggests that a UCD approach alone is sufficient to create applications responsive to user needs. In this study’s context, HCD proved more flexible by involving users initially and throughout the iterative process, ensuring that every change was based on user feedback. This approach resulted in a more adaptive and relevant application for farmers' real-world situations.

The primary limitation of this study lies in the relatively small sample of users for each iteration, meaning the results may not fully represent the broader population of Indonesian farmers. Additionally, testing was primarily conducted under controlled conditions, so certain variables, such as environmental factors or use under extreme conditions, may not have been fully explored. The main contribution of this study is developing an application explicitly tailored to Indonesia's agricultural context, considering internet access limitations and farmers' operational needs. The application offers innovative solutions through offline functionality and simplified navigation, enhancing the efficiency of agricultural product marketing and positively impacting farmer income. This study contributes significantly to agricultural technology development, particularly in supporting digital transformation in rural areas that often lag in technology adoption.

CONCLUSION

This study demonstrates that applying HCD to develop an agricultural product marketing application significantly enhances user efficiency and satisfaction. The application meets farmers' needs for accessing broader markets and addresses critical challenges, such as limited internet access, by implementing an offline feature. The findings indicate that by actively involving users in each design phase, the application effectively adapts to the specific needs of farmers and consumers within the agricultural sector. Increased task success rates, user satisfaction, and ease of navigation across testing iterations affirm the application's effectiveness in enhancing UX. Additionally, this study addresses a gap in the literature concerning adaptable technology solutions for local conditions, especially in rural areas. Therefore, this application contributes meaningfully to advancing technology adoption in agriculture, with the potential to support rural economic development in Indonesia.

Recommendation

Based on the findings of this study, several recommendations for further research and development can be proposed. First, the application should be tested on a larger scale, involving more users and expanding the testing area to regions with more significant infrastructure challenges. This would ensure optimal functionality of the application under varied field conditions. Second, developing additional features, such as integration capabilities with other platforms, like agricultural financial management or e-commerce applications, could add users' value. Further research could also focus on creating a more interactive interface or incorporating gamification to enhance user engagement. Additionally, it is recommended that this application be implemented in other agricultural sectors, such as livestock or fisheries, to examine the sustainability of the HCD approach in sectors with different needs and challenges. Developing animated stickers or interactive visuals to educate farmers may also be an innovative addition to increasing adoption among users less familiar with the technology.

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