

Enhancing Agricultural Practices through ICT: The Diffusion and Impact of the Among Tani Application in Batu City, Indonesia

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Abstract

This study examines the implementation and impact of the Among Tani application, a digital platform designed to support farmers in Batu City, Indonesia, as part of a broader smart city initiative. Utilizing a qualitative approach, the research investigates the diffusion process of the application, its role as a virtual communication medium, and its effects on organizational structures within farmer groups. The study reveals a staged adoption process influenced by factors such as farmer age and crop vulnerability. While the application has enhanced access to agricultural information and improved pest management, challenges including the digital divide and integration with traditional practices persist. The findings highlight the complex interplay between digital innovation and existing agricultural systems, emphasizing the need for context-sensitive approaches in implementing agricultural technologies. This research contributes to the understanding of digital agriculture's potential in supporting sustainable rural development and provides insights for future smart city initiatives in agricultural contexts.

Keywords: digital agriculture; smart city; communication technology adoption; farmer organizations; rural development.

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I. Introduction

The integration of smart technologies in urban areas has become a focal point in enhancing various aspects of city life, ranging from health and economy to agriculture and transportation (Chentouf & Bouchkaren, 2023). Smart city initiatives leverage IoT devices and information and communication technologies to create more efficient and sustainable urban environments (Chentouf & Bouchkaren, 2023). In the context of agriculture, the use of smart technologies can revolutionize farming practices and contribute to the realization of smart cities (Alim et al., 2019). One such application that holds promise in this regard is the Among Tani application, which serves as a virtual communication medium for farmers.

Batu City, known for its agricultural potential, aligns with its vision, "Desa Berdaya Kota Berjaya Terwujudnya Kota Batu Sebagai Sentra Agro Wisata Internasional Yang Berkarakter, Berdaya Saing Dan Sejahtera" (Dinas Komunikasi dan Informatika, 2020). The majority of Batu's population, which totals 214,597 residents, engage in farming or animal husbandry (Badan Pusat Statistik Kota Batu, 2019). This highlights the critical role of agriculture in the local economy, necessitating advancements in agricultural practices through technological interventions.

Among Tani can play a crucial role in facilitating communication and knowledge sharing among farmers, thereby enhancing agricultural practices within the framework of smart city development (Alim et al., 2019). By leveraging this virtual platform, farmers can access real-time information on weather patterns, market prices, best agricultural practices, and even connect with experts for guidance (Pambudi, 2024). This aligns with the broader goal of smart city implementations, which aim to improve efficiency, sustainability, and quality of life through the integration of technology (Baltac, 2019).

Smart technology is significantly transforming various aspects of city life, including agriculture, by integrating innovative solutions to enhance productivity, sustainability, and efficiency. The adoption of smart farming technologies, such as the Internet of Things (IoT), artificial intelligence (AI), drones, sensors, and data analytics, has revolutionized traditional agricultural practices into smart agriculture, optimizing farming operations and improving agricultural outcomes (Choudhary, 2024). These technologies enable precision agriculture, real-time monitoring, and data-driven decision-making, leading to increased crop yield, quality, and resource efficiency (Choudhary, 2024).

Wireless sensor technology plays a vital role in smart agriculture and smart irrigation, offering real-time data collection, monitoring, and control capabilities to optimize water usage and enhance crop growth (Pang, 2023). By deploying wireless sensor networks in agricultural settings, farmers can access critical information on soil moisture levels, weather conditions, and crop health, enabling them to make data-driven decisions and improve irrigation efficiency (Pang, 2023).

The adoption of smart agriculture technologies brings various benefits, including increased production, real-time data insights, remote monitoring, and enhanced sustainability (Bala, 2024). By embracing digital technologies and IoT solutions, farmers can streamline operations, reduce manual labor, and enhance overall farm management practices. Smart agriculture solutions also enable farmers to access real-time production insights, optimize resource allocation, and improve decision-making processes, leading to sustainable agricultural practices and increased profitability (Bala, 2024).

Despite the promising potential of smart technologies, the adoption and effective utilization of such tools in agriculture remain limited in some regions. Previous research has indicated that many farmers, particularly in developing countries, face challenges in accessing and using digital tools due to a lack of technical skills and infrastructure (Rachmawati et al., 2020). In the meantime, it was also widely recognized that development inequality was the crucial problem affecting agricultural development and the effectiveness of its transformation process (Abduh, 2023). The primary research problem addressed in this study is the gap in the adoption and effective use of the Among Tani application by farmers in Batu City, which hinders their ability to benefit from the smart city initiative.

To address this problem, the study proposes an investigation into the diffusion process of the Among Tani application among farmers in Batu City. This involves examining the socialization efforts by the Department of Agriculture and Food Security, the establishment of clear organizational hierarchies, and the role of community leaders and facilitators in promoting the adoption of the application. By identifying the key factors influencing the adoption and utilization of the Among Tani application, the study aims to develop strategies to enhance its effectiveness and impact on agricultural practices.

The diffusion of innovations theory, as articulated by Everett M. Rogers, provides a comprehensive framework for understanding the adoption process of new technologies. According to Rogers, the adoption process involves several stages, including knowledge acquisition, persuasion, decision-making, implementation, and confirmation (Bilali et al., 2021). This theoretical framework will guide the investigation of how farmers in Batu City learn about, evaluate, and decide to adopt the Among Tani application.

Research has shown that effective communication channels and engagement strategies are crucial for promoting the diffusion of innovations. Local-level change agents, such as community leaders or agricultural extension workers, play a significant role in facilitating the adoption of new technologies (Heriaty & Ar, 2021). By leveraging these change agents, the adoption of the Among Tani application can be accelerated, leading to widespread usage and acceptance within the farming community. Additionally, the involvement of millennials in the adoption and diffusion process can bring fresh perspectives and innovative approaches to technology uptake (Heriaty & Ar, 2021).

The study will also draw on insights from research on ICT adoption in agriculture, which emphasizes the importance of socialization efforts and community engagement in promoting technology uptake (Vanya & Suherman, 2022). Socialization activities led by the Department of Agriculture and Food Security in Batu City have been pivotal in introducing the application to farmers and encouraging its active usage within the community (Vanya & Suherman, 2022). By raising awareness, offering training, and facilitating user interactions, stakeholders can boost the adoption and utilization of the Among Tani application.

The integration of smart technologies in agriculture has been widely studied, with research highlighting the benefits of digital tools for improving agricultural practices and productivity. However, much of the existing literature focuses on the adoption of general agricultural technologies or commercially developed applications. There is a notable gap in research specifically examining government-initiated applications designed for local farmers within the framework of smart city development. This study aims to fill this gap by focusing on the Among Tani application, a government-developed tool specifically for farmers in Batu City.

Furthermore, previous studies have largely examined the technical and infrastructural challenges associated with technology adoption in agriculture. There is limited research on the social and organizational factors that influence the adoption and effective use of digital tools by farmers. This study seeks to address this gap by investigating the role of socialization, organizational structures, and community engagement in the adoption of the Among Tani application. By doing so, it aims to provide a more holistic understanding of the factors that facilitate or hinder the diffusion of agricultural innovations.

The primary objective of this study is to analyze the diffusion process of the Among Tani application among farmers in Batu City. It seeks to identify the key factors influencing the adoption and utilization of the application and to evaluate its impact on agricultural practices and productivity. The study also aims to examine the role of the Among Tani application as a virtual communication medium between farmers, government officials, and agricultural experts.

The novelty of this study lies in its focus on a government-developed application specifically designed for farmers within the context of smart city development. Unlike previous research that has primarily focused on commercially available agricultural technologies, this study examines an application developed and promoted by the local government to enhance agricultural practices and promote sustainable development. This represents a new approach to leveraging digital tools for public service delivery in the agricultural sector.

The scope of the study includes an investigation into the socialization efforts by the Department of Agriculture and Food Security, the establishment of organizational hierarchies, the role of community leaders and facilitators, and the impact of the Among Tani application on agricultural knowledge and productivity. The study will also explore the perceptions and experiences of farmers using the application, providing insights into the challenges and opportunities associated with its adoption and utilization.

The findings of this study will have practical implications for enhancing the adoption and effective utilization of the Among Tani application among farmers in Batu City. By identifying key factors influencing the adoption process and developing strategies to address these factors, the study aims to improve agricultural practices and contribute to the overall goals of smart city development.

II. Method

This study employs a qualitative research approach, which is suitable for answering research questions related to narratives obtained through interviews, observations, and document analysis (Hillebrand, 2000). Qualitative research typically generates data in the form of words for analysis, which can include images, texts, or audio recordings. The primary aim of qualitative research is to deeply understand phenomena by collecting comprehensive data. This method emphasizes the depth of data over breadth, allowing for a rich, detailed exploration of the subject matter.

To address the impact of research design choices on data analysis, this study incorporates methodological triangulation. By employing multiple qualitative methods (interviews, observations, and document analysis), we aim to provide a more comprehensive understanding of the phenomena and cross-validate our findings. This approach allows us

to examine how different data collection methods might yield varying insights and interpretations.

This study also adopts a descriptive research design, which aims to describe phenomena, events, and occurrences as they exist. Descriptive research is used to solve and answer current problems by collecting, classifying, analyzing data, and drawing conclusions and reports (Vidiati et al., 2024). The main goal is to provide an objective description of a situation. In this case, the research provides a depiction of how the Among Tani application functions as a communication medium between farmers, the government, and agricultural experts, enhancing production and economic outcomes for farmers in Batu City, East Java.

The research was conducted in several agricultural regions in Batu City and the Batu City Agriculture Department. The selection of the research location was based on the involvement and responsibility of government institutions in managing agriculture in Batu City. The Among Tani application falls under the supervision of the Batu City Agriculture Department, making it a primary location for the study. Additionally, agricultural fields were selected based on information provided by the head of information and extension.

This study employs purposive sampling to select informants. The selection criteria include: Farmers actively engaged in agricultural activities, either in farmer groups or combined farmer groups, Farmers in Batu City who have an account on the Among Tani application and actively use the application, and Officials from the Batu City Agriculture Department involved with the Among Tani application. Informants consist of farmers who are members of farmer groups and combined farmer groups in Batu City, officials from the Batu City Agriculture Department, and Farmer Companion Staff. The characteristics of informants include variations in age, education level, and experience in using the Among Tani application.

This study uses semi-structured interviews and observation methods. Interviews are conducted offline and online through WhatsApp chat application due to farmer conditions. The researcher uses an interview guide developed based on the diffusion of innovation theory and smart city concepts. Observations are made on the use of the Among Tani application by farmers, including features such as the complaint submission system, discussion forums, and product marketing.

The researcher uses a qualitative data analysis approach using the interactive model by Miles, Huberman, and Saldana. This includes data collection, data condensation, data display, and conclusion drawing/verification. Thematic analysis is used to identify key themes and patterns in the data. To ensure the validity and reliability of the data, the researcher uses triangulation techniques, comparing interview results from different informants and cross-checking with observational data. Member checking is also employed, where findings are verified with participants to ensure accuracy.

To further explore the impact of research design choices on data analysis, we have implemented an iterative approach to our analysis process. This involves constantly moving between data collection and analysis phases, allowing us to refine our research questions and methods as new insights emerge. This iterative process ensures that our research design remains responsive to the evolving understanding of the subject matter.

Throughout the research process, we maintain a reflexive journal documenting our decision-making rationales, potential biases, and how these might influence data collection

and analysis. This practice of researcher reflexivity helps us to critically examine how our methodological choices shape our findings and interpretations.

The study has obtained approval from the relevant ethics committee at the researcher's institution. All participants are provided with detailed information about the study's purpose, procedures, and potential risks and benefits before giving their informed consent. To ensure participant confidentiality, all personal identifiers are removed from the data, and pseudonyms are used in reporting findings. Participants are informed of their right to withdraw from the study at any time without consequence. Given the online nature of some data collection, particular attention is paid to digital security. Secure platforms are used for communication, and participants are advised on best practices for maintaining their privacy during online interactions.

We acknowledge that our choice of a qualitative, descriptive research design may limit the generalizability of findings. However, this approach allows for a rich, in-depth exploration of the Among Tani application's adoption and use in its specific context. In our findings, we explicitly discuss how our methodological choices, including the selection of participants and data collection methods, may have shaped our analysis and interpretations. This reflection aims to provide transparency and allow readers to better understand the context and potential biases in our research process.

These methods provide a comprehensive approach to investigating the diffusion and adoption of the Among Tani application among farmers in Batu City, while addressing concerns about the impact of research design on data analysis and interpretation.

III. Results, analysis, and discussion

The implementation and adoption of the Among Tani application among farmers in Batu City has revealed a complex interplay of technological innovation, social structures, and agricultural practices. This study's findings illuminate the multifaceted process of diffusion, the application's role as a virtual communication medium, its impact on organizational structures within farmer groups, and its implications for agricultural knowledge and productivity. Local authority owned by the government in the region can, on the one hand, improve the development of local economic progress, but on the other hand, it will give birth to what is called "special relations" between local authority holders and entrepreneurs (Permadi & Wardani, 208). In this case, it is farmers.

3.1. Diffusion Process of Among Tani Application

The diffusion of the Among Tani application among farmers in Batu City followed a structured process, characterized by distinct stages of socialization, simulation, and usage. This staged approach aligns with Rogers' diffusion of innovations theory, which posits that innovation adoption involves knowledge acquisition, persuasion, decision-making, implementation, and confirmation.

Socialization Stage The initial stage of diffusion involved extensive socialization efforts by the Batu City Department of Agriculture. These efforts included direct presentations during regular meetings of farmer groups and combined farmer groups, as well as indirect methods such as distributing pamphlets and leaflets. This multi-channel approach to information dissemination is consistent with best practices in innovation diffusion. Farmers reported that the socialization process was well-structured and involved

multiple stakeholders, including agricultural extension workers and companion workers. The use of existing farmer group structures as channels for innovation diffusion proved to be an effective strategy, leveraging established social networks within the farming community.

Simulation Stage Following socialization, the Department of Agriculture conducted simulation sessions to provide hands-on experience with the Among Tani application. These sessions were typically held at the District Agricultural Extension Centers, where Farmer Assistance Team members used smartphones to demonstrate the application's features and functionalities. An interesting aspect of the simulation stage was the proactive creation of user accounts for farmers who were already members of farmer groups or combined farmer groups. The Department of Agriculture utilized existing databases to pre-create accounts, simplifying the onboarding process for many farmers. While this approach aimed to reduce barriers to adoption, it also raised questions about user autonomy and data privacy.

Usage Stage The final stage of diffusion involved the actual use of the Among Tani application by farmers. This stage was characterized by varying levels of engagement, with some farmers fully embracing the application's features while others used it more selectively. The usage patterns were influenced by factors such as age, technological literacy, and the specific needs of different farming operations. Farmers reported that while some features of the application, such as the complaint submission system, were widely used and appreciated, others, like the marketplace function, did not meet initial expectations. This disparity between expectations and actual functionality highlights the importance of continuous user feedback and iterative development in agricultural technology initiatives.

3.2. Adoption Patterns and Influencing Factors

The adoption of the Among Tani application among farmers in Batu City exhibited interesting patterns, with certain groups of farmers more likely to embrace the technology than others. Two key factors emerged as significant determinants of adoption: farmer age and the vulnerability of agricultural commodities to disruptions.

Age as a Factor in Adoption Younger farmers demonstrated greater willingness to explore the application's features and integrate it into their agricultural practices. This trend aligns with broader observations in technology adoption literature, which often identifies age as a significant factor influencing the uptake of new technologies.

Agricultural organizations in Batu City recognized this trend and made strategic decisions to engage younger farmers in leadership roles and technology adoption. This deliberate effort reflects a recognition of the potential for youth to drive innovation in agriculture.

Vulnerability of Commodities Farmers dealing with commodities more susceptible to disruptions, such as pests or diseases, showed a higher propensity to adopt and actively use the Among Tani application. The application's feature for submitting complaints and receiving expert advice proved particularly valuable for these farmers, who faced frequent challenges with their crops.

Farmers reported that the application's ability to facilitate quick responses to agricultural issues significantly improved their ability to manage crop threats and potentially increased their yields. This highlights the potential of digital technologies to

enhance resilience in agriculture, particularly in the face of increasing environmental challenges.

Adoption Stages and User Experiences The study revealed that farmers went through various stages of adoption, as described in Rogers' diffusion of innovations theory. However, not all farmers completed all stages, with some stopping at earlier points in the process.

3.3. Among Tani as a Virtual Communication Medium

The Among Tani application has emerged as a significant virtual communication medium, facilitating interactions between farmers, government officials, and agricultural experts. This role aligns with the growing trend of using digital platforms to enhance agricultural extension services and knowledge dissemination (Alim, 2024).

Farmer-to-Government Communication One of the most impactful functions of the Among Tani application has been its role in facilitating communication between farmers and government agencies, particularly for submitting complaints and receiving assistance. Farmers reported that this feature has transformed the way they report and address agricultural challenges, allowing for quicker responses and more targeted interventions.

The efficiency of this communication channel is further enhanced by the application's location-based reporting feature. Farmers can now easily share the exact location of their problematic fields, enabling agricultural officers to provide more timely and targeted assistance.

Farmer-to-Farmer and Farmer-to-Expert Communication The Among Tani application also facilitates communication among farmers and between farmers and agricultural experts through its discussion forum feature. This virtual space for knowledge sharing and problem-solving represents a digital evolution of traditional farmer-to-farmer learning networks.

However, the study also revealed some limitations in the current implementation of this feature. Some farmers reported underutilizing the discussion function, partly due to the lack of a notification system for responses. This highlights areas for potential improvement in the application's design.

Challenges in Virtual Communication While the Among Tani application has greatly enhanced communication in the agricultural sector of Batu City, the study also revealed several challenges. These include technical issues related to hardware limitations, varying levels of digital literacy among farmers, and a preference among some farmers for traditional, face-to-face modes of communication.

Despite these challenges, the Among Tani application has significantly enhanced communication channels in the agricultural sector of Batu City. Its role as a virtual communication medium represents a key step towards the realization of smart agriculture within the broader smart city initiative.

3.4. Impact on Organizational Structures of Farmer Groups

The introduction of the Among Tani application has had notable effects on the organizational structures and dynamics of farmer groups and combined farmer groups in Batu City. These changes reflect the adaptive nature of social structures in response to technological innovations, as described in Adaptive Structuration Theory.

Shifts in Communication Patterns One of the most significant changes observed was in the patterns of communication within and between farmer groups. Traditionally, farmer groups relied heavily on regular face-to-face meetings for information sharing, problem-solving, and decision-making. The Among Tani application has introduced a new layer of virtual communication that complements these traditional structures.

The application's complaint submission feature has created a more direct line of communication between individual farmers and government agencies, bypassing the traditional hierarchy within farmer groups. Farmers reported that this direct communication channel has empowered them to address issues more quickly and efficiently. However, this shift also raises questions about the changing role of farmer group leaders and the potential for technology to disrupt established social structures.

Emergence of Tech-Savvy Leaders The adoption of the Among Tani application has led to the emergence of new informal leadership roles within farmer groups. Younger, more tech-savvy farmers often take on the role of technology facilitators, helping older members navigate the application and acting as intermediaries between the digital and traditional spheres of communication.

This trend aligns with observations in other studies about the importance of leadership characteristics in enhancing the performance of farmer groups. The emergence of these tech-savvy leaders represents an adaptive response to the introduction of new technology, potentially enhancing the overall capacity of farmer groups to engage with digital innovations.

Changes in Knowledge Dissemination The Among Tani application has also influenced how agricultural knowledge is disseminated within farmer groups. The application's information features, such as the guide to crop cultivation techniques, provide a new source of standardized, easily accessible information. This complements traditional knowledge sharing practices and potentially changes the dynamics of who is considered an "expert" within the group.

Farmers reported that the application's guide feature has become a valuable resource, allowing them to access detailed information on crop cultivation at any time. This democratization of access to agricultural information aligns with findings from other studies on the role of multi-stakeholder platforms in fostering farmers' innovation and rural development.

Adaptation of Meeting Structures While the Among Tani application has not replaced face-to-face meetings of farmer groups, it has influenced their structure and content. Meetings now often include discussions about information or issues raised through the application, and time is sometimes allocated for hands-on training in using the app's features.

This integration of digital tools into traditional meeting structures represents a form of "technology appropriation" as described in Adaptive Structuration Theory. It demonstrates how groups actively shape the use of technology to fit their existing practices while also allowing those practices to evolve in response to new technological capabilities.

Challenges in Structural Adaptation The study also revealed challenges in the structural adaptation process. Not all members of farmer groups have equally embraced the Among Tani application, leading to potential disparities in access to information and resources.

Table 1: Factors Influencing Adoption of Among Tani Application

Factor	Description	Impact on Adoption
Age	Older farmers showed more resistance	Negative
Technological Literacy	Lower levels of digital literacy led to struggles	Negative
Access to Compatible Devices	Lack of suitable smartphones	Negative
Crop Type	Less prone to pests/diseases found less immediate value	Variable

Source: research data

These challenges highlight the need for ongoing support and training to ensure that the benefits of the Among Tani application are equitably distributed across the farming community. Role of the Farmer Assistance Team The Farmer Assistance Team has played a crucial role in mediating the impact of the Among Tani application on farmer group structures. By providing training, troubleshooting support, and acting as intermediaries between farmers and the application, they have helped to smooth the transition and mitigate potential disruptions to existing social structures.

The team's approach aligns with the concept of "technology stewardship", where individuals or groups take responsibility for a community's technology use in the pursuit of its aspirations. This role is particularly crucial in the context of Batu City, where varying levels of technological literacy among farmers could potentially lead to uneven adoption and utilization of the Among Tani application.

3.5. Implications for Agricultural Knowledge and Productivity

The adoption of the Among Tani application has had significant implications for agricultural knowledge dissemination and productivity in Batu City. These impacts can be observed across several key areas:

Enhanced Access to Agricultural Information The application's "Guide" feature has emerged as a valuable resource for farmers, providing comprehensive information on crop cultivation techniques. This digital repository of agricultural knowledge represents a significant shift in how farmers access information, moving from reliance on traditional, often oral, knowledge transfer to more standardized, easily accessible digital content.

Farmers reported that this feature has allowed them to access detailed information on various aspects of crop cultivation, from seed preparation to post-harvest techniques. This enhanced access to information aligns with findings from other studies on the impact of digital technologies on agricultural knowledge systems.

Improved Pest and Disease Management One of the most significant impacts of the Among Tani application has been in the area of pest and disease management. The application's complaint submission feature has enabled farmers to quickly report issues and receive expert advice, leading to more timely and effective interventions.

Farmers described instances where rapid reporting and response through the application helped them address pest infestations more effectively than in the past. This rapid response system has the potential to significantly reduce crop losses due to pests and diseases.

Identification of New Agricultural Challenges Interestingly, the widespread use of the Among Tani application has led to the identification of new agricultural challenges. Farmers reported instances where previously unknown pests or diseases were identified through the application's reporting system. This highlights the potential of the application as a tool for agricultural surveillance and early warning systems.

Impact on Agricultural Productivity While the study found that the Among Tani application has contributed to improvements in agricultural productivity, the impact varies across different crops and contexts.

Table 2: Agricultural Production in Batu City Before and After Among Tani Application

Crop	2021 Production (Before)	2022 Production (After)
Rice	2,904 tons	7,106 tons
Corn	883 tons	1,584 tons
Potatoes	93,878 quintals	91,377 quintals
Mandarin Oranges	187,045 quintals	222,177 quintals
Roses	65,182,712 stalks	101,134,739 stalks
Chrysanthemums	37,942,366 stalks	38,744,000 stalks

Source: research data

While these increases cannot be attributed solely to the Among Tani application, they suggest a positive trend in agricultural productivity coinciding with the application's introduction.

Despite the positive impacts observed, the study also identified several challenges and limitations in the use of the Among Tani application for knowledge dissemination and productivity enhancement:

- **Digital Divide** The varying levels of digital literacy among farmers have led to uneven adoption and utilization of the application. Older farmers and those with limited exposure to smartphones reported difficulties in navigating the application's features. This digital divide could potentially exacerbate existing inequalities within the farming community.
- **Reliability of Information** While the application provides a wealth of information, ensuring the accuracy and relevance of this information for diverse local contexts remains a challenge. Some farmers expressed concerns about the applicability of generalized advice to their specific farming conditions.
- **Overreliance on Technology** There is a risk that over-reliance on the application could lead to a devaluation of traditional knowledge and practices. Several experienced farmers emphasized the importance of balancing digital information with time-tested local practices.
- **Technical Limitations** Issues such as poor internet connectivity in some areas and the inability of some farmers' smartphones to effectively run the application have limited

its impact. The Farmer Assistance Team reported frequent requests for help related to technical issues.

- **Integration with Existing Practices** The study found that while the application has been beneficial, its full potential is realized when it is effectively integrated with existing agricultural practices and knowledge systems. Farmers who successfully blended traditional methods with insights from the application reported the most satisfaction.

These challenges highlight the need for a holistic approach to the implementation of digital technologies in agriculture, one that considers not only the technical aspects but also the social, cultural, and economic contexts in which these technologies are deployed.

The findings of this study have several implications for theoretical understanding of technology adoption in agriculture and the role of digital platforms in rural development:

- **Diffusion of Innovations Theory** The study supports Rogers' diffusion of innovations theory, demonstrating the importance of factors such as relative advantage, compatibility, and observability in the adoption of new agricultural technologies. However, it also highlights the need to consider local contexts and existing social structures in understanding adoption patterns.

Table 3: Challenges in Among Tani Application Adoption

Challenge	Description	Potential Impact
Digital Divide	Varying levels of digital literacy	Uneven adoption and benefit distribution
Information Reliability	Concerns about generalized advice	Potential misapplication of information
Technology Over Reliance	Risk of devaluing traditional knowledge	Loss of valuable local practices
Technical Issues	Connectivity and device compatibility	Limited access and functionality
Integration Difficulties	Blending with existing practices	Suboptimal utilization of the application

Source: research data

The staged adoption process observed in Batu City, from awareness to full adoption, aligns with Rogers' model. However, the varied experiences of farmers, with some progressing through all stages and others stopping at earlier points, underscore the non-linear nature of technology adoption in complex social systems.

- **Adaptive Structuration Theory** The changes observed in the organizational structures of farmer groups following the introduction of the Among Tani application align with the principles of Adaptive Structuration Theory. The study demonstrates how groups actively appropriate technology, adapting both the technology and their own practices in the process.

The emergence of new leadership roles within farmer groups, particularly among tech-savvy younger members, illustrates the dynamic interplay between technology and social structures posited by this theory.

- **Knowledge Management in Agriculture** The study contributes to understanding how digital platforms can enhance knowledge management in agriculture, supporting the concept of "precision agriculture" where information and communication technologies are used to optimize agricultural processes.

The Among Tani application's role in facilitating rapid information exchange between farmers, experts, and government agencies demonstrates the potential of digital platforms to create more responsive and efficient agricultural knowledge systems.

- **Smart City Theory** The implementation of the Among Tani application as part of Batu City's smart city initiative provides insights into how smart city concepts can be applied in predominantly agricultural contexts, extending the typically urban-focused smart city theory.

This case study suggests that the smart city framework can be effectively adapted to rural and agricultural settings, promoting sustainable development through technology-enabled citizen engagement and improved public services.

The findings of this study have several practical implications for the ongoing development and implementation of the Among Tani application, as well as for broader efforts to leverage digital technologies for agricultural development:

- **User-Centered Design** The varied experiences of farmers with the application highlight the importance of user-centered design approaches that consider the diverse needs, capabilities, and contexts of the target users. Future iterations of the application should involve farmers more deeply in the design process to ensure that features align with their practical needs and technological capabilities.
- **Continuous Training and Support** The crucial role played by the Farmer Assistance Team underscores the need for ongoing training and support to ensure effective adoption and utilization of digital agricultural technologies. Developing a sustainable model for providing this support, possibly by training local community members as technology facilitators, could enhance long-term adoption and impact.
- **Integration with Existing Systems** The study highlights the importance of integrating new technologies with existing agricultural practices and knowledge systems, rather than attempting to replace them entirely. Future initiatives should focus on creating synergies between traditional farming wisdom and digital innovations.
- **Data-Driven Policy Making** The wealth of data generated through the Among Tani application has the potential to inform more targeted and effective agricultural policies and interventions. Developing robust data analysis capabilities and establishing clear protocols for using this data in policy-making processes could enhance the overall impact of the initiative.
- **Scaling and Replication** The experiences in Batu City provide valuable lessons for scaling the application to other regions or for developing similar applications in other agricultural contexts. Key factors for success include strong local government support,

engagement with existing farmer organizations, and flexible adaptation to local agricultural conditions.

IV. Conclusion and recommendation

The implementation of the Among Tani application in Batu City represents a significant step towards the digitalization of agriculture, aligning with broader smart city initiatives. Its deployment has brought about notable changes in how farmers access information, communicate with government agencies and fellow farmers, and manage agricultural challenges. While the application has shown promise in enhancing agricultural knowledge and productivity, its impact is mediated by various social, technical, and organizational factors.

The diffusion of the Among Tani application followed a staged process encompassing socialization, simulation, and usage, proving effective in introducing new technology to the farming community, albeit with varying adoption rates among different groups. Factors such as farmer age and crop vulnerability emerged as significant influencers of adoption, with younger farmers and those handling susceptible crops showing a greater propensity for quick adoption.

The introduction of the application has resulted in shifts in communication patterns and leadership structures within farmer groups, demonstrating the adaptive nature of social structures in response to technological innovation. It has significantly improved farmers' access to agricultural information, enabling faster and more informed decision-making. The application's complaint reporting feature has allowed for quicker responses to pest and disease issues, potentially reducing crop losses.

However, challenges persist in the effective utilization of the Among Tani application. The digital divide, concerns about information reliability, and integration with existing practices remain hurdles to be overcome. Despite these challenges, data suggests a positive trend in agricultural productivity coinciding with the application's introduction, although direct causation is difficult to establish.

This study highlights the complex interplay between technology, social structures, and agricultural practices in the context of digital innovation. It underscores the need for a nuanced, context-sensitive approach to the implementation of digital technologies in agriculture, one that considers not only the technical aspects but also the social and organizational dynamics of farming communities.

As Batu City continues to develop its smart city initiatives, the experiences with the Among Tani application provide valuable insights for future developments. They highlight both the potential of digital technologies to transform agricultural practices and the challenges that must be addressed to ensure these technologies deliver equitable and sustainable benefits to farming communities.

Moving forward, further research is needed to assess the long-term impacts of the Among Tani application on agricultural productivity and farmer livelihoods. Additionally, exploring how the application might be adapted or expanded to address emerging challenges in agriculture, such as climate change adaptation or sustainable resource management, could provide valuable insights. Comparative studies with similar initiatives in other regions could

offer broader perspectives on the role of digital technologies in advancing sustainable agriculture and rural development.

In conclusion, the Among Tani application represents an important milestone in the evolution of digital agriculture in Indonesia. While challenges remain, its potential to enhance agricultural productivity, strengthen farmer resilience, and support sustainable rural development is significant. With continued research and careful development, such initiatives can play a key role in shaping the future of agriculture in the digital era.

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