Jurnal Penyuluhan Pertanian Vol 20(2), 2025,155 – 169
DOI: https://doi.org/10.51852/wsc9bf39

Jurnal Penyuluhan Pertanian

Journal homepage: https://jurnal.polbangtan-bogor.ac.id/index.php/jpp

Perception Dynamics Between Farmers and Agricultural Extension Officers (PPL) Regarding Digital Agricultural Extension Using Smartphones

Yudi Rustandi*, Abdul Farid
Malang Agricultural Development Polytechnic, Animal Husbandry Extension and Animal Welfare Study Program, Malang, East Java, Indonesia 65215
**Email correspondence:* rustandiyudi64@gmail.com

Article Information

Received
Revised
Accepted
Published online

Keywords

Digitalization of agricultural Extension, android extension media application, collaborative extension media.

Abstract

Agricultural extension plays a vital role in supporting agricultural development; however, the use of digital extension media remains limited and has not yet become embedded in extension practices. This study aims to evaluate the dynamics of perceptions among farmers and Field Agricultural Extension Workers (FAEW) toward smartphone-based digital extension media using the ADDIE model. An evaluative research approach was applied by integrating the Technology Acceptance Model (TAM), the Unified Theory of Acceptance and Use of Technology (UTAUT), and the Innovation Diffusion Theory to analyze technology adoption. The study involved 100 respondents, consisting of 36 farmers and 64 FAEWs, from five Agricultural Extension Centers (BPP) under the Kostratani program in East Java. Data were collected using a structured questionnaire with a Likert scale of 1–5. Multivariate regression analysis revealed that five key factors explained 85.2% of the variance in digital media adoption (R^2 = 0.852; $p < 0.01$). Among these factors, Perceived Usefulness ($\beta = 0.42$) and Performance Expectancy ($\beta = 0.38$) were identified as the strongest determinants influencing adoption. Comparative analysis indicated perception gaps between farmers and extension workers, particularly in digital literacy. The Android-based multimedia applications developed through the ADDIE stages were shown effective in improving communication, information delivery, and collaboration in extension activities. This study offers a novel integration of the ADDIE model with dual perception analysis based on TAM and UTAUT in the Indonesian agricultural extension context. Recommendations include strengthening digital literacy training and improving infrastructure to support sustainable adoption of digital extension media.

E-ISSN: 1907-5893
P-ISSN: 2599-0403
DOI:

1. Introduction

The digitalization era has penetrated deep into rural areas, transforming the communication landscape across various sectors, including agriculture (Abiri *et al*., 2023; Trendov *et al*., 2019). Farmers and Agricultural Extension Workers (AEWs) are now faced with the need to adopt digital information sources to access technological innovations (Salsabella *et al*., 2024). Conventional extension media, which have long been relied upon, must adapt to the advancements of the digital era (Dharmawan *et al.,* 2020). The digitization of extension media is crucial for planning and implementing extension (Munthali *et al*., 2018), which requires attention to both human resources and facilities and infrastructure (Cattaneo *et al.*, 2022).

Before the digital era, PPL in Indonesia relied on conventional extension media, including print media, graphics, and audio-visual materials. Although these media were useful in delivering extension materials, their limited availability and the PPL's ability to create them posed challenges (Listiana *et al.,* 2019). Given that agricultural extension is a dynamic, ongoing learning process, extension media also need to adapt to advancements in digital technology (Fabregas, *et al.,* 2023; Singh *et al.,* 2023). The digitization of extension media entails a shift from manual to digital models in the design, creation, and utilization of extension media (Mergel *et al.,* 2019). The ADDIE model is often employed in the development of digital media, with the potential advantage of facilitating the creation and transfer of materials to farmers' smartphones for self-learning (Kuswandi *et al.,* 2021).

Agricultural extension plays a central role in the success of the Ministry of Agriculture's programs, including those focused on sustainable agriculture (Limpo, 2022). Optimizing the performance of PPL through the use of digital-based extension media is important for these programs to achieve their targets. The introduction of digital media is expected to enhance the intensity, dynamics, and effectiveness of interactions between extension workers and farmers. The development of multimedia-based digital extension media on smartphones using the ADDIE model is believed to produce structured, needs-based, and effective media (Kustiari *et al.,* 2023). To measure the success of this digitalization, a comprehensive evaluation approach is needed, including the identification of needs, user preferences, and content analysis (Reyvalda *et al.,* 2019).

Previous studies have discussed the digitalization of agricultural extension and the use of smartphones in information dissemination (Matuha, 2015)). However, several gaps need to be addressed. First, there have been few studies that comprehensively analyze the perception gap between farmers and PPLs regarding the factors that drive and hinder the adoption of smartphone-based digital extension media. A deep understanding of these perceptual differences is crucial for designing effective and inclusive implementation strategies. Second, existing research has not paid sufficient attention to the specific context of implementation in the field, including the characteristics of farmers and PPL in specific regions, as well as the available infrastructure and resources (Abbasi *et al.,* 2022; Fabregas *et al.,* 2023; Singh *et al.,* 2023). This study aims to fill this gap.

This study provides a comparative perspective on farmers' and PPLs' perceptions of smartphone-based digital extension media adoption, focusing on identifying the driving and inhibiting factors from both perspectives. Thus, this study is expected to provide new, more comprehensive insights into the implementation of digital agricultural extension. Additionally, this study is novel in its specific research context, specifically the implementation of digital media for PPL at the BPP Kostratani in East Java. A deep understanding of this local context will significantly contribute to the development of relevant and sustainable implementation models

(Annan-Aggrey *et al.,* 2022; Edgar R. Eslit, 2023). Furthermore, this study integrates the ADDIE model with user perception analysis to ensure that the developed extension media are not only technically effective but also aligned with the needs and preferences of farmers and PPL.

Research Objectives: 1) To evaluate the dynamics of farmers' and PPL's perceptions on the use of smartphone-based digital extension media, 2) To analyze the driving and inhibiting factors of digital extension adoption, and 3) To develop recommendations for effective implementation of digital extension services.

2. Research Methodology

The research covers five districts that were selected based on their accessibility and their relevance to the working area of Polbangtan Malang. This study uses a combined development and evaluation research approach (Reed *et al.,* 2021), employing both survey methods and multivariate analysis (Bamberger *et al.,* 2015; Luo & Dappen, 2005). The data collected includes primary and secondary sources, as well as qualitative and quantitative information from farmers and PPL, along with related documents (Oluwatosin Ajayi, 2023).

The research population consists of farmers who are members of farming groups and PPL from the BPP Kostratani in East Java. BPP Kostratani was selected because it is a BPP that has received government programs related to information technology. The sample was selected using area and clustered sampling methods to ensure geographical representation and population characteristics. The sample size was determined based on the percentages of the farmer population (5-10%) and PPL (10-15%) (Ahmed, 2024), as shown in Table 1.

Table 1. Sample size for research based on area and cluster

Province	Regency (District)	Sample Size (Respondents-people)	
		Farmers	PPL
East Java	Bondowoso (BPP District Congkrong)	8	30
	Blitar (BPP District Pongok)	5	6
	Pasuruan (BPP District Purwodadi)	5	6
	Tulungagung (BPP District Bonyolangu & BPP District Kota)	13	16
	Lumajang (BPP District Tekung)	5	6
	Total	36	64
	Grand Total		100

The research variables include farmer and PPL satisfaction with the use of multimedia agricultural extension on smartphones (variable Y) and factors influencing adoption (variable X). These factors originate from the Technology Acceptance Model (TAM), the Unified Theory of Acceptance and Use of Technology (UTAUT), the Diffusion of Innovation, instructional media, and implementation strategies (Celaya *et al.,* 2025). Data were collected using a 5-point Likert scale questionnaire that had been tested for validity and reliability (Cronbach's alpha > 0.7). Quantitative data were collected using structured questionnaires that incorporated appropriate measurement scales for each variable, allowing for comprehensive statistical analysis (Dickerson

& Ji, 2021; Lim, 2024). The data collection process involved surveys, observations, interviews, and discussions with farmers and PPL (Extension Agents). The questionnaire served as the primary instrument, designed to assess respondents' perceptions, attitudes, and behaviors regarding the use of digital extension media (Cronin *et al.*, 2017). Quantitative data analysis will utilize statistical software to perform both descriptive and inferential analyses (Byrne, 2011; Kotronoulas *et al.,* 2023).

The development of digital extension media using the ADDIE method involves five stages: Analysis (needs analysis), Design (material and workflow design), Development (content creation and testing), Implementation (launch and user guidance), and Evaluation (formative and summative evaluation) (Dousay & Logan, 2011). This model ensures that the resulting media is needs-based, user-friendly, engaging, effective, and continuously evaluated and updated to enhance its impact (Branch, 2009; Wibawa & Susanti, 2024).

A descriptive analysis was conducted to provide an overview of the data (Tavakol *et al.,* 2010). Dynamics of farmers' and extension workers' perceptions regarding the use of multimedia extension services via smartphones. The following variables and indicators were used to evaluate farmers' and extension workers' perceptions regarding the use of multimedia extension services via smartphones, as explained in the theories mentioned earlier. The multiple regression equation for analyzing driving and inhibiting factors and perceptions can be written as follows:

$$Y = \beta 0 + \beta 1X1 + \beta 2X2 + \beta 3X3 + \beta 4X4 + \beta 5X5 + \varepsilon \quad \ldots\ldots(1)$$

Y = Level of adoption of digitalization of agricultural extension media and use of multimedia agricultural extension on smartphones.
β0 = Constant
β1, β2, β3, β4, and β5= Regression coefficients for each independent variable Independent variables (X), as follows:
X1 = Technology Acceptance Model (TAM),
X2 = Unified Theory of Acceptance and Use of Technology (UTAUT),
X3 = Diffusion of Innovations,
X4 = Instructional Media,
X5 = Implementation Approach, and
ε = Error term (disturbing error).

This equation shows that the level of adoption of digitalization of agricultural extension media and the use of multimedia agricultural extension on smartphones (Y) is influenced by a linear combination of independent variables (X1, X2, X3, X4, and X5) and the error term (ε). The regression coefficients (β1, β2, β3, β4, and β5) indicate the extent to which each independent variable affects the dependent variable. If the coefficient is positive, the variable is a driving factor; whereas if the coefficient is negative, the variable is an inhibiting factor (Sevi, 2021).

Using this multiple regression analysis, we can identify and measure the influence of various factors related to the theories mentioned earlier, namely: 1) Technology Acceptance Model (TAM), 2) Unified Theory of Acceptance and Use of Technology (UTAUT), 3) Diffusion of Innovations, 4) Instructional Media, and 5) Implementation Approach.

Hypotheses:
H1: Technology acceptance factors (TAM, UTAUT) significantly influence the adoption of digital extension media

H2 : Innovation diffusion factors significantly affect the adoption of digital extension media
H3 : There are significant differences in perceptions between farmers and PPL regarding digital extension adoption

3. Results and Discussion

3.1. Development of Multimedia Education for Android Smartphones

Developing a multimedia agricultural extension program for Android phones can enhance communication and cooperation between farmers and agricultural extension staff (PPL). This program aims to facilitate information access, enhance communication, promote cooperation, and increase efficiency. The ability to add various types of media, interactive elements, compatibility with Android phones, sharing features, and collaborative capabilities define the key characteristics of this application, along with its user-friendly interface. The ADDIE model-Analysis, Design, Development, Implementation, Evaluation-can be employed as a techniquem when developing this application to ensure the effectiveness and efficiency of the final product (Hasanah Dewi Lestari, 2023). The ADDIE model (Branch, 2009), comprises user needs analysis, application design, application creation, application testing, and application evaluation.

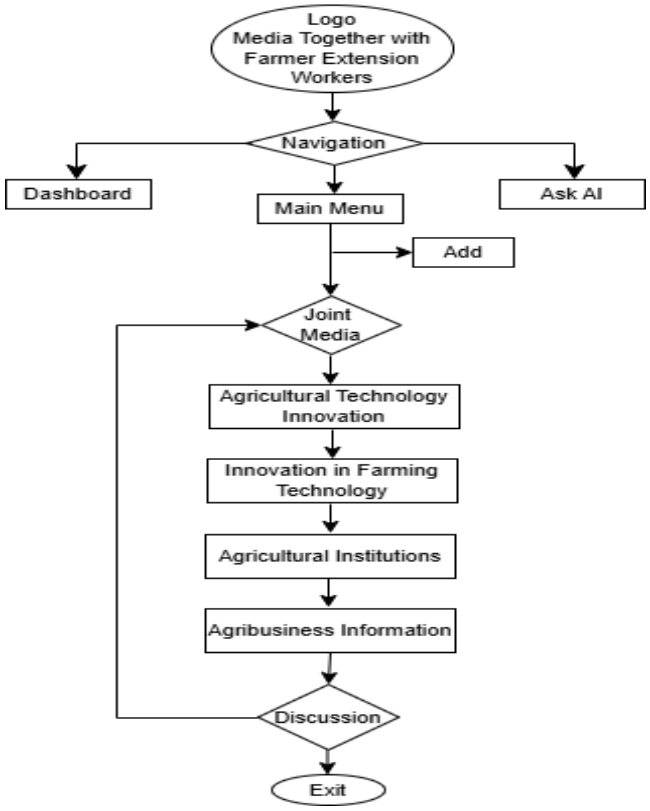

Figure 1: Development of Collaborative Media for Agricultural Extension Workers on Mobile Phones Using the ADDIE Model.

The “Media Together with Extension Workers and Farmers” application features a dashboard, main menu, AI Q&A, Media Together, and Dialogue, among several key functions. These characteristics enable farmers and PPLs to get information, communicate, and exchange experiences. Applications are tested to confirm their efficacy and efficiency. Surveys, interviews, and usage analysis can all be used for testing. The results of tests can inform the development

of the application's enhancements and updates. There are both benefits and drawbacks to using multimedia extension apps. Benefits include accessibility, interactive design, up-to-date information, and time efficiency (Sen *et al.,* 2025; Xu *et al.,* 2023). Among the disadvantages are technological abilities, network constraints, and restricted access (J. Yu *et al.,* 2024). Numerous suggestions can be made to improve the use of multimedia extension applications, including enhanced network infrastructure, farmer education and training, user-friendly application development, and the provision of relevant and high-quality content. Thus, multimedia extension applications can develop into a potent tool to help farmers in the digital era hone their knowledge and skills.

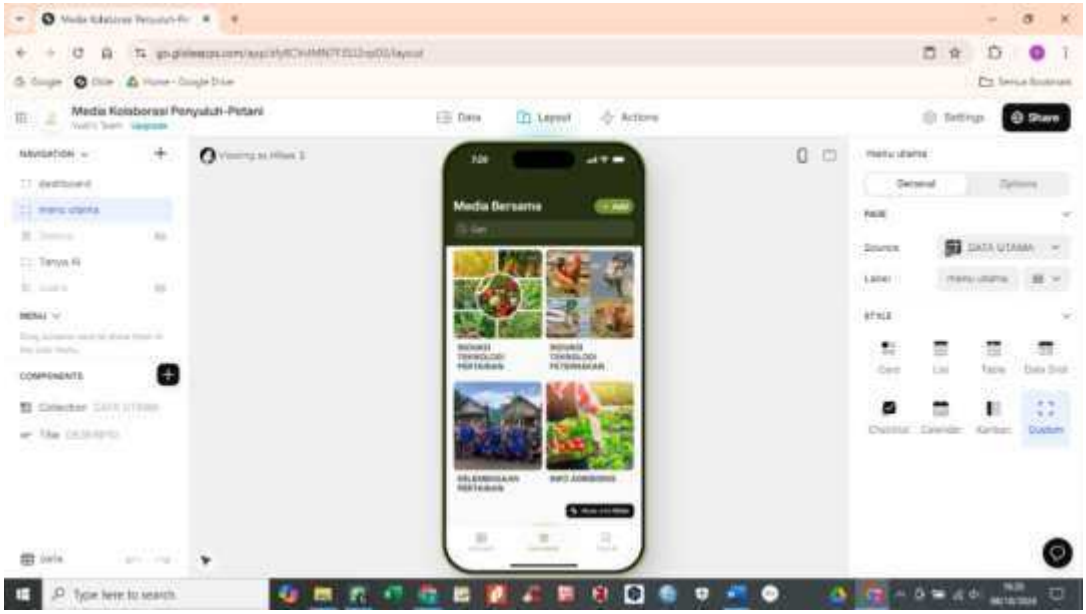

Figure 2: Process of creating collaborative media for farmer extension workers on mobile phones using the glide application

The findings of this study suggest that developing collaborative media tools for agricultural extension on Android mobile devices is crucial for enhancing communication and cooperation between extension officers and farmers. The program aims to encourage the sharing of information, innovations, and business ideas that can improve sustainability and productivity. Smart devices such as mobile phones can bridge the gap between farmers and extension workers (Hinojosa *et al.,* 2023). This application features a user-friendly interface, making it easy to navigate and use. Various types of media, interactive features, and compatibility with Android mobile phones facilitate effective collaboration and information sharing. This app is expected to deliver good performance and effectiveness through a rigorous process of research, design, development, testing, evaluation, and planning (Singh *et al.,* 2023).

Adopting this program has several obstacles, though, including education level, digital literacy, infrastructure constraints, lack of training, opposition to change, and cost. Understanding and addressing these issues is essential to advancing the adoption of cooperative agricultural extension tools on Android phones in the farming industry. Conquering these obstacles and leveraging their benefits will enhance user happiness and adoption, ultimately boosting farmer productivity and wellbeing (Arangurí *et al.,* 2025; Sen *et al.,* 2025).

3.2. Regression Analysis of Farmers' and Field Agricultural Extension Workers' Perceptions of Smartphone-Based Multimedia Extension Acceptance

Regression analysis can show a positive relationship between the acceptance of collaborative media technology for agricultural extension via Android smartphones and various factors such as perceptions of technology acceptance models, diffusion of innovation, instructional media, and implementation approaches in the context of agricultural extension.

Table 2 Regression analysis results, coefficients, p-values, and interpretations

Variable	Coefficient	p-value	Interpretation
Intercept	4.00	-	Model intercept
X1 (TAM Model)	0.50	< 0.05	Significant for Y
X2 (UTAUT Model)	0.30	< 0.05	Significant for Y
X3 (Innovation Diffusion)	0.20	< 0.05	Significant for Y
X4 (Instructional Media)	0.40	< 0.05	Significant for Y
X5 (Implementation Approach)	0.10	> 0.05	Not significant for Y
R-squared	0.85	-	The model explains 85% of the variation in Y

The results of the multiple regression analysis show a positive relationship between the development and use of multimedia extension with extension workers and farmers on Android smartphone extension media, serving as a medium for extension, with a coefficient value of 0.50 and a p-value of less than 0.05. The high R-squared value (0.85) indicates that the integrated model of TAM, UTAUT, and Diffusion of Innovation effectively explains digital extension adoption. However, the non-significance of implementation approach (X5) suggests that current implementation strategies need improvement. This finding contrasts with previous studies that emphasized implementation as a critical factor, indicating the unique context of agricultural extension in East Java.

These contextual challenges specific to East Java explain why the implementation approach (X5) showed non-significant results (p> 0.05, coefficient 0.10), despite being emphasized as critical in previous studies conducted in different contexts. The findings highlight that standardized implementation models fail to address the complex realities of East Java's agricultural ecosystem, requiring instead localized, adaptive strategies that consider: a) district-specific infrastructure readiness, b) generational digital literacy level, c) cultural communication preferences, d) Economic constraints of smallholder farmers, e) institutional support capacities The results of the comparative analysis of farmers' and PPLs' perceptions are presented in Table 3.

Table 3 Farmer and PPL perceptions

Factor	Farmers (β)	PPL (β)	Gap
Digital Literacy	-0.29	-0.11	Significant (farmers higher barrier)
Infrastructure	-0.18	-0.34	Significant PPL (PPL higher sensitivity)

The results of a comparative analysis of the perceptions of farmers and PPL indicate that there are significant differences in perception between farmers and extension workers regarding

the adoption of digital media. Farmers believe that it is important to master ease of use and that it can be useful in practice for their farming activities, while PPL are more focused on technical features and implementation strategies. The dynamics of this gap or difference in perception point to the need for a more tailored approach as an implication for the development of digital extension, particularly digital extension media that can be used collaboratively. Furthermore, hese findings support H1 (Mallick *et al.,* 2025; Sen *et al.,* 2025).

Novelty and Contribution, this study provides novelty insights by integrating the ADDIE development model with perception analysis of both farmers and PPL. The comparative perspective reveals previously undocumented perception gaps that are crucial for designing effective digital extension services. The integration of multiple technology acceptance theories in the specific context of Indonesian agricultural extension represents a significant theoretical contribution.

3.3. Perceptions of Development and Use of Multimedia Extension with Extension Officers and Farmers on Android Smartphone Extension Media

These results demonstrate a positive relationship between the variables. Perception of the multimedia technology acceptance model for Android smartphones as a medium for extension services between extension workers and farmers. The regression coefficient of 0.2 indicates a positive relationship between the independent variable (in this case, the perception of the multimedia technology acceptance model) and the dependent variable (acceptance of multimedia technology as an extension medium). This means that the higher the perception of the multimedia technology acceptance model, the higher the level of acceptance of multimedia technology as an extension medium.

These results suggest that extension using Android smartphones as a medium for extension workers and farmers has considerable potential to be accepted and utilized by the agricultural community. The results of this study suggest that the perception of multimedia technology acceptance models plays a crucial role in enhancing the acceptance of multimedia technology as an extension medium. This can be achieved through practical communication approaches, training in technology use for extension workers and farmers, and improving accessibility and availability of relevant and beneficial content through the extension media (Sen *et al*., 2025; X. Yu *et al*., 2024).

The results of this multiple regression analysis also lay the groundwork for future research into additional factors that could affect the acceptance of multimedia technology as an extension medium. For instance, social, economic, and cultural factors may impact how multimedia technology is perceived and accepted in the realm of agricultural extension. Thus, the results of this multiple regression analysis make a significant contribution to the Understanding of the acceptance of extension using Android smartphone technology as an extension medium among extension workers and farmers (Thamrin *et al*., 2015).

The practical implications of these results can serve as a basis for developing more effective and efficient agricultural extension programs through the use of multimedia technology, particularly by leveraging Android smartphones as a medium for extension services between extension workers and farmers.

3.4. Perception of the Acceptance Model of Multimedia Technology for Android Smartphone Extension as a Medium for Extension Together with Extension Workers and Farmers

The results of multiple regression analysis for the perception of acceptance and use of

Android smartphone multimedia extension technology as a medium for extension activities with extension workers and farmers show a coefficient value of 0.3 with a p-value of less than 0.05. These results indicate a positive relationship between the perception of the acceptance model of Android smartphone multimedia extension technology as a medium for extension activities with extension workers and farmers. This means that the higher the perception of the acceptance model of multimedia technology, the higher the level of farmer participation in extension activities using Android smartphones. In other words, the higher the perception of the acceptance model of multimedia technology, the higher the level of acceptance of multimedia technology as an extension medium. These results suggest that extension using Android smartphones as a medium, in conjunction with extension workers and farmers, has considerable potential to be accepted and utilized by the agricultural community. The study concludes that the perception of the multimedia technology acceptance model significantly influences the acceptance of multimedia technology (Mallick *et al*., 2025).

Therefore, when developing agricultural extension programs using Android smartphones, it is essential to consider how to enhance the community's perception of the multimedia technology acceptance model. This can be achieved through practical communication approaches, training in technology use for extension workers and farmers, and improving accessibility and availability of relevant and beneficial content through the extension medium (Seminar & Sarwoprasodjo, 2019). Additionally, the results of this multiple regression analysis provide a foundation for further research on other factors that may influence the acceptance of multimedia technology as an extension medium. For example, social, economic, and cultural factors may influence perceptions and acceptance of multimedia technology in the context of agricultural extension. Thus, the results of this multiple regression analysis provide a significant contribution to understanding the acceptance of multimedia technology as an extension medium among extension workers and farmers.

The practical implications of these results can serve as a basis for developing more effective and efficient agricultural extension programs, leveraging multimedia technology, particularly through the use of Android smartphones as an extension medium in collaboration with extension workers and farmers.

3.5. Perceptions of Acceptance and Use of Multimedia Technology Android Smartphone Extension as a Medium for Extension Workers and Farmers

The results of multiple regression analysis for the Perception of Multimedia Innovation Diffusion of Android Smartphone Extension as a Medium for Extension with Extension Workers and Farmers show a significant relationship between the variables studied. With a coefficient value of 0.2 and a p-value less than 0.05, there is a positive influence of perception on the diffusion of multimedia innovation in Android smartphones as a collaborative extension medium between extension workers and farmers.

These results suggest that a higher perception of the diffusion of multimedia extension innovation, using Android smartphones as a medium for extension activities involving extension workers and farmers, increases the likelihood of adopting this innovation. Thus, the perception of the diffusion of multimedia extension innovation using Android smartphones plays a crucial role in influencing farmers' behavior in accepting and utilizing this technology as a medium for extension activities.

These results provide an important contribution to deepening our Understanding of the effectiveness of using Android smartphone-based extension media in increasing the perception of multimedia innovation diffusion among extension workers and farmers. These findings align

with those of (Rasch *et al.,* 2021; Sen *et al*., 2025; X. Yu *et al*., 2024), who found that smartphone-based digital extension services significantly increased farmers' adoption of sustainable agricultural technologies in China. Given this significant relationship, the use of Android smartphone-based extension media can be an effective strategy in increasing Understanding and acceptance of multimedia innovation among farmers. Thi Hoa Sen *et al*., (2024), also noted that digital extension services offer new pathways for farmers to access timely information and engage with stakeholders, including extension workers. Therefore, further research is needed to deepen our Understanding of the factors that influence the perception of multimedia innovation diffusion among extension workers and farmers. Thus, these findings contribute significantly to deepening our Understanding of the factors that influence adoption. Android smartphone-based multimedia extension innovations as extension media among extension workers and farmers.

The implications of these findings can also serve as a basis for developing more effective and efficient agricultural extension policies and programs aimed at enhancing farmers' knowledge and skills in applying information and communication technology in their agricultural activities (FAO Guide, 2023).

3.6. Perception of Multimedia Innovation Diffusion: Android Smartphones as a Medium for Extension Services between Extension Workers and Farmers

A coefficient value of 0.4 indicates a significant positive relationship between people's perceptions of instructional multimedia and the effectiveness of counseling. This implies that the effectiveness of counseling increases by 0.4 units for every one-unit increase in how people perceive instructional multimedia. This good correlation suggests that counseling media influence how farmers process and understand information. In the agrarian sector, where technology and best practices are constantly evolving, farmers need to have current and relevant knowledge. Research published in Hussain *et al.,* (2022) emphasized that engaging and interactive media can help farmers become more involved, especially when delivered through social platforms and mobile devices. For example, Studies by (Karubanga *et al.,* 2016) using video tutorials that show correct agricultural methods help farmers grasp the real processes involved. In both studies and real-world uses, these figures are critical. This implies that, within the framework of sustainable agriculture, approaches based on these results can be applied with a high degree of certainty and are likely to produce good results. In this situation, utilizing smartphones as auxiliary tools is not only important but also vital for producing improved outcomes. Agricultural producers unable to participate in-person extension programs can access pertinent information via mobile devices during a period of increasing digitalization. For example, video tutorials on pest and disease control can provide farmers with clear and practical direction, therefore enabling them to apply successful solutions in their fields (Santosh & Nagaratna Biradar Rayees Ahmad Shah Adil Ahmad, 2023).

This result implies that multimedia not only enhances knowledge but also enables farmers to learn in a more flexible and needs-based manner. The study's findings suggest that extension workers can effectively integrate technology into their extension procedures. Applying technology developments in extension services could improve communication and increase agricultural participation. This can then help farmers participate and access information through facilitation.

3.7. Perception of Multimedia Instructional Media for Android Smartphone Extension as a Joint Extension Media for Extension Workers and Farmers

The interpretation of the multiple regression analysis, with a coefficient value of 0.1,

indicates that for every 1-unit increase in the use of several variables of interest in understanding differences, a 0.1-unit increase is required. In this study, the positive coefficient value indicates that the better the use of multimedia methods with smartphone support, the more satisfied both parties are with the activities carried out by extension workers for farmers. This means that the impact of the multimedia approach in terms of scaling is remarkable and not coincidental. The importance of multimedia in sustainable agricultural extension activities, particularly the use of multimedia in long-term extension through smartphones, is growing increasingly significant in this digital era (Mallick *et al.,* 2025).

Multimedia encompasses text, images, video, and audio that can be used to present messages in various ways and in a manner that is easily understood. In this case, farmers who are exposed to multimedia content are more likely to remember the agricultural techniques taught to them. With multimedia-based extension applications, farmers can quickly access the most up-to-date agricultural information, weather forecasts, and market prices. This is crucial for making quick and accurate decisions (Fabregas *et al.,* 2023). Several factors influence this perception, including experience, mentor support, and a supportive community (Thi Hoa Sen *et al.,* 2024).

3.8. Perceptions of the Implementation Approach of Multimedia Android Smartphone Extension as a Medium for Extension Workers and Farmers

To close the current information gap and improve the effectiveness of communication between farmers and extension specialists, agricultural extension must be digitized (Awasthi *et al.,* 2023). The ADDIE technique was employed to develop a multimedia smartphone application that serves as an interactive extension tool to address this problem (Branch, 2009). Despite the significant benefits this technology provides, issues to its adoption include limited digital literacy, infrastructure restrictions, and a reluctance to accept change still abound. Regarding technology adoption, current research indicates that the use of Android-based applications has the potential to facilitate cooperation and information exchange between extension workers and farmers. The ADDIE development model comprises five separate phases: needs analysis, design, development, implementation, and evaluation. This technique makes it easier for farmers to access the program, as it allows for customization according to individual tastes. Integrating interactive and multimedia features aims to enhance user engagement in the learning process by providing farmers with greater freedom and autonomy in accessing extension materials (FAO Guide, 2023).

However, a perception gap exists between farmers and PPL that hinders the effectiveness of deploying digital extension materials. Often, agricultural producers encounter digital literacy barriers that hinder their willingness to adopt modern technology. Moreover, infrastructure constraints, including sporadic internet connections in rural areas, significantly impede the deployment of smartphone-based applications (Sen *et al.,* 2025). Some farmers demonstrate a certain amount of change aversion, particularly those more used to traditional extension

techniques. Therefore, implementation plans must involve continuous digital literacy instruction and upgrades to agricultural area information technology infrastructure. This study demonstrates that utilizing multimedia-based extension media can enhance farmer wellbeing and improve the effectiveness of extension programs. Digitalization means that extension services are no longer limited to face-to-face contacts. Instead, they can be flexible, scalable, and inclusive, reaching farmers in remote areas and adapting to their learning preferences (Mallick *et al.,* 2025).

4. Conclusion

Developing digital media for agricultural extension is of utmost importance. Farmers and agricultural extension workers (AEWs) must use multimedia on cellphones in the digital age. User satisfaction with digital media is influenced by factors such as usability, access rate, content quality, and overall user experience. The primary goal is to provide farmers with agricultural information through their mobile phones. This will increase agricultural output and their knowledge.

Theoretical Contributions: This study contributes to the extension of technology acceptance models in agricultural contexts and provides empirical evidence of perception dynamics between users and facilitators of digital extension.

Practical Effects: a) for Policy: Improve rural digital infrastructure and create focused digital literacy initiatives, b) for Extension Practice: Provide differentiated training for farmers and PPL depending on their particular perception patterns, c) Include perception gap analysis in the ADDIE model for more user-centered digital extension development.

To enhance the efficacy of East Java's agricultural extension programs, smartphone-based extension technology holds great potential. Its success relies on the willingness of extension officials and farmers to adopt the technology, as well as sufficient policy backing. Making sure that the digitization of extension services properly improves the welfare of Indonesian farmers calls for a thorough plan including better technological infrastructure, continuing training, and increased digital literacy.

5. Research Limitations and Future Research

This study was limited to five districts in East Java. Future research should expand to other regions and incorporate longitudinal design to track perception changes over time.

6. Acknowledgments

We would like to express our gratitude to Polbangtan Malang for funding this research, the results of which will be published in the Polbangtan Bogor Agricultural Extension Journal.

7. References

Abbasi, R., Martinez, P. & Ahmad, R. (2022). The digitization of agricultural industry – a systematic literature review on agriculture 4.0. *Smart Agricultural Technology*, *2*(February), 100042. https://doi.org/10.1016/j.atech.2022.100042

Abiri, R., Rizan, N., Balasundram, S. K., Bayat, A. & Abdul-hamid, H. (2023). Heliyon Application of digital technologies for ensuring agricultural productivity. *Heliyon*, *9*(12), e22601. https://doi.org/10.1016/j.heliyon.2023.e22601

Ahmed, S. K. (2024). How to choose a sampling technique and determine sample size for research: A simplified guide for researchers. *Oral Oncology Reports*, *12*(December). https://doi.org/10.1016/j.oor.2024.100662

Annan-Aggrey, E., Arku, G., Atuoye, K. & Kyeremeh, E. (2022). Mobilizing 'communities of practice' for local development and accleration of the Sustainable Development Goals. *Local Economy*, *37*(3), 219–229. https://doi.org/10.1177/02690942221101532

Arangurí, M., Mera, H. & Noblecilla, W. (2025). *Digital Literacy and Technology Adoption in Agriculture : A Systematic Review of Factors and Strategies*. 1–29.

Awasthi, S., Tripathi, S., Pandey, A. & Pandey, A. (2023). *Bridging the Gap : Enhancing Farmers ' Access to Extension Services in Rural Areas*. *4*(September).

Bamberger, M., Rao, V. & Woolcock, M. (2015). Using Mixed Methods in Monitoring and Evaluation: Experiences from International Development. *SAGE Handbook of Mixed Methods in Social & Behavioral Research*, *March*, 613–642. https://doi.org/10.4135/9781506335193.n24

Branch, R. M. (2009). Instructional Design: The ADDIE Approach. In *Department ofEducational Psychology and Instructional Technology*.

Byrne, G. (2011). A Statistical Primer: Understanding Descriptive and Inferential Statistics. *Evidence Based Library and Information Practice*, *6*(2), 48–50. https://doi.org/10.18438/b8hk89

Cattaneo, A. A. P., Antonietti, C. & Rauseo, M. (2022). How digitalised are vocational teachers? Assessing digital competence in vocational education and looking at its underlying factors. *Computers and Education*, *176*(March 2021), 104358. https://doi.org/10.1016/j.compedu.2021.104358

Celaya, C., Downing, P. J., Shifflett, J., Gdula, D., Barr, T. & Ramlatchan, M. (2025). *Instructional Systems Design : The Diffusion and Adoption of Technology ODU Digital Commons Instructional Systems Design : The Diffusion and Adoption of Technology : (Volume 2)* (Vol. 2, Issue October 2024).

Cronin, P., Coughlan, M. & Smith, V. (2017). Data Collection in Research. *Understanding Nursing and Healthcare Research*, *11*(10), 128–145. https://doi.org/10.4135/9781473910836.n9

Dharmawan, L., Muljono, P., Hapsari, D. R. & Purwanto, B. P. (2020). Digital information development in agriculture extension in facing new normal era during covid-19 pandemics. *Journal of Hunan University (Natural Sciences)*, *47*(12), 64–73. http://jonuns.com/index.php/journal/article/view/482

Dickerson, C. E. & Ji, S. (2021). Structured Methods. *Essential Architecture and Principles of Systems Engineering*, 39–60. https://doi.org/10.1201/9781003213635-4

Dousay, T. A. & Logan, R. (2011). Analyzing and evaluating the phases of ADDIE. *Proceedings from Design, Development and Research Conference 2011*, *August*, 32–43. https://doi.org/10.13140/2.1.1715.5206

Edgar R. Eslit. (2023). *Empowering Change at the Grassroots: Community-Led Initiatives for Local Environmental Protection*. https://doi.org/10.20944/preprints202307

Fabregas, Raissa, Tomoko Harigaya, Michael Kremer, and R. R. (2023). Introduction to Development Engineering. A Framework with Applications from the Field. Chapter 8. Digital Agricultural Extension for Development. In *Introduction to Development Engineering*. https://doi.org/10.1007/978-3-030-86065-3_1

Guide, F. (2023). Guide on digital agricultural extension and advisory services. In *Guide on digital agricultural extension and advisory services*. https://doi.org/10.4060/cc4022en

Hasanah Dewi Lestari, D. R. M. H. U. (2023). Application of the Addie Model in Designing Digital Teaching Materials. *Jurnal Pendidikan Dan Pengajaran Guru Sekolah Dasar (JPPGuseda)*, *6*(1), 105–109. https://doi.org/10.55215/jppguseda.v6i1.7525

Hinojosa, C., Sanchez, K., Camacho, A. & Arguello, H. (2023). *AgroTIC: Bridging the gap between farmers, agronomists, and merchants through smartphones and machine learning*. http://arxiv.org/abs/2305.12418

Hussain, A., Ting, D. H. & Mazhar, M. (2022). Driving Consumer Value Co-creation and Purchase Intention by Social Media Advertising Value. *Frontiers in Psychology*, *13*(February), 1–11. https://doi.org/10.3389/fpsyg.2022.800206

Karubanga, G., Kibwika, P., Okry, F. & Sseguya, H. (2016). Empowering farmers to learn and innovate through integration of video-mediated and face-to-face extension approaches: The case of rice farmers in Uganda. *Cogent Food and Agriculture*, *2*(1). https://doi.org/10.1080/23311932.2016.1274944

Kotronoulas, G., Miguel, S., Dowling, M., Fernández-Ortega, P., Colomer-Lahiguera, S., Bağçivan, G., Pape, E., Drury, A., Semple, C., Dieperink, K. B. & Papadopoulou, C. (2023). An Overview of the Fundamentals of Data Management, Analysis, and Interpretation in Quantitative Research. *Seminars in Oncology Nursing*, *39*(2), 1–9. https://doi.org/10.1016/j.soncn.2023.151398

Kustiari, T. & Ananta Budiman, Y. (2023). Peningkatan Kinerja Digital Penyuluh Pertanian Dinas Pertanian dan Pangan Kabupaten Banyuwangi Jawa Timur. *Jurnal Penyuluhan*, *19*(02), 62–79. https://doi.org/10.25015/19202346275

Kuswandi, D., Zulnaidi, H., Kurniawan, C., Aulia, F., At Thaariq, Z. Z., Wijanarko, D. A., Nafi'a,

M. Z. I. & Maknuunah, L. (2021). Digital Learning Literacy Training and Mentoring using ADDIE Model. *Proceedings of the International Conference on Information Technology and Education*, *609*(December), 98–103.

Lim, W. M. (2024). What Is Quantitative Research? An Overview and Guidelines. *Australasian Marketing Journal*. https://doi.org/10.1177/14413582241264622

Limpo, S. Y. (2022). Menapak pemikiran Syahrul Yasin Limpo. In *Repository.Pertanian.Go.Id*. http://repository.pertanian.go.id/handle/123456789/15680%0Ahttp://repository.pertanian.go.id/bitstream/handle/123456789/15680/isi MENAPAK PEMIKIRAN SYH YSN LMPO NEW EDIT kirim.pdf?sequence=1&isAllowed=y

Listiana, I., Efendi, I., Mutolib, A. & Rahmat, A. (2019). The behavior of Extension Agents in Utilizing Information and Technology to Improve the Performance of Extension Agents in Lampung Province. *Journal of Physics: Conference Series*, *1155*(1). https://doi.org/10.1088/1742-6596/1155/1/012004

Luo, M. & Dappen, L. (2005). Mixed-methods design for an objective-based evaluation of a magnet school assistance project. *Evaluation and Program Planning*, *28*(1), 109–118. https://doi.org/10.1016/j.evalprogplan.2003.12.001

Mallick, S., Burman, R. R., Padaria, R. N., Mahra, G. S., Aditya, K., Shekhawat, K., Satyapriya, Paul, S., Sahu, S., Bishnoi, S., Singh, R., Manjunath, K. K., Saini, S. & Mukherjee, S. (2025). Exploring farmers' psychological perspectives on multimedia-based agro-advisory services. *Scientific Reports*, *15*(1), 1–14. https://doi.org/10.1038/s41598-025-92936-3

Matuha, M. (2015). Mobile Phone Use in Ugandan Aquaculture: Farmer Experiences and Aspirations. *Proceedings of the National Academy of Sciences*, *3*(1), 1–15.http://dx.doi.org/10.1016/j.bpj.2015.06.056%0Ahttps://academic.oup.com/bioinformatics/article-abstract/34/13/2201/4852827%0Ainternal-pdf://semisupervised-3254828305/semisupervised.ppt%0Ahttp://dx.doi.org/10.1016/j.str.2013.02.005%0Ahttp://dx.doi.org/10.10

Mergel, I., Edelmann, N. & Haug, N. (2019). Defining digital transformation: Results from expert interviews. *Government Information Quarterly*, *36*(4),101385. https://doi.org/10.1016/j.giq.2019.06.002

Munthali, N., Leeuwis, C., van Paassen, A., Lie, R., Asare, R., van Lammeren, R. & Schut, M. (2018). Innovation intermediation in a digital age: Comparing public and private new-ICT platforms for agricultural extension in Ghana. *NJAS - Wageningen Journal of Life Sciences*, *86–87*, 64–76. https://doi.org/10.1016/j.njas.2018.05.001

Oluwatosin Ajayi, P. V. (2023). Comparison between Primary Data and Secondary Data Basis for Comparison Primary Data Secondary Data. *European Journal OfEducation and Pedagogy*, *2*(3), 1–7. www.ej-edu.orgdoi:http://dx.doi.org/19810.21091/

Rasch, S., Shang, L., Heckelei, T., Gerullis, M. K. & Jan, B. (2021). *Adoption and diffusion of digital farming technologies - integrating farm-level evidence and system interaction*. *190*. https://doi.org/10.1016/j.agsy.2021.103074

Reed, M. S., Ferré, M., Martin-Ortega, J., Blanche, R., Lawford-Rolfe, R., Dallimer, M. & Holden, J. (2021). Evaluating impact from research: A methodological framework. *Research Policy*, *50*(4). https://doi.org/10.1016/j.respol.2020.104147

Reyvalda, R., Rustandi, Y. & Warnaen, A. (2019). Desain Media Penyuluhan Interaktif Berbasis Flash Player dengan Model ADDIE pada Materi Probiotik sebagai Pakan Aditif Sapi Perah. *Jurnal Penyuluhan Pembangunan*, *1*(1), 64–70. https://doi.org/10.34145/jppm.v1i1.16

Salsabella, I. H., Bakhtiar, A. & Ibrahim, J. T. (2024). The Role Of Agricultural Extension Workers During The Digital Transformation Period At The Agricultural Extension Center In Lowokwaru District, Malang City. *Agromix*, *15(2)*(4098), 255–261.

Santosh, D. & Nagaratna Biradar Rayees Ahmad Shah Adil Ahmad, E. (2023). *Recent Advances in Agricultural Sciences and Technology Agricultural Entrepreneurship: Exploring Opportunities, Challenges, and Impacts.June*. https://www.researchgate.net/publication/371789826

Seminar, A. U. & Sarwoprasodjo, S. (2019). ICTs for small scale farmers in Indonesia: How to make it possible? *IOP Conference Series: Earth and Environmental Science*, *335*(1).

https://doi.org/10.1088/1755-1315/335/1/012028

Sen, L. T. H., Phuong, L. T. H., Chou, P., Dacuyan, F. B., Nyberg, Y. & Wetterlind, J. (2025). The Opportunities and Barriers in Developing Interactive Digital Extension Services for Smallholder Farmers as a Pathway to Sustainable Agriculture: A Systematic Review. *Sustainability (Switzerland)*, *17*(7), 1–21. https://doi.org/10.3390/su17073007

Sevi, S. (2021). A guide to interpreting regression tables. In *Universit´e de Montr´eal Department of Political Science* (Issue January).

Singh, N. K., Sunitha, N. H., Tripathi, G., Saikanth, D. R. K., Sharma, A., Jose, A. E. & Mary, M. V. K. J. (2023). Impact of Digital Technologies in Agricultural Extension. *Asian Journal of Agricultural Extension, Economics & Sociology*, *41*(9), 963–970. https://doi.org/10.9734/ajaees/2023/v41i92127

Tavakol, M., Gruppen, L. D. & Torabi, S. (2010). Using evaluation research to improve medical education. *Clinical Teacher*, *7*(3), 192–196. https://doi.org/10.1111/j.1743-498X.2010.00383.x

Thamrin, M., Ibrahim, J. T., Sutawi & Barus, W. A. (2015). *Pemanfaatan Teknologi Informasi dan Komunikasi dalam Peningkatan Kinerja Penyuluh Pertanian*.

Thi Hoa Sen, L., Chou, P., Dacuyan, F. B., Nyberg, Y. & Wetterlind, J. (2024). Barriers and enablers of digital extension services' adoption among smallholder farmers: the case of Cambodia, the Philippines and Vietnam. *International Journal of Agricultural Sustainability*, *22*(1), 1–19. https://doi.org/10.1080/14735903.2024.2368351

Trendov, N. M., Varas, S. & Zeng, M. (2019). *Digital technologies in agriculture and rural areas – Status report*. Food and Agriculture Organization of the United Nations Rome, 2019.

Wibawa, R. P. & Susanti, M. D. E. (2024). *Design And Construction of Project Based Learning Media Using The Addie Method* (Vol. 2024, Issue Ijcse). Atlantis Press International BV. https://doi.org/10.2991/978-94-6463-626-0_20

Xu, Z., Ezekiel, A., Id, A., Catalan, E. & Ma, S. (2023). *A scoping review on technology applications in agricultural extension*. 1–22. https://doi.org/10.1371/journal.pone.0292877

Yu, J., Bekerian, D. A. & Osback, C. (2024). Navigating the Digital Landscape: Challenges and Barriers to Effective Information Use on the Internet. *Encyclopedia*, *4*(4), 1665–1680. https://doi.org/10.3390/encyclopedia4040109

Yu, X., Sheng, G., Sun, D. & He, R. (2024). Effect of digital multimedia on the adoption of agricultural green production technology among farmers in Liaoning. *Scientific Reports*, *0123456789*, 1–15. https://doi.org/10.1038/s41598-024-64049-w