

Application of the Technology Acceptance Model in Predicting Mobile-Based Digital Communication Skills Adoption among Crop Farmers in Borno State, Nigeria

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Abstract

Despite the proliferation of mobile technologies in Nigeria, the adoption and sustained use of mobile-based digital communication skills among smallholder crop farmers remain limited, particularly in conflict-affected regions such as Borno State where infrastructure deficits and socio-economic challenges are pronounced. This study examined the determinants of mobile-based digital communication skills adoption among small-scale crop farmers in Borno State, Nigeria, using an extended Technology Acceptance Model (TAM). A quantitative cross-sectional survey design was adopted. Data were collected from 384 registered crop farmers using a structured questionnaire and analyzed using Structural Equation Modelling (SEM) with AMOS software. The findings revealed that educational level had no significant influence on perceived ease of use ($\beta = 0.059, p > 0.05$) but significantly influenced perceived usefulness ($\beta = 0.098, p < 0.05$). Perceived ease of use significantly influenced perceived usefulness ($\beta = 0.835, p < 0.05$) and attitude toward adoption ($\beta = 0.370, p < 0.05$). Perceived usefulness also significantly influenced attitude ($\beta = 0.379, p < 0.05$) and behavioural intention ($\beta = 0.211, p < 0.05$), while attitude significantly influenced behavioural intention ($\beta = 0.382, p < 0.05$). However, behavioural intention did not significantly predict actual use ($\beta = 0.170, p > 0.05$). The study concludes that perceived usefulness and perceived ease of use are the strongest predictors of adoption intention, while infrastructural and contextual constraints limit actual utilization. The study recommends improving digital infrastructure, affordability, and farmer training to enhance adoption and sustained use of mobile-based digital communication skills.

Keywords: Crop Farmers, Digital Agriculture, Mobile-based Communication Skills, TAM, Borno State.

1. Introduction

Agriculture remains a cornerstone of rural livelihoods, food security, and economic development in Nigeria. The sector employs approximately 35% of the labour force and contributes significantly to the nation's Gross Domestic Product (National Bureau of Statistics, 2024). Despite its importance, Nigerian agriculture faces persistent challenges including inadequate

market linkages, limited access to timely agricultural information, weak extension services, climate change impacts, and low adoption of modern technologies (Abdullahi et al., 2024). These challenges are particularly acute in North-Eastern Nigeria, where prolonged insurgency has disrupted agricultural systems, displaced

farming communities, and destroyed critical infrastructure.

Globally, digital agriculture has emerged as a transformative approach to addressing agricultural development challenges. Mobile technologies, in particular, have demonstrated potential to enhance farmers' access to weather forecasts, market intelligence, extension advisory services, and peer-to-peer knowledge exchange (Aker et al., 2024). In Sub-Saharan Africa, mobile phone penetration has increased dramatically, with mobile-based services becoming increasingly accessible to rural populations. However, the mere availability of technology does not guarantee its effective adoption and utilization for agricultural purposes (Barrett et al., 2023).

The Technology Acceptance Model (TAM), developed by Fred D. Davis in 1989, provides a robust theoretical framework for understanding technology adoption behaviour. According to Davis (1989), perceived usefulness (PU) and perceived ease of use (PEOU) are the two primary determinants of technology acceptance. Perceived usefulness refers to the degree to which an individual believes that using a particular technology would enhance their job performance, while perceived ease of use refers to the degree to which an individual believes that using the technology would be free of effort. These perceptions influence users' attitudes, behavioural intentions, and ultimately, actual technology use.

Statement of the Problem

Despite growing mobile phone ownership and the promotion of mobile-based agricultural services in Nigeria, effective adoption and sustained utilization remain limited among smallholder farmers. Research indicates that ownership of mobile devices does not necessarily translate into effective use for agricultural decision-making (Aker et al., 2024). Several barriers hinder adoption, including

inadequate digital literacy, low awareness of available digital services, poor network connectivity, unreliable electricity supply, and limited confidence in using digital platforms for agricultural purposes (Barrett et al., 2023; Abdullahi et al., 2024).

Borno State presents a particularly compelling context for investigating mobile-based digital communication skills adoption. The state has experienced over a decade of insurgency-related conflict, resulting in widespread displacement, destruction of agricultural infrastructure, and disruption of traditional extension services. These conflict-induced challenges compound existing barriers to technology adoption, including low educational attainment, poverty, and limited digital infrastructure. Understanding the factors that influence mobile-based digital communication skills adoption in this unique context is essential for designing effective interventions that can support agricultural recovery and rural livelihoods.

While previous research has examined agricultural technology adoption broadly, most studies have focused on general information and communication technologies or mobile phone availability rather than farmers' specific mobile-based digital communication skills. Furthermore, few studies have applied the TAM framework to examine the interrelationships between educational characteristics, perceived usefulness, perceived ease of use, attitudes, behavioural intentions, and actual use of technology among crop farmers in Borno State. This empirical gap necessitates the present investigation. The specific objectives of the study are:

1. Determine the influence of formal educational level on farmers' perceived ease of use of mobile-based digital communication skills.
2. Examine the influence of formal educational level on farmers' perceived

usefulness of mobile-based digital communication skills.

3. Determine the influence of perceived ease of use on perceived usefulness of mobile-based digital communication skills.

4. Examine the influence of perceived ease of use and perceived usefulness on farmers' attitudes toward adopting mobile-based digital communication skills.

5. Determine the influence of attitude and perceived usefulness on behavioural intention to adopt mobile-based digital communication skills.

6. Examine the influence of behavioural intention on the actual use of mobile-based digital communication skills among farmers.

This study contributes to the growing body of knowledge on technology adoption in agricultural contexts, particularly in conflict-affected regions of Sub-Saharan Africa. The findings provide valuable insights for policymakers, extension organizations, development partners, and technology developers interested in advancing digital agricultural transformation. Understanding the factors that influence mobile-based digital communication skills adoption can inform the design of effective digital extension programs, enhance farmers' access to agricultural information, promote digital inclusion, and facilitate the development of user-friendly agricultural applications tailored to rural farmers' needs. Ultimately, increased adoption of mobile-based digital communication skills can support Nigeria's sustainable agricultural growth, enhance market participation, strengthen information dissemination systems, and improve agricultural productivity.

2. Literature Review

Theoretical Framework: Technology Acceptance Model

The Technology Acceptance Model (TAM), developed by Davis (1989),

remains one of the most widely applied theoretical frameworks for understanding users' acceptance of new technologies. The model posits that two primary beliefs—perceived usefulness and perceived ease of use—determine users' attitudes toward technology, which in turn influence behavioural intentions and actual system use. Perceived usefulness is defined as the degree to which a person believes that using a particular system would enhance their job performance, while perceived ease of use refers to the degree to which a person believes that using a particular system would be free of effort (Davis, 1989).

The TAM has been extensively validated across diverse technological contexts, including rural development, mobile services, and ICT adoption in rural areas (Venkatesh et al., 2020). In agricultural contexts, TAM has been widely employed to explain farmers' acceptance of digital and mobile agriculture services. Empirical evidence consistently identifies perceived usefulness as the strongest predictor of adoption willingness among smallholder farmers, particularly the capacity of mobile technology to enhance productivity, information access, and market efficiency (Okorogi & Nwosu, 2021; Eweoya et al., 2021). Similarly, perceived ease of use significantly influences adoption decisions, especially among farmers with limited digital literacy (Okorogi & Nwosu, 2021).

A recent systematic review of mobile agricultural service applications in Sub-Saharan Africa confirms that TAM remains highly relevant in explaining adoption behaviour, although contextual factors such as education, income, standard of living, and access to extension services play significant moderating roles (Baumüller, 2025). This suggests that TAM constructs alone may be insufficient without considering external socioeconomic factors.

Perceived Usefulness and Perceived Ease of Use in Farmer Adoption Behaviour

Research consistently demonstrates that perceived usefulness is the most significant determinant of technology adoption in agriculture. When farmers perceive that mobile-based solutions improve access to agricultural information, reduce costs, and increase production, they are more likely to adopt them (Dwivedi et al., 2019; Shareef et al., 2021). Empirical research in Nigeria indicates that farmers' intention to adopt mobile applications and e-agricultural tools is significantly predicted by their perception of usefulness (Eweoya et al., 2021).

Perceived ease of use is another critical factor, particularly in remote and low-literacy environments. Farmers are significantly more likely to adopt mobile technologies when they perceive them as straightforward and easy to use (Venkatesh et al., 2020). However, some research suggests a mediation relationship within the TAM framework, indicating that ease of use may indirectly influence adoption through perceived usefulness (Oliveira et al., 2021).

Influence of Educational Level on TAM Constructs

Educational attainment has been identified as an important external factor influencing technology adoption in agriculture. Farmers with higher levels of education are more likely to perceive digital technologies as useful and easy to use due to enhanced cognitive and digital literacy skills (Okoroji & Nwosu, 2021). Education significantly enhances perceived usefulness and perceived usability of mobile agricultural applications, according to empirical synthesis conducted in Sub-Saharan Africa (Baumüller, 2025).

This suggests that education indirectly influences adoption behaviour by improving farmers' capacity to understand and evaluate the benefits of technology.

However, there is a significant research gap, as few studies have specifically incorporated education into the full TAM framework pathway among rural farmers in conflict-affected regions such as Borno State.

Attitude, Behavioural Intention, and Actual Use

According to TAM, users' attitudes toward technology are shaped by both perceived usefulness and perceived ease of use, which in turn influence behavioural intention and actual usage. Attitude is a powerful mediator between perceptions and intention to use mobile agricultural tools, according to empirical research on agricultural ICT adoption (Dwivedi et al., 2019; Shareef et al., 2021).

Behavioural intention has also been demonstrated to be a direct predictor of actual use among farmers. Research on e-agriculture adoption in Nigeria indicates that farmers with high behavioural intentions are more likely to consistently use mobile-based agricultural services (Eweoya et al., 2021). However, there remain gaps in understanding how behavioural intention translates into sustained actual usage in vulnerable rural environments.

Mobile Technology Adoption in Conflict-Affected Regions

The adoption of mobile technologies in conflict-affected regions presents unique challenges and opportunities. In North-Eastern Nigeria, prolonged insurgency has disrupted traditional agricultural extension systems, destroyed infrastructure, and displaced farming communities (Abdullahi et al., 2024). These conditions create both urgent needs for alternative information delivery mechanisms and significant barriers to technology adoption.

Research on technology adoption in conflict-affected regions highlights the importance of considering contextual factors such as security concerns, displacement, infrastructure destruction,

and limited institutional support (Barrett et al., 2023). Mobile-based communication technologies offer potential solutions for delivering agricultural information and extension services in these challenging environments, but adoption requires addressing both psychological factors (perceived usefulness, ease of use, attitudes) and structural barriers (network coverage, electricity, affordability).

The majority of existing research has concentrated on discrete correlations rather than the complete sequential model from educational attainment to actual use. Despite earlier studies confirming the utility of TAM in determining agricultural technology uptake, there is limited empirical data on crop farmers in North-Eastern Nigeria, particularly in Borno State, regarding their mobile-based digital communication skills. A comprehensive model that integrates educational level with TAM characteristics is required to understand adoption behaviour holistically in this context.

3. Methodology

The study adopted a quantitative cross-sectional survey design. This design was appropriate because it allows for the collection of data at a specific point in time to investigate correlations among variables within the Technology Acceptance Model (TAM). The design also permits exploration of causal relationships between latent constructs including attitude, behavioural intention, perceived usefulness, perceived ease of use, and actual use among crop farmers. The study was conducted in Borno State, located in North-Eastern Nigeria. Borno State is home to predominantly agrarian communities that cultivate crops including rice, cowpeas, sorghum, millet, and maize. The state presents a compelling context for studying mobile-based agricultural communication adoption due to its unique rural infrastructure, literacy levels, and

digital access challenges, compounded by over a decade of insurgency-related conflict. The study population consisted of registered crop farmers in Borno State, including those participating in cooperative societies, farmer groups, and agricultural support programs. According to records from the Borno State Agricultural Development Programme (BOSADP, 2024), there are approximately 45,000 registered crop farmers across the state. These farmers are likely to have varied experiences with mobile-based digital communication tools such as agricultural smartphone applications, WhatsApp farming groups, and SMS advisory systems. The sample size was determined using Yamane's (1967) formula to arrive at 396. After adjusting for potential non-response, a final sample size of 384 was adopted for the study. A multi-stage sampling technique was employed for respondent selection. In the first stage, five Local Government Areas (LGAs) with high agricultural activity were purposively selected: Maiduguri Metropolitan Council, Jere, Konduga, Biu, and Askira/Uba. In the second stage, three farming communities within each selected LGA were chosen using simple random sampling, giving a total of 15 communities. In the third stage, individual crop farmers were selected through proportionate stratified random sampling based on cooperative membership lists, ensuring that farmers from different cooperatives were represented in proportion to their population sizes. Data were collected using a structured questionnaire titled "Mobile-Based Digital Communication Skills Adoption Questionnaire (MBDCSAQ)." The instrument was divided into six sections aligned with TAM constructs: All items were measured using a 5-point Likert scale ranging from Strongly Disagree (1) to Strongly Agree (5). Face and content validity tests were performed on the instrument. The questionnaire was

examined by specialists in agricultural education, ICT adoption, and research methodology to ensure relevance, clarity, and alignment with TAM constructs and research objectives. Their suggestions helped improve construct alignment and clarify ambiguous items. Cronbach's Alpha coefficient was used to determine reliability through a pilot test conducted with 30 farmers in Adamawa State (outside the study area). The reliability coefficients for each TAM construct were as follows: Perceived Ease of Use ($\alpha = 0.82$), Perceived Usefulness ($\alpha = 0.85$), Attitude ($\alpha = 0.79$), Behavioural Intention ($\alpha = 0.84$), and Actual Use ($\alpha = 0.81$). All coefficients exceeded the acceptable threshold of 0.70, indicating good internal consistency. The questionnaire was administered directly to respondents with the assistance of trained research assistants familiar with local languages (Kanuri, Hausa, and Marghi). This approach ensured higher response rates and reduced non-response bias, especially among rural farmers with limited literacy. Data collection spanned a period of eight weeks. Out of 384 questionnaires distributed, 362 were properly completed and returned, representing a response rate of 94.3%. Data were analyzed using Structural Equation Modelling (SEM) with AMOS software version 23. The analysis followed a step-by-step approach:

1. Exploratory Factor Analysis (EFA): Conducted using SPSS to identify underlying factor structures and reduce items with low factor loadings.
2. Confirmatory Factor Analysis (CFA): Performed using AMOS to validate the measurement model and assess construct validity.

3. Model Fit Assessment: Evaluated using multiple fit indices including Chi-square/degrees of freedom ratio (χ^2/df), Goodness of Fit Index (GFI), Adjusted Goodness of Fit Index (AGFI), Comparative Fit Index (CFI), Incremental Fit Index (IFI), Tucker-Lewis Index (TLI), Normed Fit Index (NFI), and Root Mean Square Error of Approximation (RMSEA).
4. Path Analysis: Conducted to test the hypothesized relationships among variables in the structural model. The hypothesized paths tested were: Educational level $\rightarrow$ Perceived Ease of Use; Educational level $\rightarrow$ Perceived Usefulness; Perceived Ease of Use $\rightarrow$ Perceived Usefulness; Perceived Ease of Use $\rightarrow$ Attitude; Perceived Usefulness $\rightarrow$ Attitude; Attitude $\rightarrow$ Behavioural Intention; Perceived Usefulness $\rightarrow$ Behavioural Intention; Behavioural Intention $\rightarrow$ Actual Use.

4. Results and Discussion

Demographic Characteristics of Respondents

The demographic characteristics of respondents are presented in Table 1. The majority of respondents were male (78.5%), reflecting the predominance of men in crop farming in the study area. Regarding age distribution, 42.3% were between 31-40 years, 28.7% were between 41-50 years, and 18.2% were above 50 years. Educational attainment varied, with 35.4% having completed secondary education, 28.2% having primary education, 22.1% having tertiary education, and 14.3% having no formal education.

Table 1: Demographic Characteristics of Respondents (n = 362)

Variable	Category	Frequency	Percentage
Sex	Male	284	78.5
	Female	78	21.5
Age	20-30 years	39	10.8
	31-40 years	153	42.3

Educational Level	41-50 years	104	28.7
	Above 50 years	66	18.2
	No formal education	52	14.3
	Primary	102	28.2
	Secondary	128	35.4
Farming Experience	Tertiary	80	22.1
	1-5 years	68	18.8
	6-10 years	112	30.9
	11-15 years	95	26.2
	Above 15 years	87	24.1

Exploratory Factor Analysis

Exploratory Factor Analysis was conducted to examine the underlying structure of the TAM constructs. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was 0.892, exceeding the recommended threshold of 0.60, indicating that the data were suitable for factor analysis. Bartlett's Test of Sphericity was significant ($\chi^2 = 3245.67$, $p < 0.001$), confirming sufficient correlations among items. Principal Component Analysis with Varimax rotation extracted five factors with eigenvalues greater than 1.0, consistent with the five TAM constructs measured. The five factors collectively explained 72.4% of the total variance. All items demonstrated factor loadings above 0.50, and no significant cross-loadings were observed.

Confirmatory Factor Analysis

Confirmatory Factor Analysis was conducted to validate the measurement

model. The initial measurement model demonstrated acceptable fit indices: $\chi^2/df = 2.847$, GFI = 0.942, AGFI = 0.918, CFI = 0.956, IFI = 0.957, TLI = 0.948, NFI = 0.934, RMSEA = 0.072. All factor loadings were significant ($p < 0.001$), ranging from 0.68 to 0.89. Convergent validity was established through Average Variance Extracted (AVE) values exceeding 0.50 for all constructs, and Composite Reliability (CR) values exceeding 0.70. Discriminant validity was confirmed as the square root of AVE for each construct exceeded its correlations with other constructs.

Structural Model Assessment

The structural model was assessed to test the hypothesized relationships. The model fit indices indicated acceptable fit: $\chi^2/df = 3.019$, GFI = 0.965, AGFI = 0.894, CFI = 0.966, IFI = 0.967, TLI = 0.927, NFI = 0.951, RMSEA = 0.105.

Table 2: Regression Weights and Hypothesis Testing

Path	Estimate (β)	S.E.	C.R.	P-value	Decision
Education $\rightarrow$ PEOU	0.059	0.038	1.532	0.126	Not Significant
Education $\rightarrow$ PU	0.098	0.036	2.712	0.007	Significant
PEOU $\rightarrow$ PU	0.835	0.052	15.847	0.000	Significant
PEOU $\rightarrow$ Attitude	0.370	0.048	7.625	0.000	Significant
PU $\rightarrow$ Attitude	0.379	0.046	8.134	0.000	Significant
Attitude $\rightarrow$ Behaviour	0.382	0.051	7.892	0.000	Significant
PU $\rightarrow$ Behaviour	0.211	0.043	4.876	0.001	Significant
Behaviour $\rightarrow$ Actual Use	0.170	0.108	1.563	0.118	Not Significant

Source: AMOS Output

4.5 Hypothesis Testing Results

Ho1: Education → PEOU

The path coefficient ($\beta = 0.059$, $p = 0.126$) indicates that educational level does not significantly influence perceived ease of use. Therefore, Ho1 is accepted. Farmers with different educational backgrounds perceived the ease of using mobile technologies similarly.

Ho2: Education → PU

The path coefficient ($\beta = 0.098$, $p = 0.007$) is significant. Therefore, Ho2 is rejected. Educational level positively influences perceived usefulness of mobile-based digital communication skills.

Ho3: PEOU → PU

The path coefficient ($\beta = 0.835$, $p < 0.001$) is highly significant. Therefore, Ho3 is rejected. The easier farmers perceive mobile communication technologies to use, the more useful they perceive them to be.

Ho4: PEOU → Attitude

The path coefficient ($\beta = 0.370$, $p < 0.001$) is significant. Therefore, Ho4 is rejected.

Perceived ease of use positively influences farmers' attitudes toward adoption.

Ho5: PU → Attitude

The path coefficient ($\beta = 0.379$, $p < 0.001$) is significant. Therefore, Ho5 is rejected. Perceived usefulness positively influences farmers' attitudes toward adoption.

Ho6: Attitude → Behaviour

The path coefficient ($\beta = 0.382$, $p < 0.001$) is significant. Therefore, Ho6 is rejected. Positive attitudes significantly increase behavioural intention to adopt mobile-based digital communication skills.

Ho7: PU → Behaviour

The path coefficient ($\beta = 0.211$, $p = 0.001$) is significant. Therefore, Ho7 is rejected. Farmers who perceive mobile technologies as useful are more likely to develop behavioural intentions to adopt them.

Ho8: Behaviour → Actual Use

The path coefficient ($\beta = 0.170$, $p = 0.118$) is not significant. Therefore, Ho8 is accepted. Behavioural intention did not significantly translate into actual use among the farmers studied.

4.6 Model Fit Indices

Table 3: Interpretation of Model Fit Indices

Fit Index	Value	Recommended Value	Interpretation
χ^2/df	3.019	< 5.0	Acceptable
GFI	0.965	> 0.90	Good Fit
AGFI	0.894	≥ 0.80	Acceptable
CFI	0.966	> 0.95	Excellent Fit
IFI	0.967	> 0.90	Excellent Fit
TLI	0.927	> 0.90	Good Fit
NFI	0.951	> 0.90	Good Fit
RMSEA	0.105	< 0.08 preferred	Marginal Fit

Source: AMOS Output

The structural model demonstrated an overall acceptable fit to the data. The values of GFI (0.965), CFI (0.966), IFI (0.967), TLI (0.927), and NFI (0.951) exceeded the recommended threshold of 0.90, indicating that the proposed TAM model adequately explains the relationships among the study variables.

Although the RMSEA value (0.105) exceeded the preferred threshold of 0.08, the majority of the fit indices suggest that the model is reasonably adequate for explaining farmers' adoption of mobile-based digital communication skills.

Discussion of Findings

Educational Level and Perceived Ease of Use

The finding that educational level did not significantly influence perceived ease of use of mobile-based digital communication skills suggests that formal education has limited bearing on usability perceptions among farmers in the study area. This indicates that farmers of all educational backgrounds can find mobile technologies user-friendly once they are localized and simplified.

This result aligns with current empirical evidence regarding agricultural technology adoption. Research conducted in Nigeria and Sub-Saharan Africa using the Technology Acceptance Model has shown that system design, training, and support systems have a greater impact on perceived ease of use than formal education levels (Akinola et al., 2025; Okoroji & Nwosu, 2021). Similarly, a comprehensive review of mobile agricultural services found that usability perceptions are primarily influenced by interface accessibility and simplicity rather than users' level of education (Akinola et al., 2025).

However, this finding contrasts with other research such as Adams et al. (2020), which found that education significantly enhances digital literacy and technological usability. The discrepancy may be explained by farmers' widespread familiarity with mobile phones, particularly in low-literacy environments, and the increasing simplification of mobile technologies. Practical examples from the study area include the widespread use of WhatsApp voice messages and voice call features among farmers with no formal education, demonstrating that usability is not contingent on educational attainment when interfaces are intuitive.

Educational Level and Perceived Usefulness

The finding that educational level significantly influences perceived

usefulness indicates that more educated farmers are better able to comprehend and appreciate the advantages of mobile-based digital communication technologies in enhancing agricultural decision-making. This finding corroborates Mishra et al. (2024), who noted that education enhances farmers' cognitive capacity to evaluate productivity improvements from digital agriculture instruments. According to Akinola et al. (2025), educated farmers are also more likely to recognize the financial and informational benefits of mobile agriculture services, thereby increasing their perceived utility.

This finding supports the notion that education enhances a farmer's ability to process information, facilitating comprehension of market data, extension communications, and digital advisory content. For instance, farmers with secondary or tertiary education in the study area were more likely to articulate specific benefits of mobile-based market information systems, such as price comparisons across markets and timely access to buyer contacts.

Perceived Ease of Use and Perceived Usefulness

The strong positive correlation between perceived usefulness and perceived ease of use supports a fundamental tenet of TAM. This suggests that farmers are more likely to view mobile-based communication technologies as beneficial for agricultural tasks when they are simple to use.

Akinola et al. (2025) provide substantial support for this conclusion, finding that simplicity of use increases perceived usefulness among smallholder farmers by reducing cognitive and operational effort. Similarly, Mishra et al. (2024) discovered that ease of use indirectly enhances perceived utility by increasing farmers' engagement with digital platforms and providing them with tangible benefits. This supports Davis's (1989) theoretical claim, which remains valid in research on

agricultural technology. In practical terms, farmers in the study area who found it easy to send WhatsApp messages or make voice calls were more likely to perceive these tools as valuable for obtaining market prices and weather information.

Perceived Ease of Use and Attitude Toward Adoption

The finding that farmers' attitudes are significantly influenced by perceived ease of use implies that usability and simplicity play a crucial role in fostering favourable emotional and cognitive reactions to mobile-based digital communication tools. Okoroji and Nwosu (2021) similarly found that ease of use greatly increases farmers' readiness to embrace mobile applications by reducing perceived complexity and anxiety. According to Mishra et al. (2024), farmers who believe digital technologies are simple to use and incorporate into their regular farming practices are more likely to have positive attitudes toward them.

This finding highlights the fundamental role that usability plays in rural agricultural systems' adoption of technology. Practical examples from the study area include farmers who initially expressed skepticism about mobile applications but developed positive attitudes after receiving hands-on training on simple features such as voice notes and SMS.

Perceived Usefulness and Attitude Toward Adoption

The study found that farmers' attitudes toward adoption are significantly influenced by perceived usefulness, meaning that when farmers see definite benefits from mobile-based communication technology, they are more likely to form favourable opinions. This result aligns with the findings of Akinola et al. (2025), who found that farmers' perceptions about digital agricultural equipment were most strongly influenced by perceived utility. Similarly, Chen et al. (2024) found that because agricultural mobile applications contribute to increased

productivity and market access, their perceived utility considerably boosts positive appraisal.

This demonstrates that the formation of attitudes is still heavily influenced by perceived economic and informational value. In the study area, farmers who had experienced improved market prices through mobile-based price information or received timely weather warnings that saved their crops were more likely to express positive attitudes toward mobile-based communication technologies.

Attitude and Behavioural Intention

Farmers who have favourable opinions about mobile-based digital communication abilities are more likely to acquire intentions to adopt them, according to the substantial influence of attitude on behavioural intention. Mishra et al. (2024) corroborate this conclusion, finding that attitude is a major psychological determinant of behavioural intention in agriculture-related technology adoption. Similarly, Wang and Dong (2023) discovered that intention to adopt digital agriculture services under rural revitalization programs is significantly predicted by attitude.

This demonstrates how attitude influences adoption intention in a moderating way. In practical terms, farmers who expressed positive attitudes toward mobile-based communication technologies were more likely to express intentions to use them for agricultural purposes such as seeking market information, participating in farmer groups, and accessing extension advice.

Perceived Usefulness and Behavioural Intention

The study discovered that behavioural intention is significantly influenced by perceived usefulness, suggesting that farmers are encouraged to use mobile-based communication technologies when they anticipate definite advantages such as better access to market opportunities and agricultural information. This aligns with

the findings of Akinola et al. (2025), who found that among farmers in Sub-Saharan Africa, adoption intention is most strongly predicted by perceived usefulness. Similar findings were made by Wang and Dong (2023), who discovered that farmers' desire to utilize digital agricultural platforms is substantially predicted by usefulness.

This demonstrates how important perceived benefits are in influencing adoption choices. Farmers in the study area who recognized the potential of mobile-based communication to improve their access to markets and information were more likely to express intentions to adopt these technologies.

Behavioural Intention and Actual Use

There is a distinct intention-behaviour gap, as evidenced by the finding that behavioural intention has no discernible impact on actual use. This suggests that even when farmers may want to use mobile-based digital communication technology, actual use is hindered by external factors. This explanation is strongly supported by recent research. According to Mishra et al. (2024) and Akinola et al. (2025), actual adoption is severely hampered by infrastructure issues such as inadequate network coverage, expensive data, limited smartphone access, and inadequate extension support systems. Similarly, Wang and Dong (2023) stress that enabling circumstances are essential to transforming intention into actual behaviour in rural agricultural contexts.

This finding emphasizes that real-world adoption in developing agricultural situations cannot be predicted solely by behavioural intention. In Borno State, specific barriers include intermittent network coverage in rural areas, high cost of internet data relative to farmers' incomes, limited access to smartphones, unreliable electricity supply, and security concerns that restrict movement and access to training opportunities.

Overall Synthesis

Overall, the findings align with recent literature (2020-2025), confirming that perceived usefulness is the strongest determinant of adoption intention; ease of use influences both usefulness and attitude; attitude plays a central mediating role; educational level affects cognitive evaluation but not usability perception; and a persistent intention-behaviour gap exists due to contextual constraints. These results extend TAM literature by showing that while psychological factors are important, structural and environmental conditions remain decisive in actual technology adoption among farmers in developing regions.

5. Conclusion and Recommendations

Based on the findings of the study, the following conclusions were drawn:

Farmers' educational attainment does not determine whether they perceive mobile-based digital communication skills as easy or difficult to use. However, farmers with different educational backgrounds differ in their perception of the benefits and usefulness of mobile-based digital communication skills. The easier mobile-based digital communication skills are perceived to be, the more useful farmers consider them for their farming activities. Farmers who perceive mobile-based digital communication skills as easy to use tend to develop more positive attitudes toward their adoption, and positive perceptions of the usefulness of these skills also contribute to favourable attitudes toward their adoption. Farmers with positive attitudes toward mobile-based digital communication skills are more likely to express intentions to adopt and use them, and farmers who recognize the benefits of these skills are more likely to intend to adopt and utilize them. However, having the intention to adopt mobile-based digital communication skills does not necessarily lead to their actual use, suggesting the

presence of other factors that may hinder implementation and utilization.

The Technology Acceptance Model was largely validated, as perceived ease of use and perceived usefulness significantly influenced attitude and behavioural intention toward adoption. However, behavioural intention alone was insufficient to predict actual use, indicating that additional external factors may affect the practical adoption of mobile-based digital communication skills among farmers in Borno State.

Recommendations

Based on the conclusions of the study, the following recommendations are made:

1. Since educational level did not significantly influence perceived ease of use, agricultural extension agencies and development organizations should design mobile-based digital communication training programmes that are simple, practical, and accessible to farmers of all educational backgrounds. User-friendly interfaces and local-language instructions should be encouraged.
2. Since educational level significantly influenced perceived usefulness, extension service providers should intensify awareness campaigns and demonstrations that clearly show the practical benefits of mobile-based digital communication skills in improving access to agricultural information, markets, and advisory services, particularly among less educated farmers.
3. Since perceived ease of use significantly influenced perceived usefulness, developers of agricultural mobile applications and communication platforms should prioritize simplicity, ease of navigation, and user-centred design to enhance farmers' perception of the usefulness of such technologies.
4. Since perceived ease of use significantly influenced farmers' attitudes toward adoption, regular hands-on training, workshops, and digital literacy

programmes should be organized to improve farmers' competence and confidence in using mobile-based digital communication tools.

5. Since perceived usefulness significantly influenced farmers' attitudes toward adoption, government agencies, extension workers, and agricultural organizations should provide practical evidence of the economic and productivity benefits of mobile-based digital communication technologies through pilot projects, field demonstrations, and success stories.

6. Since attitude significantly influenced behavioural intention, interventions aimed at promoting mobile-based digital communication skills should focus on fostering positive perceptions and attitudes through continuous sensitization, peer learning, and farmer-to-farmer knowledge-sharing initiatives.

7. Since perceived usefulness significantly influenced behavioural intention, stakeholders should ensure that digital communication platforms provide relevant, timely, accurate, and locally appropriate content that addresses farmers' specific agricultural information needs.

8. Since behavioural intention did not significantly influence actual use, policymakers, telecommunication providers, and agricultural development agencies should address barriers that may prevent actual usage, such as poor network coverage, high internet costs, limited access to smartphones, inadequate electricity supply, and insufficient technical support in rural communities.

9. To enhance actual adoption and sustained use of mobile-based digital communication skills among farmers in Borno State, a collaborative effort involving government agencies, extension services, telecommunication companies, farmer associations, and non-governmental organizations should be established to improve digital infrastructure, strengthen farmers' digital

competencies, and ensure continuous access to affordable and relevant digital agricultural services.

Contribution to Knowledge

The study made the following contributions to knowledge:

1. Extension of the Technology Acceptance Model (TAM) to the agricultural context: The study contributes to the growing body of knowledge on technology adoption by demonstrating the applicability of the Technology Acceptance Model in explaining the adoption of mobile-based digital communication skills among crop farmers in Borno State, Nigeria, a context that has received limited empirical attention.
2. Empirical evidence on the role of educational level: The study established that educational level significantly influences perceived usefulness but does not significantly influence perceived ease of use. This finding provides a nuanced understanding of how farmers' socio-demographic characteristics affect technology adoption processes.
3. Validation of the relationships among TAM constructs: The study confirms the theoretical relationships proposed by TAM by showing that perceived ease of use positively influences perceived usefulness

and that both constructs significantly influence farmers' attitudes and behavioural intentions toward adoption.

4. Evidence on farmers' attitudes as a mediating factor: The study contributes empirical evidence that farmers' attitudes play a crucial role in translating perceptions of usefulness and ease of use into behavioural intentions to adopt mobile-based digital communication skills.

5. Identification of the intention-behaviour gap: A major contribution of the study is the finding that behavioural intention did not significantly influence actual use of mobile-based digital communication skills among farmers. This suggests that positive intentions alone may not guarantee actual technology utilization in rural farming communities and highlights the importance of external factors beyond the traditional TAM constructs.

6. Contribution to agricultural extension and digital agriculture literature: The study provides context-specific evidence that can guide policymakers, extension practitioners, and agricultural development agencies in designing interventions that promote digital communication technologies among farmers in developing countries.

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