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Original Article

The Influence of Perceived Innovation Characteristics on Small-scale Commercial Farmers' Perception of the Adoption of Mobile Applications in Makonde District, Zimbabwe

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*Perceived Innovation
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Small-Scale
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Adoption of Mobile
Applications,
Makonde District,
Zimbabwe.*

This study aims to examine the influence of perceived innovation characteristics on small-scale commercial farmers' perception of the adoption of mobile applications in Makonde District, Zimbabwe. The study adopted the Diffusion of Innovations Theory (DIT) to understand the important concepts of the adoption of mobile applications to inform the analysis of the results. To collect data, the study used a bounded case study. The study employed a purposive sampling technique to select the study area and forty-eight small-scale commercial farmers for focus group discussions. Further, the study adopted snowball sampling to select twelve key informants, that is, lead farmers, agricultural extension officers, mobile applications developers, agricultural researchers and network providers referred by agricultural extension personnel for in-depth interviews. The study employed thematic analysis to analyze data into codes, themes and sub-themes. The research demonstrates that the importance of each perceived innovation characteristic in the adoption process of mobile applications for improved small-scale commercial agriculture is different. Relative advantage and observability were the most important characteristics of the adoption of mobile applications for improved small-scale commercial agriculture. The research highlighted that small-scale commercial farmers are more likely to embrace mobile phone applications that possess a high relative advantage, are less complex, highly compatible, are trial-able and exhibit visibility of results. The study consolidates and presents the perceived innovation characteristics, offering researchers valuable insights into the adoption patterns of mobile applications among small-scale commercial agriculture. The research findings have implications for policy-makers and mobile application developers.

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INTRODUCTION

The adoption of mobile applications has revolutionised smallholder agriculture, particularly in developing countries. They have provided farmers with essential tools vital to access agricultural information (Abubakari et al., 2023; Ahmad et al., 2024; Akter & Tan, 2023; Landman et al., 2020; Mutuma et al., 2020; Quandt et al., 2020; Thar et al., 2020). Further, they have improved linkages along the agriculture value chain (AVCs), thereby enabling farming communities to recover from shocks and stresses to which farmers are exposed (Sidibé et al., 2021). Furthermore, mobile applications play a significant role in transforming the way farmers work and interact on agricultural issues such as weather forecasts and alerts, crop management and advisory services, market prices and trends, agricultural news and updates, and agricultural best practices and tutorials. Thus, mobile applications have benefited farmers by increasing productivity, improving decision-making, enhancing efficiency, accessing better markets, increasing income, reducing transport and production costs and improving livelihoods.

Studies on the adoption of mobile applications have largely focussed on the smallholder agriculture sector, there is a concern that mobile applications have not benefited small-scale commercial agriculture, despite the increased awareness of the benefits of adopting mobile phones and the

availability of useful mobile applications, their utilisation for accessing agricultural information remains low in Makonde district, Zimbabwe. Stakeholders in agriculture need a significant amount of information to which they do not have access in order to understand why the adoption of mobile applications remains low. Given this background, the study seeks to examine the influence of perceived innovation characteristics on small-scale commercial farmers' perception of the adoption of mobile applications in Makonde district, Zimbabwe.

LITERATURE REVIEW

The perceived innovation characteristics in this study were selected based on a review of the adoption of agricultural technology-related literature. Previous studies on innovation characteristics often reference the work of Rogers (2003) which identifies key characteristics such as relative advantage, complexity, compatibility, trialability and observability.

Innovation Characteristics

A study by Astuti et al., (2022) found that innovation characteristics had a significant impact on the adoption of Probio_FM technology in the implementation of an integrated farming system. Similarly, a study by Rizzo et al (2023) revealed that specific innovation characteristics foster the innovation adoption process. Likewise, a study by

Masere and Worth (2021) revealed that key factors affecting the adoption are interrelated with small-scale farmers' innovation attributes of the technology itself on public agricultural extension. Likewise, a study by Kumar et al (2020) showed that technology characteristics influenced the early adoption of alternative catfish production technologies in the United States of America. Further, a study by Timpanaro et al (2023) found that perceived innovation characteristics influenced farmers' intention to adopt sustainable irrigation innovations. Furthermore, a study by Gandasari et al (2020) showed that innovation attributes influenced the adoption of two-wheeled hand tractor and water pump innovations. However, a study by Shang et al (2021) indicated that farm-level studies tend to neglect the attributes of technology on the adoption and diffusion of digital farming technologies.

Relative Advantage

A study by Nyagadza et al (2022) revealed that relative advantage had a positive impact on the adoption of smartphone technology and acceptance of agricultural marketing information by rural small-scale farmers. Likewise, a study by Aparo et al (2022) revealed that perceived usefulness (relative advantage) influenced farmers' adoption of mobile technologies. Kabir et al (2022) in their study indicated that perceived usefulness influenced positively influenced extension workers' intention to use ICT-based information systems. A study by Elahi et al (2022) found that farmers' intention to install a solar-powered water pump was positively associated with relative advantages. In Maasin, Philippines, a study by Diaz et al (2021) showed that perceived usefulness exhibited significantly influenced farmers' willingness to adopt mobile technology in the marketing of bamboo products. A study by Abdullahi et al (2021) showed that relative advantage significantly contributed to ICT adoption in Somalian agribusiness enterprises. Okoroji et al (2021) in their study indicated that perceived usefulness had a positive impact on the actual use of

mobile applications by farmers. Pillai and Sivathanu (2020) in their study revealed that relative advantage was the reason for adopting the Internet of Things (IoT-A) in the agriculture sector. A study by Caffaro et al (2020) showed that perceived usefulness influenced farmers' intention to adopt technological innovations.

Simplicity/Complexity

A study by Aparo et al (2022) revealed that perceived ease of use (simplicity) influenced farmers' adoption of mobile technologies. Similarly, a study by Masere & Worth (2022) found that simplicity influenced the adoption and innovation of new technology and decision-making by small-scale resource-constrained farmers. Further, a study by Strong et al (2022) found that simplicity (low complexity) influenced the adoption of smart agriculture technology by Brazilian agriculturists. A study by Dissanayake et al (2022) found that simplicity played a crucial role in the adoption of technology in Sri Lanka's agricultural sector. A study by Diaz et al (2021) revealed that perceived ease of use significantly influenced farmers' willingness to adopt mobile technology in Maasin, Philippines. A study by Abdullahi et al (2021) showed that complexity significantly contributed to ICT adoption in Somalian agribusiness enterprises. A study by Mehra et al (2020) found that perceived ease of use was a significant determinant of intention to use mobile applications among young adults. A study by Mahata and Mhagama (2022) found that simplicity influenced the adoption of mobile applications among farmers in Lilongwe, Malawi. In contrast, the study revealed that complexity hindered the adoption of mobile applications for improved small-scale commercial agriculture. This finding is consistent with the findings of Rizzo et al (2023) which revealed that complexity hindered innovation adoption. Similarly, a study conducted by Coggins et al (2022) revealed that complexity impeded the utilisation of digital extension tools among smallholder farmers. A study by Strong et al (2022)

observed that smart agriculture innovation's excessive complexity hindered adoption. A study by Nyaplue-Daywhea et al (2021) revealed that complexity significantly impeded the user competency and usage frequency of mobile phone-assisted agricultural extension in Eastern Ghana. A study by Misaki (2021) revealed that a lack of understanding of the technology impeded small-scale farmers' awareness of e-Agriculture. A study by Masi et al (2022) found that complexity could significantly reduce the potential for technology adoption.

Compatibility

The results of the study revealed that compatibility enhanced the adoption of mobile applications for improved small-scale commercial agriculture. This finding is consistent with the findings by Strong et al (2022) who observed that smart agriculture innovation's elevated levels of compatibility predicted agriculturists' adoption. A study by Dissanayake et al (2022) found that compatibility played a crucial role in the adoption of technology in Sri Lanka's agricultural sector. A study by Dhehibi et al (2023) found that compatibility influenced the use of SMS for the adoption of mobile applications. Conversely, a study by Strong et al (2022) observed that smart agriculture innovation's minimal compatibility levels hindered agriculturists' adoption. Similarly, a study by Nyaplue-Daywhea et al (2021) revealed that compatibility impeded the user competency and usage frequency of mobile phone-assisted agricultural extension in Eastern Ghana. Likewise, a study by Karunathilake et al (2023) showed that compatibility issues could be significant barriers for small-scale farmers. Thus, a study by Abdul-Majid et al (2024) noted that agricultural technology may have mixed effects on farmers' well-being, depending on the type of technology adopted and the compatibility of farmers with technology in their agricultural practices.

Trial-ability

A study by Dissanayake et al (2022) found that trial-ability played a crucial role in the adoption of technology in Sri Lanka's agricultural sector. Similarly, a study by Ojiako-Chigozie (2024) indicated that trial-ability or the ease with which an innovation can be experimented with influenced the adoption rate. Likewise, previous research studies by Akter and Tan (2023); Duc et al. (2023); Hoang (2020); Landman et al. (2020); Mutambara, (2021); Mutuma et al. (2023) and Osman et al. (2022) underscored the importance of trial-ability in empowering farmers to assess the functionality, utility and compatibility of the mobile applications to make informed decisions in their particular farming contexts.

Observability

A study by Strong et al (2022) observed that smart agriculture innovation's elevated levels of observability predicted agriculturists' adoption. Similarly, a study by Dissanayake et al (2022) found that observability played a crucial role in the adoption of technology in Sri Lanka's agricultural sector. Similarly, a study by Dhehibi et al (2023) found that observability influenced the use of SMS for the adoption of mobile applications in developing countries. Likewise, studies by Antony et al. (2020); Emeana et al. (2020); Hoang (2020); Kudama et al. (2021); Mutambara (2021); Osman et al. (2022); Singh et al. (2020) and Suri and Udry (2022) indicated that the visibility of mobile phone applications in the agricultural community, through demonstrations, trainings and promotional activities enhance adoption process.

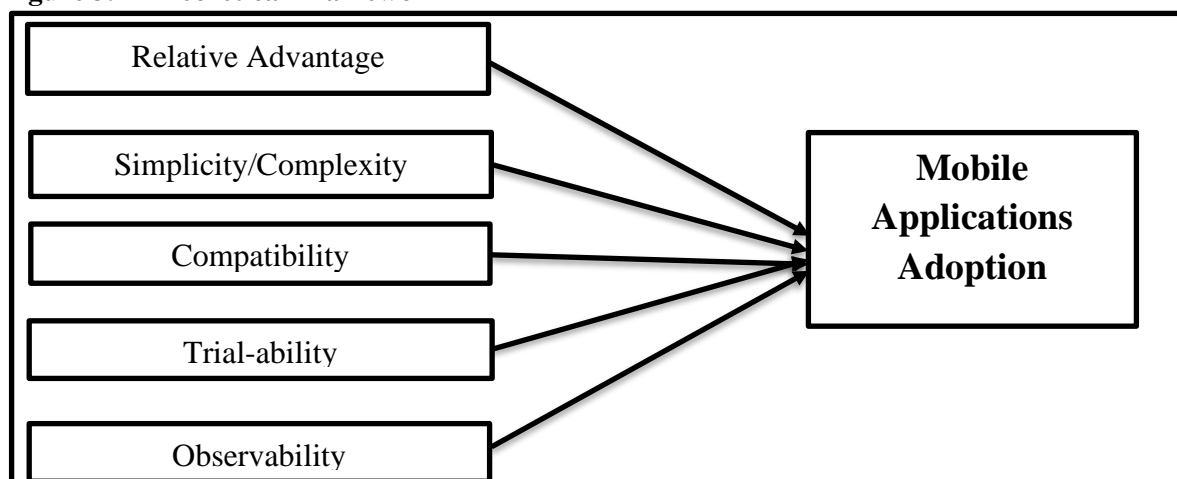
THE DIFFUSION OF INNOVATION THEORY

The Diffusion of Innovations Theory (DIT) is concerned with understanding the process by which the use of innovations spreads throughout a social system (Rogers, 1995). Rogers (1995) identified five characteristics (relative advantage, complexity, compatibility, trial-ability and observability) generalized in their relation to the degree of

adoption in a social system. Further, the theory provides practical implications and analytical guidelines for research on innovation adoption (Rogers, 1995). Furthermore, it provides an understanding of the adoption behaviours of potential adopters and predicts the adoption of technological innovations. This highlights the

difference in the predictive power of adopters. The research adopted the DIT due to its prior use and the robustness of its constructs. Rogers (1995) proposed a relationship between perceived innovation characteristics and the adoption of innovation in a theoretical framework as depicted in Figure 3.1.

Figure 3. 1 Theoretical Framework



Source: Rogers (1995)

The Perceived Innovation Characteristics

An innovation is defined as an idea, practice or object that an individual recognises as novel. The objective novelty of the innovation, as determined by the passage of time, is less significant than the subjective perception of newness held by the potential adopter (Rogers, 2003). The characteristics of an innovation reflect the interaction between the innovation and adopters (Geenhalgh et al., 2004). Perceived innovation characteristics have been regarded as significant determinants affecting the speed of technology diffusion within the social system.

Relative Advantage

Relative advantage represents the degree to which an innovation is seen as better than the precedent innovation (Rogers, 2003). Relative exists if an innovation offers superior performance relative to previous technologies used to perform the same function. Diffusion studies have found a relative

advantage to be one of the best predictors of an innovation's perception of adoption.

Complexity

Complexity represents the degree to which an innovation is perceived as being difficult or hard to understand and use (Rogers, 2003). New ideas that are simpler to understand by members of a social system are adopted more rapidly than innovations that require the adopter to develop new skills and understanding. Low levels of complexity lead to a higher adoption rate and high levels of complexity increase the rate of rejection (Rogers, 2003).

Compatibility

Compatibility represents the degree to which an innovation is perceived as being consistent with norms and values, experiences and needs of the potential adoptive entity of the innovation. Innovations that are simpler to understand and coalesce with farmers' existing habits and lifestyles

are adopted more rapidly than innovations that are not compatible (Rogers, 2003).

Trial-ability

Trial-ability represents the degree to which an innovation can be experimented on a limited basis (Rogers, 2003). Latent adopters, who are invited to experiment with an innovation, would feel comfortable adopting innovations (Rogers, 2003). Triable innovations reduce the level of uncertainty for individuals contemplating its adoption as it allows individuals to gain insights through practical experience.

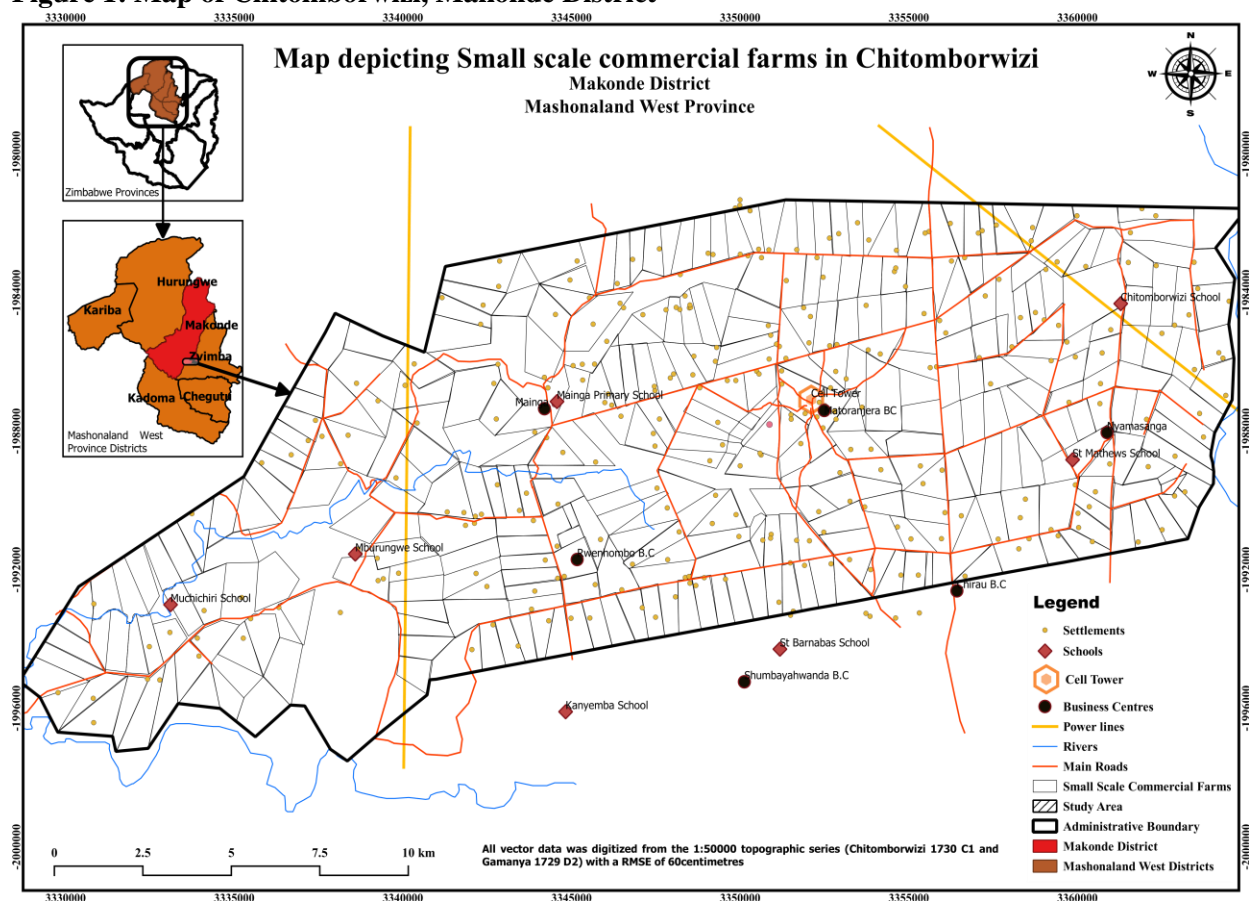
Observability

Observability refers to the degree to which the results of an innovation are visible to other individuals or other entities (Rogers, 2003). Visibility stimulates peer discussion of the innovation evaluating information about the innovation. The more visible the results, the higher the probability of adoption (Rogers, 2003).

METHODOLOGY

The study was conducted in Makonde District, Mashonaland West Province, Zimbabwe. The study covered Chitomborwizi small-scale commercial farming area. Fig. 2.1 shows the study area.

Figure 1: Map of Chitomborwizi, Makonde District



Source: Author's Illustration

The study employed the qualitative method. The study adopted a bounded case study to collect primary data from small-scale commercial farmers.

The study adopted purposive sampling techniques to select the research area and forty-eight small-scale commercial farmers for focus group

discussions. Further, the study utilized the snowball-sampling technique to select twelve key informants, that is, lead farmers, agricultural extension officers, mobile applications developers, agricultural researchers, network providers and financial institutions personnel. Participation in the study was based on the research participants' ownership of smartphones, fully practising small-scale commercial agriculture and the agreement to participate voluntarily. Prior to data collection, permission was sought from Chinhoyi University of Technology and from the resident minister of Mashonaland West Province's Office of Economic Affairs. Before the interviews, a thorough consent procedure was conducted with all prospective research participants. Data was collected from small-scale commercial agriculture, lead farmers, agricultural extension officers, mobile applications developers, agricultural researchers, network providers and financial institutions personnel. The study adopted thematic analysis to analyze data, which were presented in codes, themes and sub-themes.

PRESENTATION, ANALYSIS AND DISCUSSION OF RESEARCH FINDINGS

Factors Influencing Small-scale Commercial Farmers' Perception to Adopt Mobile Phone Applications

Relative Advantage

Relative advantage was evaluated in terms of transport and production cost reduction. Research participants noted that transport and production cost reduction enhanced the adoption of mobile applications. When asked about the reduction in transport and production costs as a relative advantage, all research participants reported that,

"Farmers' presence at the farm is very important. They do not have to spend money, time and energy travelling to seek information since they can easily get the information using their mobile devices with the click of a button"

(Key Informants and Focus Group Discussion Participants).

All the research participants were of the view that the adoption of mobile phone applications reduced production and transport costs.

Further, relative advantage was evaluated in terms of enhanced communication. Research participants noted that mobile applications enhanced communication. When asked about enhanced communication as a relative advantage, all research participants reported that,

"Through the convenience and immediacy brought about by mobile phone applications, small-scale commercial farmers can get the right information in real-time in their locations without restrictions" (Key Informant and Focus Group Discussion Participants).

"Mobile applications enhanced effective communication between farmers and extension, farmers and farmers, farmers and markets and farmers and other agricultural stakeholders" (Key Informant and Focus Group Discussion Participants).

All the research participants were of the view that the adoption of mobile phone applications enhanced communication in agricultural settings.

The relative advantage was evaluated in terms of time and effort saving. Research participants noted that mobile applications saved time and effort. When asked about time and effort saving, all research participants reported that,

"The use of mobile applications in agriculture helps farmers to concentrate more on farming productivity" (Key Informants and Focus Group Discussion Participants).

All the research participants were of the perception that the adoption of mobile phone applications benefited them in saving time and effort.

The relative advantage was evaluated in terms of improved quality and integration of agricultural services. Research participants noted that mobile applications improved the quality and integration of agricultural services. When asked about improved quality and integration of agricultural services as a relative advantage, all research participants reported that,

“Mobile phone applications have led to the improvement in quality and integration of agricultural services into a one-stop virtual platform, which provides the information farmers need” (Key Informants and Focus Group Discussion Participants).

The majority of the research participants viewed mobile applications as tools that improve the quality and integration of agricultural services in agricultural settings.

The results of the current study found that relative advantage significantly influenced the adoption of mobile applications for improved small-scale commercial agriculture. This finding concurs with the findings of Abdullahi et al (2021); Aparo et al (2022); Caffaro et al (2020); Diaz et al (2021); Elahi et al (2022); Mehra et al (2020); Nyagadza et al (2022); Okoroji et al (2021) Pannell and Llewellyn (2020) and Pillai and Sivathanu (2020). These studies argued that relative advantage influenced the adoption of mobile applications in agriculture. The higher the relative advantage, the higher the adoption rate of mobile applications. This reflects that relative advantage is an important characteristic in the adoption of mobile applications for improved small-scale commercial agriculture.

Simplicity/Complexity

The simplicity of mobile phone applications was evaluated in terms of ease of use. Research participants noted that mobile applications are easy to use. When asked how simplicity based on ease of use influences the adoption of mobile phone applications, fifty-eight research participants reported that:

“The increasing availability of user experience design has enabled the majority of small-scale commercial farmers to navigate easily mobile phone applications, even those farmers with limited digital literacy and technical skills” (Key Informants and Focus Group Discussion Participants).

The research highlighted that the majority of research participants were of the view that mobile phone applications are easy to use.

In contrast, complexity has emerged as a barrier to the adoption of mobile phone applications. Complexity was evaluated in terms of not being easy to use impeded the adoption of mobile phone applications. Research participants noted mobile applications were complicated. When asked how simplicity based on ease of use influences the adoption of mobile phone applications, two research participants reported that,

“Complicated mobile phone applications are not easy to use and understand. This creates difficulties for most farmers who lack digital literacy and technical skills to navigate the applications effectively” (Key Informants and Focus Group Discussion Participants).

Few research participants viewed mobile applications as complicated to use.

The simplicity of mobile phone applications was evaluated in terms of clarity and understanding. Research participants noted mobile applications were clear and understandable. When asked how simplicity based on clarity and understanding influences the adoption of mobile phone applications, fifty research participants reported that:

“Mobile phone applications have clear and understandable instructions in that they let the farmer know what to do next when using them.” (Key Informants and Focus Group Discussion Participants).

The research highlighted that the majority of research participants were of the view that mobile phone applications as clear and understandable.

In contrast, complexity was evaluated in terms of the lack of clarity and understanding that impeded the adoption of mobile phone applications. Research participants noted mobile applications lacked clarity and understanding. When asked how complexity based on lack of clarity and understanding influences the adoption of mobile phone applications, ten research participants reported that,

“Mobile phone applications lack clarity and are not easy to understand” (Key Informants and Focus Group Discussion Participants).

Few research participants viewed mobile applications as lacking clarity and understanding.

The simplicity of mobile phone applications was evaluated in terms of user-friendliness. Research participants noted that mobile applications are user-friendly. When asked how simplicity based on user-friendliness influences the adoption of mobile phone applications, fifty-five research participants reported that:

“Mobile applications are user-friendly because of simplified user interfaces brought about by continuous advancement of agricultural technology” (Key Informants and Focus Group Discussion Participants).

“The incorporation of multilingual interfaces and the use of voice commands, which cater to diverse linguistic needs has bridged the language gap and made it easy for farmers to use mobile phone applications” (Key Informants and Focus Group Discussion Participants).

The research highlighted that the majority of research participants were of the view that mobile phone applications are user-friendly.

In contrast, complexity has emerged as a barrier to the adoption of mobile phone applications. Complexity was evaluated in terms of not being user-friendly. Research participants noted that mobile applications are not user-friendly. When asked how simplicity based on user-friendliness influences the adoption of mobile phone applications, five research participants reported that,

“Mobile phone applications are not user-friendly in that they require digital literacy and technical expertise to navigate” (Key Informants and Focus Group Discussion Participants).

Few research participants viewed mobile applications in agriculture as not user-friendly.

The results of the study revealed that simplicity enhanced the adoption of mobile applications for improved small-scale commercial agriculture. This finding concurs with the research findings by Abdullahi et al (2021); Aparo et al (2022); Diaz et al (2021); Dissanayake et al (2022); Mehra et al (2020); Strong et al (2022). These studies argued that the simplicity of mobile applications enhanced adoption. Further, simplicity indirectly influences goal desire through its effect on the relative advantage offered by mobile applications (Kaine & Wright, 2022). In contrast, the study revealed that complexity hindered the adoption of mobile applications for improved small-scale commercial agriculture. This finding is consistent with the findings of Coggins et al (2022); Misaki (2021); Nyaplue-Daywhea et al (2021); Rizzo et al (2023) and Strong et al (2022). These studies argued that a lack of understanding impeded the adoption of mobile applications by small-scale commercial farmers.

Compatibility

Compatibility of mobile phone applications was evaluated in terms of whether it fits well with the socio-cultural attitudes, beliefs, values, norms, taboos and traditional practices. Research

participants noted that mobile applications are compatible with socio-cultural attitudes, beliefs, values, norms, taboos and traditional practices. When asked how socio-cultural attitudes, beliefs, values, norms, taboos and traditional practices influence the adoption of mobile phone applications, fifty-six research participants reported that:

“Socio-cultural factors fit well with attitudes, beliefs, values and norms, taboos and traditional agricultural practices of small-scale commercial farmers’ needs in small-scale commercial agriculture” (Key Informant and Focus Group Discussion Participants).

The majority of the research participants were of the view that the adoption of mobile phone applications fits well with the socio-cultural influences of small-scale commercial farmers.

Conversely, four research participants mentioned that socio-cultural attitudes, beliefs, values, norms, taboos and traditional practices impede the adoption of mobile phone applications. Research participants noted that mobile applications are incompatible with socio-cultural attitudes, beliefs, values, norms, taboos and traditional practices. When asked how socio-cultural attitudes, beliefs, values, norms, taboos and traditional practices are incompatible with mobile phone applications, four research participants reported that:

“The socio-cultural and religious beliefs of the apostolic Christian churches which are anti-technology impede the use of mobile phones” (Key Informant and Focus Group Discussion Participants).

The study revealed that four research participants disagreed that socio-cultural attitudes, beliefs, values, norms, taboos and traditional practices enhance the adoption of mobile applications.

Compatibility was assessed based on whether mobile phone applications fit well with previously introduced agricultural technologies. Research

participants noted that mobile applications are compatible with previously introduced technologies. When asked how previously introduced agricultural technologies influence the adoption of mobile phone applications, sixty research participants reported that:

“Mobile phone applications fit well with previously introduced agricultural technologies and ideas, which bring the much-needed help for farmers in agricultural activities and operations in the absence of extension officers” (Key Informant and Focus Group Discussion Participants).

The majority of the research participants were of the perception that mobile phone applications fit well with previously introduced ideas for improved small-scale commercial agriculture.

Compatibility was assessed based on small-scale commercial farmers’ needs and preferences in small-scale commercial agriculture. Research participants noted that mobile applications are compatible with small-scale commercial farmers’ needs and preferences. When asked how commercial farmers’ needs and preferences in small-scale commercial agriculture influence the adoption of mobile phone applications, fifty-four research participants reported that:

“Mobile phone applications fit well small-scale commercial farmers’ needs in that they provide real-time market prices, input prices and best agricultural practices that promote efficiency, productivity and profitability” (Key Informants and Focus Group Discussion Participants).

The majority of research participants were of the view that mobile phone applications fit well with small-scale commercial farmers’ needs and preferences.

The results of the study revealed that compatibility enhanced the adoption of mobile applications for improved small-scale commercial agriculture. This

finding is consistent with the findings by Dissanayake et al (2022) and Strong et al (2022). These studies argued that compatibility played a crucial role in the adoption of technology in reducing uncertainty. The more compatible mobile applications are with norms and values, previously introduced technologies and farmers' needs and preferences, the higher the adoption rate. Conversely, compatibility hindered the adoption of mobile applications for improved small-scale commercial agriculture. This finding is consistent with the findings by Nyaplue-Daywhea et al (2021) and Strong et al (2022). These studies argued that incompatibility impeded the adoption of mobile applications in agriculture. The incompatibility of mobile applications with norms and values, previously introduced technologies and farmers' needs and preferences, lower the adoption rate.

Trial-ability

Trial-ability was evaluated in terms of small-scale commercial farmers' ability to experiment with mobile phone applications for improved small-scale commercial agriculture. Research participants noted that small-scale commercial farmers' ability to experiment with mobile phone applications enhanced the adoption of mobile applications for improved small-scale commercial agriculture. When asked how trial-ability influenced the adoption of mobile phone applications, fifty-five research participants reported that,

"The experience of knowing how to navigate mobile phone applications through experimenting with them motivates farmers to be able to make informed decisions on whether to adopt mobile phone applications or not" (Key Informant and Focus Group Discussion Participants).

"Experimenting with the mobile phone applications helps farmers to overcome their concerns and reservations as regards mobile phone applications' features, functionalities and usability in agricultural settings" (Key

Informant and Focus Group Discussion Participants).

Thus, the majority of research participants were of the view that experimentation is necessary for the adoption of mobile phone applications.

On the contrary, five research participants expressed doubts about trial-ability as an enabler in the adoption of mobile phone applications. Research participants noted that trial-ability impeded the adoption of mobile applications. When asked how trial-ability negatively influenced small-scale commercial farmers' perception to adopt mobile phone applications, five research participants reported that:

"Having the chance to test and utilise mobile phone applications may not accurately reflect the true effectiveness of mobile phone applications in agricultural settings" (Key Informants and Focus Group Discussion Participants).

"Not all farmers are able to fully explore all the features and capabilities of mobile phone applications during the limited trial period, leading to biased evaluations, which in turn may not increase the rate of adoption" (Key Informants and Focus Group Discussion Participants).

"There is a need to consider that there are alternative mobile phone applications being used in agricultural settings, which are clustered in an environment of stiff competition, influence small-scale commercial farmers' decisions to adopt or not to adopt mobile phone applications" (Key Informants and Focus Group Discussion Participants).

The outcomes of this study results revealed that trial-ability could not consistently reflect the genuine effectiveness of mobile phone applications for improved small-scale commercial agriculture.

On the one hand, the results of the study indicated that trial-ability significantly influenced the adoption of mobile applications for improved small-scale commercial agriculture. This finding aligns with research findings by Barrios et al (2023); Diao et al (2023); Dissanayake et al (2022); Duc et al (2023); Hoang (2020); Landman et al (2020); Ma et al (2023); Mutambara (2021); Mutuma et al (2023) and Osman et al (2022). These studies argued that trial-ability played a crucial role in the adoption of technology. Farmers who had the opportunity to test mobile applications were more likely to perceive them as valuable and suitable for their farming needs. The higher the experimentation with mobile applications, the higher the likelihood of adoption. On the other hand, the results of the study revealed that trial-ability reflects the genuine effectiveness of mobile phone applications for improved small-scale commercial agriculture. This finding concurs with the research findings by Adams and Jumpah (2021); Akter and Tan (2023); Duc et al (2023); Hoang (2020); Landman et al (2020); Mutambara (2021); Mutuma et al (2023); Schulz et al. (2021); Suri and Udry (2022); Osman et al (2022); Thar et al (2020) and Yakomo (2020). These studies argued that even if farmers had the opportunity to experiment with mobile phone applications, farmers still opt for more conventional and familiar solutions leading to farmers' decision to reject mobile applications. The trial-ability of mobile applications by farmers may not lead to an increased adoption rate.

Observability

Observability was evaluated in terms of small-scale commercial farmers' ability to observe other farmers using mobile phone applications in agriculture. Research participants related mobile phone applications to similar technologies with which they were familiar and had experience. When asked how observing other farmers utilising mobile phone applications in agriculture, forty research participants recounted that:

“Before using the mobile phone applications, for a simple challenge, the majority of farmers

used to ask for help from neighbouring farmers and observe how they go about using mobile phone applications” (Key Informant and Focus Group Discussion Participants).

“The majority of farmers would want to see how mobile phone applications work and the practical benefits before committing themselves to adopt it” (Key Informant and Focus Group Discussion Participants).

“Success stories where mobile phone applications were used enhanced farmers' capabilities” (Key Informant and Focus Group Discussion Participants).

The majority of research participants were of the view that observing other farmers' satisfaction with mobile phone applications resulted in other farmers adopting mobile phone applications.

Moreover, trial-ability was evaluated in terms of being observed by other farmers using mobile applications in agricultural activities and operations. Research participants noted that being observed by other farmers utilising mobile applications enhanced the adoption rate. When asked how being observed by other farmers utilising mobile phone applications influenced their perception to adopt mobile phone applications, twenty research participants recounted that:

“Seeing other farmers utilising mobile applications enhanced their interest to adopt mobile applications for the reasons, particularly of market information” (Key Informant and Focus Group Discussion Participants).

“Being observed by other farmers using mobile phones arouses in them the interest to adopt mobile phone applications” (Key Informant and Focus Group Discussion Participants).

The research findings revealed that being observed by other farmers utilising mobile applications positively influenced the adoption of mobile phone

applications for improved small-scale commercial agriculture.

The results of the study revealed that the visibility of mobile applications results significantly influenced the adoption process. This finding is consistent with the findings by Adams and Jumpah (2021); Dissanayake et al (2022); Kumar et al (2020); Li et al (2020); Mutuma et al (2023); Osman et al (2022); Schulz et al (2021); Strong et al (2022); Suri and Udry (2022) and Wang and Dong (2023). These studies argued that the visibility of the practical benefits of mobile applications increased the perception of value and significantly led to a higher willingness to adopt among farmers. This implies that the greater the visibility of mobile phone applications, the greater the adoption rate. Overall, the results of the current study revealed that innovation characteristics significantly influenced the adoption of mobile applications for improved small-scale commercial agriculture. This finding aligns with the findings of Astuti et al., (2022); Masere & Worth (2021); Rizzo et al (2023) revealed that specific innovation characteristics foster the innovation adoption process. However, a study by Shang et al (2021) indicated that farm-level studies tend to neglect the attributes of technology on the adoption and diffusion of digital farming technologies.

LIMITATIONS OF THE STUDY

The research provides an in-depth examination of the adoption of mobile applications among small-scale commercial agriculture in Zimbabwe; however, it is not without its limitations. A primary constraint is the rapid advancement of mobile applications, which, when combined with the fluctuating patterns of adoption among small-scale commercial farmers, poses challenges to the study's findings. The investigation was confined to a single case study involving a limited sample of participants, which raises concerns regarding the applicability of the result to other regions and contexts. Consequently, the generalisability of the findings is restricted. While the outcomes may have

some relevance for small-scale commercial farmers in different areas, the specific focus of this research limits the ability to draw broader conclusions. The sampling techniques employed resulted in a relatively uniform group of participants, sharing similar traits, which may have led to minimal variation in the data collected. This lack of diversity in perceptions regarding the subject matter raises questions about the applicability of the findings to other research environments. The implications of this study are significant for the current landscape of mobile application adoption. Future research could benefit from exploring additional agricultural sectors and increasing the participant pool to include individuals with diverse experiences and insights into mobile application adoption for enhancing small-scale commercial agriculture. Moreover, employing quantitative methodologies, such as surveys, could yield results that are more generalizable due to a larger sample size. It is essential to conduct follow-up studies to capture the evolving trends in the adoption of mobile applications in agriculture over time.

CONCLUSIONS

The study concludes that perceived innovation characteristics (relative advantage, complexity, compatibility, trial-ability and observability) of mobile applications influenced small-scale commercial farmers' perception in making the decisions to adopt mobile applications for improved small-scale commercial agriculture. The research underlined that relative advantage based on reduced transport and production costs, enhanced communication, time and effort saving and improved quality and integration of agricultural services significantly and positively influenced the adoption of mobile applications. The research emphasised that simplicity based on ease of use, clarity, understand-ability and user-friendliness influence the adoption of mobile applications. On the contrary, the results indicated that the complexity of mobile applications impedes the adoption of mobile applications. The study results

stressed that mobile applications that are compatible with small-scale commercial farmers' socio-cultural values, norms, attitudes, beliefs, taboos and traditional agricultural practices; previously introduced technologies and small-scale commercial farmers' needs and preferences are likely to be adopted. Conversely, incompatible mobile applications are less likely to be adopted. The results underscored that mobile applications that small-scale commercial farmers are able to experiment with are adopted faster. Contrariwise, trial-ability does not reflect the increased adoption rate of mobile applications. The study indicated that mobile applications that have visible results are easily adopted. The research highlighted that mobile phone applications that possess a higher relative advantage, are less complex, highly compatible, are trial-able and exhibit visibility of results are more likely to be embraced by small-scale commercial farmers. The perceived innovation characteristics were robust in reflecting the small-scale commercial perception of the adoption of mobile applications as significant predictors. This implies that the government, non-governmental organisations and mobile applications developers and researchers in the agriculture sector should consider the interplay of perceived innovation characteristics in developing mobile applications that address the needs and preferences of small-scale commercial farmers. For further research, studies should replicate this study in other contexts to find out how perceived innovation characteristics influence small-scale commercial farmers' perception of adoption of mobile phone applications.

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