2022 International Conference on Multidisciplinary Research
https://doi.org/10.26803/MyRes.2022.28

Factors affecting adoption of mobile phone applications among farmers in Lilongwe, Malawi: The case of *Mchikumbe 212*

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Abstract
The Ministry of Agriculture, through the Department of Agriculture Extension Services, intensified the use of ICTs in Agriculture extension as one way of mitigating the high extension worker to farmer ratio in Malawi. ICT-based agricultural extension in Malawi has evolved from using traditional ICT tools to modern ones. Of interest to this study is the Mchikumbe 212 platform. This service was launched by Airtel Malawi, in partnership with the Human Network International (HNI) in September 2015. The service aims to transform farming by increasing farmers' access to information and advisory services. It provides farmers with access to practical information about agriculture via interactive voice response and short messaging services, where farmers listen to agriculture extension advisory services on a crop of their choice on their mobile phones by dialing 212. However, the adoption of the Mchikumbe 212 platform has not been satisfactory as the number of registered users has decreased since its launch. The study, therefore, aimed at analysing the factors affecting the adoption or rejection of the Mchikumbe 212 platform among farmers in Malawi. Data was collected using face-to-face interviews with both adopter and non-adopter farmers of the technology drawn from Lilongwe district. Key informant interviews were also conducted with officials from Airtel Malawi, Ministry of Agriculture and Human Network International. The study finds that there are several factors that both positively and negatively affect the adoption of the technology. Farmers who adopted the Mchikumbe 212 platform found it easy to use and navigate, convenient, affordable and accessible, and that it gave timely and relevant information for direct application in their gardens. Non-adopters showed preference for face-to-face extension over the Mchikumbe 212 platform citing absence of instant feedback as the main reason for non-adoption. Further, very little was done to promote the platform by the Ministry of Agriculture and Airtel Malawi. As a result, farmers did not associate Mchikumbe 212 platform with the government extension system. This is one of the factors that have negatively affected its adoption.

Keywords: access to information, farming, ICT-based agriculture extension, Mchikumbe 212, mobile phone application.

1. Introduction

The Ministry of Agriculture, through the Department of Agriculture Extension Services, intensified the use of ICTs in Agriculture extension as one way of mitigating the high extension worker to farmer ratio in Malawi. ICT-based agricultural extension in Malawi has evolved from using traditional ICT tools to modern ones. The successful implementation of ICT-based agricultural extension hinges on the uptake of the various technologies that are available to farmers. Of interest in this study is the Mchikumbe 212 platform, a mobile phone-based service that provides agricultural information to farmers via Interactive Voice Response and short messaging services where farmers listen to agriculture extension advisory services on a crop of their choice on their mobile phones by dialing 212. The Mchikumbe 212 Platform was launched by Airtel Malawi, in partnership with the Human Network International (HNI) in September 2015 (Palmer & Darabian, 2017). Airtel Malawi is one of the providers of telecommunication services in Malawi. The Mchikumbe 212 platform aims to transform farming by increasing farmers' access to information and advisory services. The platform also pushes SMSes to farmers on crop production, animal production, weather advisory and market services (Palmer & Darabian, 2017). The platform is hosted on the Airtel Malawi network, and the Agricultural Communication branch is responsible for producing content that is uploaded onto the platform.

Use of ICT in Agriculture Extension

Agricultural development relies to a larger extent on the rate at which farmers are able to adopt recommended agricultural practices, which are transferred to farmers through the provision of extension and advisory services. ICTs play a crucial role in the process of collecting, storing, processing and disseminating agricultural information to farmers. They help to bridge the gap between researchers, who are the generators of agricultural technologies (recommended practices) and farmers, who are the users of agricultural technologies. Agriculture extension service providers use ICTs to capture best agricultural practices from researchers, craft them into messages and disseminate them to farmers. Apart from disseminating best practices for agricultural production, ICTs are also used by farmers to access market information, financial services and weather advisories. Manda and Chapota (2015) categorised ICTs that are used in agriculture in Malawi into "radio programming, television which includes direct streaming, use of videos and mobile cinema, mobile platforms which include SMS, voice, Interactive Voice Response (IVR) and data by use of handsets, smart phones and tablets and use of internet-based extension systems" (p.15). Of interest in this study is the use of mobile phones for agricultural extension.

Mobile phones have become a common ICT tool used for disseminating agricultural information. In Malawi, Farm Radio Trust (FRT), the Department of Agricultural Extension Services (DAES), the National Smallholder Farmers' Association of Malawi (NASFAM), Self Help Africa and Airtel Malawi are some of the organisations that are providing agriculture extension and advisory services through the mobile phone (Manda & Chapota, 2015). Farmers access information through SMSs either by requesting for the information, as is the case with Farm Radio International's 'beep for

weather' service, where farmers beep to request weather information which is sent to them via SMSs (Farm Radio International (FRI), 2014) or by registering to receive scheduled messages that are pushed to them periodically, as is the case with the Esoko System. 'Esoko', meaning 'electronic market', is Ghana's mobile phone-based information system managed by the Agricultural Commodity Exchange which provides farmers with current market information (Asare-Kyei, 2013). The mobile phone is also used to provide information to farmers through interactive voice response, which is a system that allows callers to access pre-recorded voice messages without having to speak with an agent. In Malawi, this service is provided by FRT who also provide a mobile phone-based service that allows farmers to speak with an agent, called the Mlimi [Farmers'] hot line (Zeigler, 2019). It follows that the country's agricultural sector has a lot to gain from farmers adopting ICT tools, and conversely, a lot to lose from low adoption.

Factors affecting adoption of ICT among farmers

Various studies have found a positive relationship between the use of ICT-based agricultural extension tools and increased productivity (Gebru et al., 2019; Masambuka-Kanchewa et al., 2020). Evidence from studies done in Malawi and elsewhere shows that there are many factors that affect the adoption of ICTs among farmers. The cost of technology, its perceived usefulness, infrastructural development, access to technology, literacy levels of users, and knowledge of the existence of available tools are some of the factors that keep emerging across a number of studies (Kabbiri, 2018; Gebru, 2019; Krell et al., 2020; Diaz et al., 2021).

Krell et al. (2020) investigated smallholder farmer's use of mobile phone services in central Kenya and found that some of the factors affecting the adoption of such services are related to literacy levels and the cost of technology. Alant & Bakare (2021), in their study to establish the relationship between smallholder farmers' literacy levels and use of ICTs, agreed with the above findings. Their study established that farmers with low levels of literacy failed to display various ICT related skills such as decoding symbols on the phone, accepting and terminating a call, increasing and decreasing volume on the phone and identifying a caller in the case of a missed call. Harris & Achora (2018) echo similar ideas and point out that ICT-based systems in agriculture oftentimes fail to consider conditions such as high illiteracy rates which, the authors argue, only worsens the digital divide. The Mchikumbe 212 platform mainly targets smallholder farmers in Malawi, the majority of who are illiterate. This may pose a limitation on the rate at which farmers can adopt the service.

Gender is another factor that affects the adoption of ICTs in agriculture. In Malawi, more than half of the agricultural labour force are women (Chabane, 2019) which would ordinarily mean that they would demand agricultural information more than men. However, women usually lag behind when it comes to adopting ICT-based agricultural extension tools due to the fact that they have less access to mobile phones. The Malawi Digital identity country report of 2019 shows that gender disparities when it comes to phone ownership are very significant in Malawi, with 52% of males owning phones, compared to 33% of females (GSM Association, 2019). According to the report,

the disparities are more pronounced in rural areas where 26% of women own a mobile phone compared to 47% of men. This is reiterated by a study that was conducted in Malawi and other African countries by Marron et al. (2020) which established that there are gender gaps in mobile phone ownership, with women being 15% less likely to own phones than men. Blumenstock & Eagle (2010) also compared the demographics of Rwandan mobile phone users with the country's demographic survey and established that men accounted for 67% of the phone owners, despite only accounting for 47% of the total population.

Age is another factor that affects the adoption of ICT based platforms in agriculture, with the younger generation being more open to owning and using technologies that facilitate access to agricultural information such as mobile phones and smart phones. Consequently, the adoption and use of ICT-based agricultural platforms is much higher among younger people. In a study to establish the relationship between various demographics and mobile phone usage in Sri Lanka, Subashini and Fernando (2017) registered a negative relationship between age of subjects and mobile phone usage. The older the subjects, the less their phone usage.

Another important determinant of the extent of ICT adoption among farmers is the usability of the technology. Usability refers to "the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use" (Raikar & Gawade, 2017). Even though usability of ICTs in agriculture closely relates to personal characteristics of users such as literacy and level of education, ICTs that are user-friendly are easy to use across all demographics. Raikar & Gawade (2017) points out that farmers are more satisfied with a technology when they find it usable and when they feel it has useful agriculture information that will help them achieve their production goals. They argue that new technology usually gets limited 'user acceptance' among farmers as they are more inclined to use older traditional technologies which they already know to be usable and useful. Taking into consideration the different characteristics of farmers, ICTs must have an easy-to-navigate user interface design. Soares & Rebelo (2013) summarised the qualities of a navigable user interface design as flexible, customized for different user levels, simple, ease to retrieve information, feedback and minimisation of user's memory load, among others.

The Technology Acceptance Model

The Technology Acceptance Model (TAM) was used in this study to explain why people adopt or reject use of technologies. The Technology Acceptance Model postulates that perceived ease of use and perceived usefulness are very important determinants of user acceptance of technologies. It holds that individuals make an analysis of what they stand to benefit against the work they have to put into a given behaviour. This implies that the adoption and use of an information system is determined by its perceived usefulness and the perceived difficulty in using it (Lai, 2017). Marikyan and Papagiannidis (2022) describe perceived usefulness as the "individual's perception of the extent to which the use of a given technology improves performance" (p.2) and perceived ease of use as "the degree to which a person believes

that using a particular system is free of effort" (p.2). TAM also postulates that when exposed to new technology, individuals go through a three-stage process where the "external factors of the new technology, or the system design features trigger cognitive responses or perceived ease of use and perceived usefulness, which, in turn, form an effective response or attitude toward using technology, influencing use behavior" (Marikyan and Papagiannidis, 2021, p.3).

This study sought to establish the factors that affect the adoption of the Mchikumbe 212 platform. The platform was promoted through testimonials from farmers who had previously used the service and these were aired on agricultural radio programmes. Airtel Malawi also trained over 1,100 front-line extension staff from the Department of Agriculture and Extension Services to promote the service. In addition, Airtel Malawi ran an SMS campaign promoting Mchikumbe 212 targeting Airtel Money users (Palmer & Darabian, 2017).

Even though this is the case, the adoption of the Mchikumbe 212 platform has not been satisfactory as the number of registered users has decreased since its launch. By December 2016, a year after it was launched, Mchikumbe 212 had 400,000 registered users (Palmer & Darabian, 2017), but a recent report generated by the Human Network International (HNI) shows that in the year 2021, the platform had 115,576 users only (HNI (2021). However, this could be due to the fact that the year 2016 was the pilot period and some of the 400,000 users may have simply registered out of curiosity, others may not have been farmers at all. Even then, the number of farmers who repeatedly use the platform is also very low. According to Palmer & Darabian (2017), less than half of active users each month have been repeat users. The HNI report of 2021 also indicated a drop in the number of repeat users. Repeated use of the Mchikumbe 212 platform is crucial in this study because it was established that repeat users were more likely to adopt recommended agricultural technologies and more likely to report an increase in production (Palmer & Darabian, 2017). The present study aimed to get an in depth understanding of the factors that affect the adoption of mobile phone applications among farmers by focusing on the farmers as users of such platforms and overall management of the platforms by the originators and concerned stakeholders.

The study, therefore, aimed to analyse the factors affecting the adoption or rejection of the Mchikumbe 212 platform among farmers in Malawi. Specifically, the study examined the user-friendliness of the Mchikumbe 212 platform by analysing its navigability, content, packaging, and convenience. The study also examines farmers' perceptions and attitudes towards the platform and towards use of ICT in agriculture, and how they affect adoption.

2. Methods

The study employed qualitative methods of collecting and analysing data and employed the purposive sampling technique to select farmers and key informants to participate in the study. Of interest to this study were farmers who had adopted and those who had not adopted the Mchikumbe 212 platform. A total of 50 farmers from

Lilongwe district were selected, 30 of which were male and 20 were female. Of these, 22 were adopters and 28 were non-adopters. These adopter and non-adopter farmers were interviewed to understand their perceptions towards the Mchikumbe 212 and the factors that affect their decision to adopt or reject the service.

Three Key Informants, especially those who were directly involved in the management of the Mchikumbe 212 platform from various organisations, were also purposefully selected to participate in the study. One informant was a project officer responsible for the Mchikumbe 212 service from HNI and another was a project officer responsible for the service from Airtel Malawi. The third one was from the Agriculture Communication Branch. Further, six Agriculture Extension Development Coordinators were interviewed to provide further understanding on why farmers adopt or reject the Mchikumbe 212 platform. A semi-structured questionnaire was administered to both the respondents and key informants. The interviews were recorded and notes were taken to note important points. These were later transcribed for analysis. Data was analysed using the six-phase process of thematic analysis which "involves dataset familiarisation, systematic coding process, generating initial themes, developing and reviewing themes, refining, defining and naming themes, and writing up" (Braun and Clarke, 2022, p 35).

Ethical Considerations

Participants were informed of the objective of the study, their role in the study and how the results would be used and that the conversation was being recorded. Participants were interviewed only after being given the relevant information and after they had given their consent. Participants were also assured of anonymity.

3. Results and discussion

User-friendliness: Usability and Navigability of the Mchikumbe 212 platform

The farmers who had adopted the Mchikumbe 212 platform reported that they found it easy to use, liked the way its content was packaged, found the content applicable, found the platform convenient, affordable and accessible. Usability is the measure of perceived satisfaction and acceptability of a system by the user (Atalatti et al., 2015). It is an attribute that assesses how easy user interfaces are to use. Usability is determined by factors such as the design of the system, which affects the system's navigability. The respondents also reported to have found the platform easy to use and navigate. Adopters of the platform indicated that the instructions that were given when one dialed 212 and the steps taken to get to the required information on the platform were easy to follow. When one dialed 212, they were given options to choose what messages they wanted to listen to. Each option was represented by a number. Once an enterprise is selected, they were also given options to choose an activity that they wanted along the value chain. For example, one farmer indicated that, "*Mchikumbe 212 is not difficult at all to use because the voice tells you exactly which number to press, depending on what you want, and I already know where 1 or 2 is on my phone*" (female adopter, Mpenu EPA, 23 July, 2022), and another farmer said "*the good thing is that the voice is in Chichewa* [*the local language*]*, so it is easy to use even if you did not go to school*" (male adopter, Chitsime EPA, 17 July, 2022).

The Technology Acceptance Model purports that perceived ease of use is one of the determinants of technology adoption, and that users are more likely to adopt new technology if they think it is easy to use and if they think it requires minimum effort (Marikyan and Papagiannidis, 2022). Key informant interviews with the Human Network International revealed that the Mchikumbe 212 platform was designed to be easy to navigate to make it more user-friendly to most Malawian smallholder farmers.

User-friendliness: Packaging and applicability of Mchikumbe 212 Content

Apart from the navigability of the system, another element that came out was the packaging of the messages. Farmers reported that the Mchikumbe 212 content was very easy to follow. One farmer said, "*It is very easy for me to follow the message on Mchikumbe because it is created in the form of a conversation; this also makes it very interesting*" (female adopter, Mpenu EPA, 23 July, 2022). The messages on the Mchikumbe 212 platform were packaged in the form of conversations between two or more people in the setting of a rural farming family, where one asks questions and another answers in conversation style. Another farmer reported that, "*The voices on Mchikumbe speak slowly and do not rush, which makes it very easy to follow. You can even replay it if you did not understand"* (male non-adopter, Mpingu EPA, 7 August, 2022).

Another aspect that was interrogated during interviews was the ease with which the messages on Mchikumbe 212 platform were applicable on the ground. The farmers reported that the platform content was very applicable because it gave step by step guides on how to carry out all farming activities for each enterprise. One farmer pointed out how she uses her phone as she is carrying out farming activities in the field so that she can keep referring back if she is not clear. She narrated that: *"I grow maize and they tell us everything we need to know on Mchikumbe. If you want information on how to plant Maize, they tell you the recommended varieties, how to prepare the land, how to space the ridges and how to space the planting stations. It is very easy to do it in the field"* (female adopter, Mpenu EPA, 23 July, 2022). The applicability of the content is another crucial determinant of the adoption of the Mchikumbe 212 platform, considering that it is a one-way communication channel. For farmers to be able to use the technology, the content has to be comprehensive so that it does not leave a lot of questions.

Key informant interviews with Mchikumbe 212 content creators from the Ministry of Agriculture revealed that messages were produced based on farmers' needs and after carrying out a needs assessment. They also indicated that they involved subject matter specialists from the Department of Crop Development, Department of Livestock, and Department of Research to ensure that the messages are technically correct and complete. Messages were also pretested among farmers before they were uploaded onto the platform.

Factors that positively affected the adoption of the Mchikumbe 212 Platform

Perceived usefulness of Mchikumbe 212 content

Farmers who participated in the study indicated that they liked the Mchikumbe 212 platform because it gave them an opportunity to choose information that is useful to them, depending on what they produce. Marikyan (2021) describes perceived

usefulness as the "individual's perception of the extent to which the use of a given technology improves performance" (p.2). When asked about what they like most about Mchikumbe 212 platform, one farmer pointed out that, "*You can find whatever you want on Mchikumbe 212 platform. Sometimes we only have access to extension officers who only concentrate on crop production, but there are farmers who want information on livestock production, because that is also farming*" (male adopter, Mpingu EPA, 7 August, 2022).

Apart from crop production, the platform also provides information on the production of various livestock, including dairy production. Key informant interviews with Agriculture Extension Development Officers (AEDOs) revealed that ideally, each section should have an extension officer who specialises in crop production and one who specialises in livestock production, but there is a shortage of livestock specialists. One livestock extension officer, therefore, has to cover two or more sections, which makes them less available.

When asked about the usefulness of information on the Mchikumbe 212 platform, one farmer pointed out that all information is useful to someone. "*The good thing is that you have the option to choose. Even if we do not grow pigeon peas in this area, there are other areas in Malawi that do and will find the message on pigeon pea production relevant and useful*" (male adopter, Chitsime EPA, 17 July 2022). Another farmer said, "*You can travel a long distance for a meeting only to find that an extension officer has brought information on a crop that is not of interest to you. Mchikumbe is much more direct as you can simply choose what you want to listen to*" (female adopter, Chigonthi EPA, 30 July, 2022).

This is in line with one of the postulates of the Technology Acceptance Model, which states that users are more likely to adopt an innovation if they think it is useful. It suggests that the "intention and behaviour of users in relation to the adoption of technology is primarily dependent on the technology's perceived usefulness and perceived ease of use" (Wagner, 2017, P. 4).

Convenience and affordability of the Mchikumbe 212 platform

The convenience associated with accessing information from the Mchikumbe 212 platform was interrogated during the interviews. Farmers who had adopted the platform kept referring to how long it took them to access advisories from an agriculture extension officer as compared to the Mchikumbe 212 platform. When asked about why he adopted the Mchikumbe 212, one farmer said; "*it's a shortcut. Even if rains started today, I will simply call 212, instead of waiting for an extension officer to come round*" (male adopter, Mpingu EPA, 7 August, 2022). He added that at the onset of rainfall, the services of extension officers are on high demand because it is the planting season, and if he had to wait his turn, he may not plant in good time.

When asked of her opinion of the Mchikumbe 212 platform, another farmer said "*You would simply take your phone to the field and listen to the messages as you work. If they say you need to space ridges at 75cm apart, you will simply use your ruler and measure the spaces. This is a shortcut instead of waiting for an extension officer to visit.*" (female adopter, Mpenu EPA, 23 July, 2022). Therefore, it can be argued that convenience is an

important aspect in the adoption of technologies in agriculture because time is a very crucial factor in the work of a farmer as activities are guided by the agricultural calendar. It is clear that the traditional way of accessing advisories is not very convenient for some individual farmers as it takes too long to get the attention of an extension officer. In this regard, Mchikumbe 212 platform offers a timely and convenient method for accessing information, a factor that can positively affect its adoption. Interviews with Agriculture Extension Development Coordinators revealed that due to the shortage of extension officers, farmers are usually asked to gather at one convenient place where they are met by an extension officer. Since extension officers cover large areas, the meeting points are usually very far from most farmers' homes. The adopter farmers indicated that they used the Mchikumbe 212 platform because it does not require them to travel long distances to access agricultural information. It can, therefore, be argued that ICT-based Agricultural extension services can facilitate the accessibility of agricultural information in the comfort of one's home.

Other farmers pointed out that even if they were willing to travel long distances to meet an extension officer, the timing may not be convenient for them. "*You cannot choose the time to be visited by an extension officer, you just have to drop everything you were doing when they show up*" (male adopter, Mpenu EPA, 23 July, 2022).Further, when asked about the cost of accessing the platform, one farmer reported that "*it is affordable and it is worth it considering the importance of the information that we access from Mchikumbe 212*" (male adopter, Mpingu EPA, 7 August, 2022). These responses show that in order to arrive at a decision to adopt Mchikumbe 212, some farmers compared the amount of time it would take them to access information from an extension officer to the time it would take to access the same from the platform, they compared the instantaneity of accessing information from the two sources and the convenience. This led to their conclusion that accessing information from the platform had a number of advantages over accessing information from extension officers, which contributed to their decision to adopt the platform. Another factor that contributes to the usability of technology is the cost of accessing it. Most adopters and non-adopters in this study indicated that they can easily access the Mchikumbe 212 platform since they either own or have access to a mobile phone.

Factors that negatively affect the adoption of the Mchikumbe 212

Absence of instant feedback

Absence of an instant feedback channel appeared to negatively affect the adoption of the Mchikumbe 212 platform. Non-adopters who showed a preference for face-to-face extension over the platform cited the absence of a provision for instant feedback as the main reason for non-adoption. These farmers acknowledged that getting advisories from the Mchikumbe 212 platform is much quicker and convenient as they do not have to wait their turn to be visited by an extension worker. They also acknowledged that the platform is much more accessible compared to extension workers who sometimes face mobility issues. They, however, still showed preference for face-to-face extension, regardless of the above, due to the fact that face-to-face extension

allows them to interact with the extension officer, ask questions and get instant feedback.

When asked to explain their preference for face-to-face extension, some farmers said, *"The voice on the phone keeps talking, without giving us a chance to respond"* (female adopter-Ukwe EPA, 6 August, 2022); *"At least an extension worker will clearly guide us where we do not understand"* (female non adopter, Ukwe EPA, 6 August, 2022); *"What if we are doing something wrong? At least an extension worker will be able to demonstrate right there and then in the field" (male non-adopter, Mpingu EPA, 7 August, 2022).*

One of the common methods used in the delivery of agricultural extension and advisory services in Malawi is the use of demonstration plots or gardens. This is where an extension worker facilitates the establishment of comparative experimental fields in the locality where farmers learn and practice in their fields. Other methods, such as using model villages and holding village gatherings also involve the extension worker being present for back-and-forth questions. Farmers are thus used to the conventional way of incorporating a feedback session after each gathering. This finding is consistent with Wagner's (2017) argument that consumers' established traditions create barriers to the adoption of technologies. He points out that this is overcome by "designing communication activities that educate consumers about the innovation's functionality" (p5). Non-adopter farmers who participated in this study demonstrated resistance to deviating from the traditional way of accessing agricultural advisory services.

Perceived complexity of Mchikumbe 212

The findings of this study also show that non-adopter farmers shared a belief that the Mchikumbe 212 platform was complex and not easy to navigate and that it was different from the regular agriculture extension system. In addition, non-adopter farmers held the perception that mobile phones are used only for communicating with family and friends and had no interest in using them for other purposes such as accessing agricultural information. One farmer said, *"I simply haven't thought of ever using the Mchikumbe platform"* (male non-adopter, Mpingu EPA, 7 August, 2022), and another said, *"Yes, I have a phone but I just use it to communicate to family and friends"* (female non-adopter, Chitsime EPA, 17 July, 2022). These farmers often alluded their lack of interest in adopting the platform to the probability that it was difficult to use. Even farmers who demonstrated ability to use other functions on their mobile phones without assistance showed elements of resistance to trying the platform simply because they thought it was complex. When asked why she had not tried to use the platform despite knowing about it, one farmer indicated that she simply thought it was hard to navigate; "*I am not motivated to use the Mchikumbe 212 on my phone, I just think I cannot not manage*" (female non-adopter, Chitsime EPA, 17 July, 2022).

This finding can best be explained by the Technology Acceptance Model which postulates that when exposed to new technology, individuals go through a three-stage process where the "external factors of the new technology, or the system design features trigger cognitive responses or perceived ease of use, which in turn form an

effective response or attitude toward using technology, influencing use behavior" (Marikyan and Papagiannidis, 2022, p.3). The TAM places emphasis on the perceptions of the potential user and holds that even if the generator of a new technology may believe the product is easy to navigate, potential users will not adopt it if they do not share the same opinion. Without first attempting to use the platform, non-adopter farmers perceived the external design features of the Mchikumbe 212 to be very complex, which kept them from getting past the first stage of the technology adoption process, and as a result, failed to adopt
the platform.

Perceived disconnection between the Mchikumbe 212 and the extension service system

Interviews with both adopter and non-adopter farmers revealed that both groups did not associate the Mchikumbe 212 platform with the Ministry of Agriculture and they did not take it as a part of the regular agriculture extension service. Non-adopters who claimed that they did not understand the platform enough to use it were asked why they did not simply ask the extension officers in their locality for more information, as is usually the case with all new recommendations. The recurring responses to the question were: "*It never occurred to me to ask our extension officer since I got the information from the phone*" (male non-adopter, Mpingu EPA, 7 August, 2022); "*I just thought those are ordinary phone messages and I should not bother our extension officer, I did not think there was any connection*" (male non-adopter, Chileka EPA, 21 August, 2022).

The responses above show that some of the farmers perceived ICT-based agriculture extension as a separate and independent system from the conventional agriculture extension system. However, ICT-based extension is a part of the regular extension system and they complement each other. This mismatch reveals that civic education and stakeholder consultations were not conducted among the farmers by the Ministry of Agriculture. Technologies such as the Mchikumbe 212 may be used without the involvement of an extension officer, but farmers still needed to get oriented by the officers at the onset so that messages from extension workers and the platform complement each other for better effect. In addition, the Mchikumbe 212 platform is a one-way communication, and the only way farmers may get feedback is through extension officers.

Role of Airtel Malawi and the Ministry of Agriculture in promoting Mchikumbe 212 platform

Inadequate promotion of the Mchikumbe 212 platform by Airtel Malawi and the Ministry of Agriculture and lack of visible government involvement in the promotion of the platform affected its adoption. The reluctance of farmers to adopt the platform due to perceived complexity and perceived disconnection between the platform and the regular extension service system point to an information gap among farmers. Farmers failed to adopt the platform because they have not been adequately sensitized on how to navigate it. Lack of visible government's involvement in the promotion of the platform also contributed to farmers' perception that there is no relationship between the platform and the regular extension service. This resulted in farmers'

failure to seek the help of extension officers on how to use it or to seek clarifications from extension officers on information obtained from the platform. This negatively affected its adoption.

According to Wagner (2017) the 'newness' of an innovation is one of the barriers to adoption, as people are generally sceptical of new ideas. Wagner emphasises the importance of promoting and marketing new innovations among the targeted audience. "Given the complexity and newness of many technological innovations, the effective use of reasoned marketing communication activities is critical in this regard" (Wagner, 2017, p.3). Data from non-adopters of the platform showed a lack of continuous systematic promotion of the Mchikumbe 212 platform as farmers showed that they had not been sufficiently exposed to its promotional messages. Some farmers pointed out that they had received Mchikumbe 212 promotional text messages from Airtel and some indicated that they heard about it on the radio. Responses such as, "*I once heard about Mchikumbe 212 on the radio, but I missed part of the message*"; "*I was looking for health information on polio on 321, when I heard that I can also access agricultural information*" (female non-adopter, Chitsime EPA, 17 July, 2022) suggest that a lot of farmers simply stumbled upon Mchikumbe 212 promotional messages. This points to a lack of intentional, targeted promotion of the platform.

Lack of visible government involvement in the promotion of Mchikumbe 212

Interviews with both adopter and non-adopter farmers established that the most trustworthy source of information for them was the Ministry of Agriculture/extension workers and that they did not regard Airtel Malawi as an important source of Agricultural information. Farmers clearly had trouble differentiating the Mchikumbe 212 promotional messages from regular advertisements from Airtel Malawi, which they usually ignore. Most non-adopters who indicated that they had or may have received a Mchikumbe 212 promotional message from Airtel Malawi before, reported that they ignored it and did not act up on it. "*I remember receiving a message from* Airtel *but I didn't explore it further*, *I thought it's one of those chain messages from* Airtel" (male non-adopter, Chigonthi EPA, 30 July, 2022); "*I don't recall receiving a message from* Airtel*, I may have received it but did not open it, I usually don't open those messages*" (male non-adopter, Chigonthi EPA, 30 July, 2022); "*I thought* Airtel *was advertising something as usual*" (female non-adopter Chileka EPA, 21 August, 2022); "*Extension workers should have properly introduced the Mchikumbe 212 platform to us, just like they do with all 'recommended agricultural practices'*" (female non-adopter, Ukwe EPA, 6 August, 2022). Farmers clearly have more trust in the government extension system than in alternative sources of information and are more receptive to new information if it is coming from government extension officers. The lack of visible involvement of the Ministry of Agriculture in the promotion of the platform negatively affected its adoption. The Technology Acceptance Model proposes that one of the barriers to adoption of technologies is how much the consumer will be expected to deviate from tradition to adopt a certain technology. Antioco & Kleijen (2009) categorise such barriers as psychological barriers, as they arise through conflicts with consumer's prior beliefs and traditions.

Farmers' level of education

The level of farmers' education also plays a role in the adoption of ICT interventions among farmers. In this study, farmers' education levels were categorised into informal education, primary school education, Secondary school education, and tertiary education based on the Malawian education system. In this study, farmers who had dropped out of primary school were categorised as farmers without formal education, while farmers who had dropped out of secondary school were categorized as farmers with primary level education.

Out of the 50 farmers that participated in the study, 22 were adopters and 28 were non adopters. Out of the 22 adopters, 11 had secondary school education, 6 had primary school education and 5 were informally educated through an adult literacy programme and were literate. However, farmers with secondary school education demonstrated an ability to use the mobile phone and to navigate the Mchikumbe 212 platform unlike farmers who did not go to school at all or those who dropped out of primary school. This shows that the more educated a farmer is, the easier they find it to navigate the mobile phone and the more likely they are to adopt the platform. These results are consistent with a number of studies that found that the level of farmers' education has a positive correlation with the level of adoption of ICT-based platforms among farmers (Tata & McNamara, 2016; Shang et al., 2021; Diaz et al., 2021).

4. Conclusions and recommendations

We conclude that there are several factors that both positively and negatively affect the adoption of Mchikumbe 212 platform. From the farmers' own testimonies, the Mchikumbe 212 platform is user-friendly as it is easy to use and navigate, convenient, affordable and accessible, and gives timely and relevant information for direct application in their gardens. Non-adopters showed preference for face-to-face extension over the Mchikumbe 212 platform citing absence of instant feedback as the main reason for non-adoption. Another main finding of the study is that there was inadequate knowledge about the existence of the platform among some farmers. Some farmers indicated that they could recall hearing about the platform but they still could not explain what it was and how it worked. The first step to increasing the adoption of ICT use in agriculture extension is ensuring that the target population knows of the existence of the technology. The study has also established that farmers' perceptions towards ICTs play an important role in influencing the adoption of ICTs in agriculture extension. Farmers who thought the Mchikumbe 212 platform was very complex were more likely to be non-adopters. The evidence for this is that some farmers who thought the platform was complex had never tried to use it before, despite knowing of its existence.

Furthermore, some framers indicated that they adopted the Mchikumbe 212 platform because they found it to be useful and helpful towards achieving their agricultural production goals. The study has also established that education and literacy is another important factor that determines whether a farmer can use a new technology such as the Mchikumbe 212, and consequently affect its adoption. In addition, the farmers, including those who had adopted the platform, still preferred and trusted information

from Agriculture Extension officers and from the Ministry of Agriculture. Farmers who participated in the study viewed any messages originating from an organisation that is not agricultural in nature with suspicion. Some farmers indicated that they ignored Mchikumbe 212 promotion text messages because they thought they were just regular Airtel messages. This shows that there is an information gap regarding the Mchikumbe 212 platform sensitisation messages. The relative advantage that the platform has over the regular extension service system is what could have positively contributed to the adoption of the platform.

Based on these conclusions, it is recommended that the Ministry of Agriculture must increase awareness of the existence of Mchikumbe 212 platform so that more farmers can use it to access agricultural information. The Ministry must adopt a systematic, targeted and consistent way of promoting the platform. One way of doing this could be to use existing channels of communication such as extension officers and agricultural radio programmes to sensitise farmers on the use of the platform. This can help demystify the perceived complexity that some farmers associate with the platform and encourage more farmers to try using it. The Ministry can also use the adopters as model farmers who can teach fellow farmers about the importance of the platform. Finally, Agriculture Extension Officers must be well trained in the use and promotion of the platform.

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