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Farmers' characteristics and use of mobile services in rural areas

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Abstract

The rate of adoption, use, and impact of mobile telephony varies over time and across space. The issue concerns farmers' limited ability to fully benefit from mobile services. The aim of this research is to identify the characteristics of farmers and their impact on the performance of mobile services. This leads to the research question: what roles do the capabilities of the target group play in mobile usage? The hypothesis suggests that farmers' intellectual, financial, and technical capacities are assets for the use of mobile services in rural areas. Conducted in Analamanga and Itasy regions of Madagascar, the study examines farmers' socio-economic capacities as well as their adoption and use of mobile services. Data were collected in late 2024 through semi-structured interviews with 384 farmers using open-ended questions. The qualitative responses were coded before being processed through multiple correspondence analysis and discriminant factor analysis. Radar benchmarking graphs were then used to compare each individual's socio-economic factors with the maximum values of selected variables. The strategic rectangle identified six dominant and influential variables: ability to use mobile money services, use of SMS services, ability to make a call, inability to use mobile money services, inability to make a call, and limited French-language ability. The prospective study evaluates the evolution of mobile users' capabilities over a 10-year period. The findings show that rural mobile telephony depends not only on infrastructure but also on functional, cognitive, and linguistic capacities.

Keywords: Capacities; Use; Farmers; Mobile phone; Mobile money

1. Introduction

Mobile telephony has developed rapidly and provides access in peripheral areas lacking any other modern infrastructure. Small artisans and traders in the "popular economy" sector, as well as men and women from all walks of life, have adopted it because they have understood the value of the prepaid card subscription system and because they can easily access the wide range of services offered near their workplaces or homes [1]. According to Hellstrom [2], the greatest barrier to mobile phone use in Africa is the total cost, in other words the purchase cost of the device plus the cost of use, which notably includes the purchase of communication credit and the cost of periodically recharging the battery. A widely accepted approach shows that the expansion of telecommunication infrastructure and electricity constitutes the main determinant of the adoption of mobile technologies in rural areas. From this perspective, farmers appear as passive beneficiaries of an innovation whose availability alone would determine appropriation.

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Van Dijk [3] emphasizes that access to technologies does not guarantee their effective use, as this depends on individuals' skills, resources, and differentiated uses. Similarly, the capability approach highlights that access to resources does not automatically translate into real capacities for use; these depend on opportunities and individual abilities [4].

In the case of Madagascar, despite notable progress in mobile coverage and improvements in telecommunication infrastructure [5], the effective use of mobile services remains unevenly distributed among the population. Operators and public policies continue to play a key role in the expansion of the mobile sector, although structural constraints persist [6].

In this context, it appears that the mere availability of infrastructure is not sufficient to explain the use of mobile services. The issue concerns farmers' limited ability to fully benefit from mobile services. The aim of this research is to identify the characteristics of farmers and their impact on the performance of mobile services. This leads to the research question: what roles do the capabilities of the target group play in mobile usage? To test the hypothesis that farmers' capacities, particularly intellectual, financial, and technical capacities, constitute assets for the use of mobile services in rural areas, the analysis focused on farmers' capacities to use and adopt mobile services.

2. Materials and Methods

2.1. Study Area, Data Collection, and Data Processing

The study area consists of two regions, namely the Analamanga Region, including the rural commune of Alasora (longitude 47°33′44.22″ and latitude 18°57′13.31″) and the commune of Alakamisy Fenoarivo (longitude 47°.25` 33.00`` and latitude 18° 57` 50.00``), and the Itasy Region, more specifically the rural commune of Ambatomirahavavy (longitude 47°.22 60.02`` and latitude 18°.55` 60.00``). The Itasy Region is among the regions with a high coverage rate in Madagascar, immediately after Analamanga. Indeed, 95% of the communes in the Analamanga Region are covered by a 3G network, while the Itasy Region has a coverage rate of 92% [7].

In total, 384 farming households were surveyed through interviews with one respondent per household, randomly selected in these two regions were surveyed. Data processing was carried out in several successive stages: first, descriptive analyses, then in-depth statistical analyses, and finally the use of other analytical tools.

2.2. Data Analysis

The analysis focused on the socio-economic conditions of households and their capacities. The multivariate statistical tools used were multiple correspondence analysis (MCA) and discriminant factor analysis (DFA). The MCA results were used as the basis for classifying respondents into three user profiles. DFA was then used to validate this classification and identify the variables that best discriminated between the classes. The strategic tools used were benchmarking, the strategic rectangle, and prospective analysis.

For this purpose, 55 variables were used, but only the significant variables were retained. Benchmarking made it possible to characterize the classes derived from MCA on the basis of the most discriminating socio-economic variables. The analysis matrix was first established and then processed using XLSTAT through DFA.

DFA then made it possible to assess the contribution of the variables to class differentiation, based on the associated p-values. Variables whose p-value was greater than 0.05, at the retained α risk-of-error threshold, were considered non-significant and excluded from the analysis. Significant variables were retained for the subsequent processing. In order to construct the radar charts, negative values were first eliminated to allow a coherent change of scale. The retained observations were then relativized according to the ratio $X_i/\sum X_i$ and then compared with the maximum value observed for each variable.

This approach made it possible to obtain, for each class, a synthetic socio-economic profile in the form of a radar chart. The maximum values served as comparison references, which facilitated the identification of the relative strengths, weaknesses, and gaps specific to each class. Thus, benchmarking provided a comparative reading of the classes by highlighting the variables that most strongly distinguish their socio-economic conditions.

Table 1 Variables Used for Benchmarking

Variables	Codification
Gender	GE
Age	AG
Level of education	NE
Profession	PS
Land ownership	PTR
Ownership of means of transport	PMC
Radio ownership	PR
TV ownership	PT
Amount received via mobile money per month	MRM

The strategic rectangle led to the identification of influential and dominant variables relating to mobile user behaviors. Non-significant variables and the lower diagonal part of the correlation matrix were eliminated, and a significance threshold of 0.10 was retained for intervariable correlations. Then, the values of X and Y were calculated as follows:

- $X = L/P$
- $Y = L*P$

where:

- L = sum of the absolute values of the row variables in the correlation matrix
- P = sum of the absolute values of the column variables in the correlation matrix

The variables were sorted in descending order based on the values of X, and values greater than 1 ($X > 1$) are influential variables (colored in yellow). All these influential variables were then sorted in descending order according to the values of, and the highest values up to a significant gap between them are grouped into dominant and influential variables colored in green [8].

The prospective study of mobile users' capacities over 10 years was conducted to determine the likely evolution of respondents' capacities for each class in the study area and is presented in the form of a sparkline curve. The variables studied were the dominant and influential variables identified through the strategic rectangle.

3. Results

3.1. Socio-Economic Factors

The socio-economic situation of the surveyed households differs from one class to another among the 3 classes.

- Class 1: Occasional Mobile User. This class is mainly composed of women aged 48 to 61 years. A large proportion of them have not attended formal schooling and mainly engage in agricultural and livestock activities. They own their land or cultivate it through rental arrangements and do not have a television. Most of them use voice services, rarely send SMS messages, and make limited use of mobile money (Figure 1).
- Class 2: Smartphone User. Individuals in this class generally have a secondary level of education (high school). They own equipment such as a motorcycle or a plow, as well as a radio. They use voice services, often send SMS messages, and use mobile money and data services. Some receive monthly amounts exceeding 1,000,000 Ar via mobile money (Figure 2).
- Class 3: Feature Phone User. This class mainly includes people aged 18 to 47 years who engage in professions such as craftsmanship. They do not have means of transport. They use voice, SMS, data, and mobile money services. The amounts received monthly through mobile money range between 51,000 Ar and 1,000,000 Ar (Figure 3).

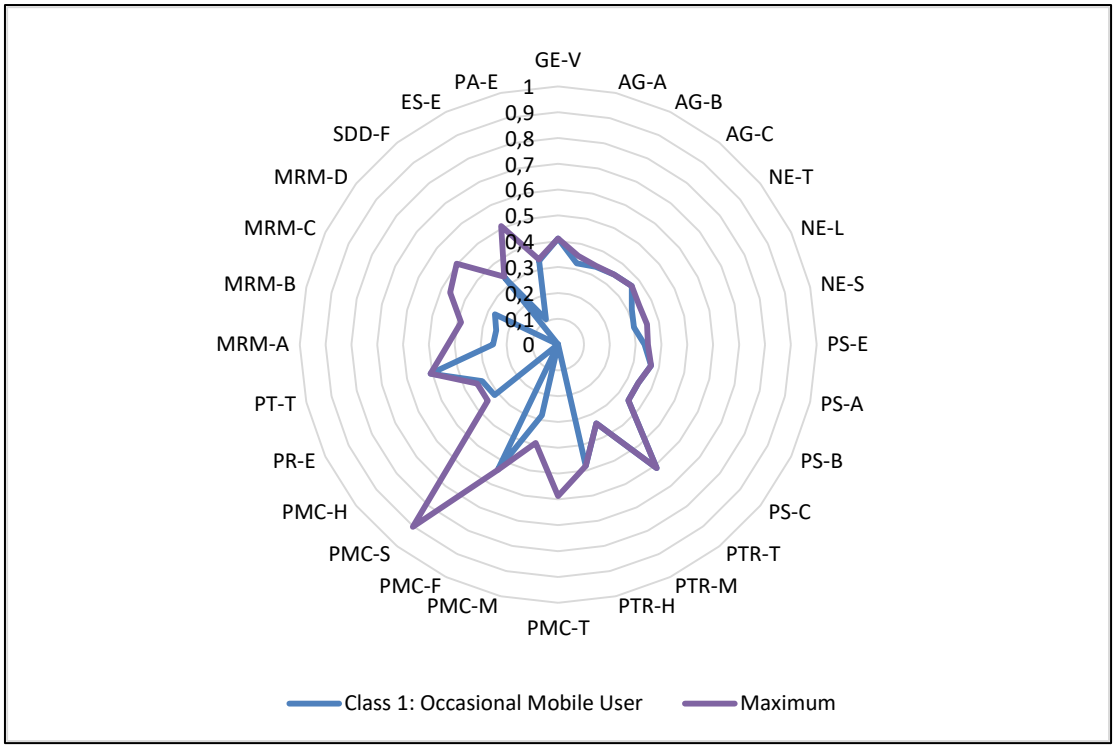


Figure 1 Socio-economic factors of the occasional mobile phone user (Class 1)

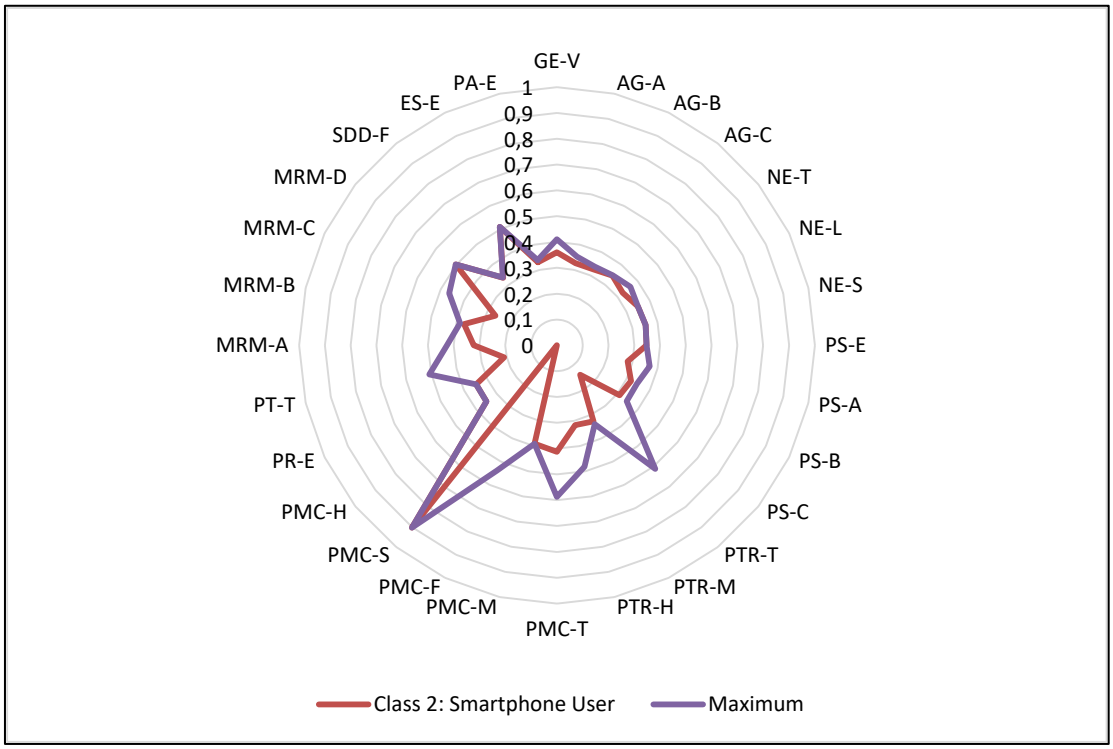


Figure 2 Socio-economic factors of the smartphone user (Class 2)

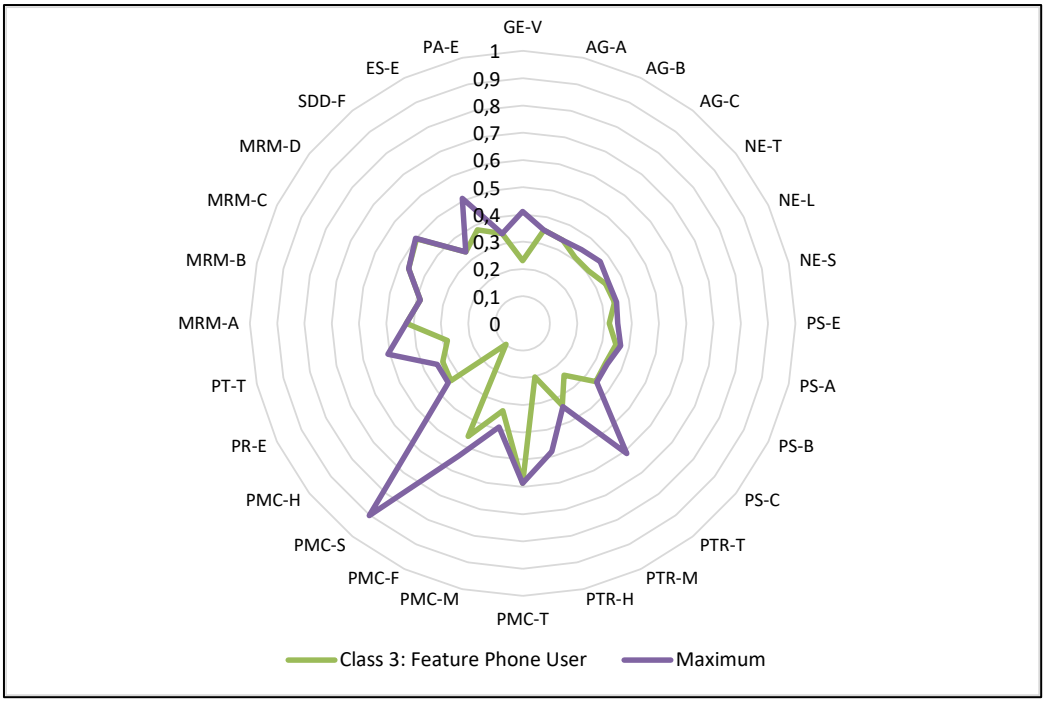


Figure 3 Socio-economic factors of the feature phone user

Legend: GE-V: Gender-Female; PS-B: Occupation-Livestock farming; PR-E: Radio ownership-Yes; AG-A: Age-18 to 32; PS-C: Occupation-Handicraft; PT-T: TV ownership-No; AG-B: Age-33 to 47; PTR-T: Land ownership-No; MRM-A: Amount received via mobile money-Less than 50,000 Ar; AG-C: Age-48 to 61; PTR-M: Land ownership-Individual; MRM-B: Amount received via mobile money-51,000 Ar–200,000 Ar; NE-T: Education level-No schooling; PTR-H: Land ownership-Rental; MRM-C: Amount received via mobile money-200,100 Ar–999,100 Ar; NE-L: Education level-High school; PMC-T: Ownership of means of transport-No; MRM-D: Amount received via mobile money-More than 1,000,000 Ar; NE-S: Education level-Secondary; PMC-M: Ownership of means of transport-Motorcycle; SDD-F: Data service used-Facebook; PS-E: Occupation-Other; PMC-S: Ownership of means of transport-Plow; ES-E: Uses SMS service-Yes; PS-A: Occupation-Agriculture; PMC-H: Ownership of means of transport-Other; PA-E: Able to make a call-Yes

3.2. Strategic Rectangle: Dominant and Influential Variables

The study of the dominance and influence effects of farmers' capacities made it possible to obtain the strategic rectangle (Table 2). The rows in green in the table group together six dominant and influential variables, namely: Able to use the mobile money service-Yes (UM-E); Uses the SMS service-Yes (ES-E); Able to make a call-Yes (PA-E); Able to use the mobile money service-No (UM-T); Able to make a call-No (PA-T); French-language proficiency-No (CF-T).

Table 2 Dominance and Influence Effects of Factors Related to the Capacities of Mobile Telephony Users

Variables		Codes	X=L/P	Y=L*P
Dominant and influential variables	Able to use mobile money-Yes	UM-E	1.47	67.82
	Uses the SMS service-Yes	ES-E	1.58	66.25
	Able to make a call-Yes	PA-E	2.54	48.99
	Able to use mobile money-No	UM-T	1.15	43.44
	Able to make a call-No	PA-T	1.97	36.83
	French-language proficiency-No	CF-T	2.62	35.23
Influential variables	French language capacity-Yes	CF-E	3.88	29.64
	Level of education-University	NE-U	6.85	10.44
	Level of education-High school	NE-L	4.22	10.17

	Age-18 to 32	AG-A	6.24	6.24
	Level of education-No schooling	NE-T	5.32	5.32
	Level of education-Secondary	NE-S	1.94	5.03
	Age-48 to 61	AG-C	1.84	4.34
	Gender-Female	GE-V	2.91	2.91

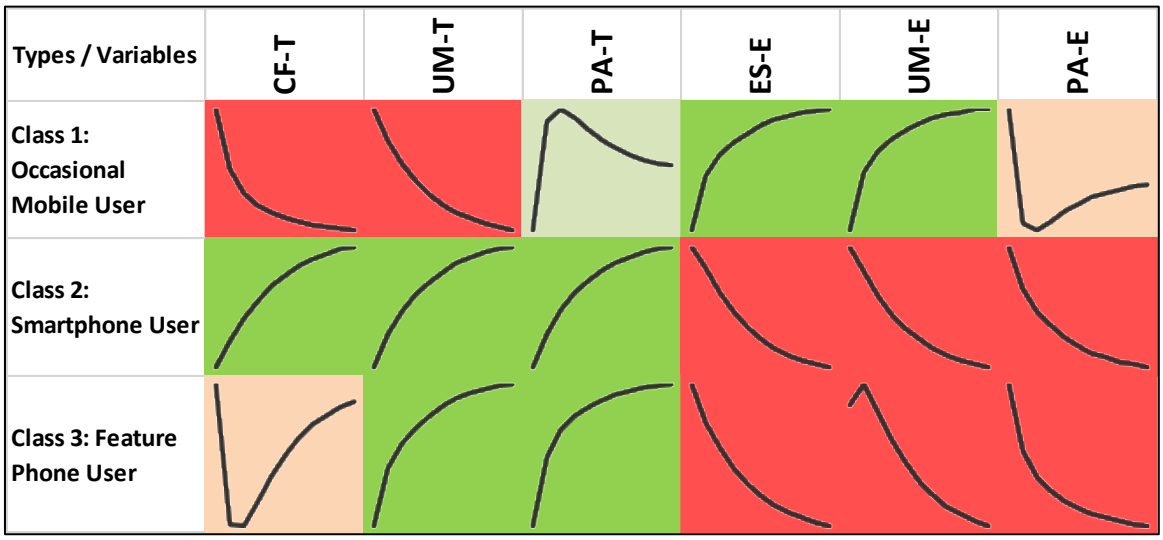
Legend: L: Sum of the absolute values of the variables in the rows of the correlation matrix; P: Sum of the absolute values of the variables in the columns of the correlation matrix; X: Quotient of L divided by P; Y: Product of L and P.

3.3. Prospective Analysis of Farmers' Capacities

For Class 1, the inability to communicate in French (CF-T) gradually decreases, while the capacity to use SMS (ES-E) and the capacity to use the mobile money service (UM-E) show a notable increase (Figure 4).

For Class 2, the lack of French-language proficiency (CF-T) tends to increase. In contrast, the capacity to use SMS (ES-E), the capacity to use the mobile money service (UM-E), and the capacity to make calls (PA-E) decrease (Figure 4).

For Class 3, the lack of French-language proficiency (CF-T) initially decreases before subsequently increasing, whereas the capacity to use SMS (ES-E), the capacity to use the mobile money service (UM-E), and the capacity to make calls (PA-E) generally decline (Figure 4).



Legend: UM-E: Able to use mobile money-Yes; PA-E: Able to make a call-Yes; PA-T: Able to make a call-No; ES-E: Uses SMS service-Yes; UM-T: Able to use mobile money-No; CF-T: French-language ability-No.

Figure 4 Overall view of the evolution of dominant and influential variables by class

4. Discussion

4.1. Mobile Use According to Socio-Economic Profiles for Each User Group

User profiles vary according to their group (Figures 1, 2, and 3). Class 1, composed mainly of farmers and livestock farmers, falls within a subsistence logic characteristic of rural economies in developing countries. In educational terms, the majority of this population has a low level of schooling, and they make very limited use of screen-based technologies, such as television or smartphones. Access to these devices remains limited due to economic constraints and a low level of digital skills. This situation is consistent with Sen's capability approach [4]. Income level and individual capacities strongly condition access to resources, including technological resources. The non-use of SMS by Class 1 is also explained by the statement of Raballand [9], according to a study in Africa who argues that in rural areas, literacy problems compromise the broader use of mobile phone functionalities, particularly SMS. According to Piccoli *et al.* [10], an individual's level of education influences the adoption and use of ICTs through its effect on individual capacities to use technology. Razafindrabe [11] shares the same view, stating that "the higher a person's level of education, the greater their probability of using ICTs to a higher degree."

Occasional mobile phone users mainly use basic mobile phones, intended primarily for voice communication rather than multimedia or connected uses. Furthermore, the predominance of voice communication reflects a utilitarian logic of use, focused on meeting immediate needs, as shown by Aker and Mbiti [12] in their analyses of mobile uses in rural Africa.

The use of mobile telephony within smartphone user is distinguished by a relatively more advanced profile. Individuals in this group, most of whom have a secondary and high school level of education, own production and information equipment such as motorcycles, plows, and radios, which facilitates their economic activities. This category illustrates the progressive adoption process described by Rogers [13], in which certain individuals act as "early adopters" in the diffusion of innovations. The mobile phone is used not only for voice communication but also for digital financial services, particularly mobile money. These results are consistent with those of Zahonogo [14], who states that the level of education positively influences the probability of adopting mobile telephony, and that an improvement in an individual's level of education increases their chances of adopting mobile telephony.

The feature phone user, mainly young people engaged in craft activities, illustrate a form of targeted appropriation of mobile technologies, centered on financial services. Despite limited access to traditional information equipment such as radio and television, these individuals make intensive use of mobile money services, which highlights the role of ICTs as a lever for financial inclusion. According to Jack and Suri [15], based on a research carried out in Kenya, mobile financial services make it possible to secure transactions, smooth income, and reduce economic vulnerability. This result also confirms that technological innovation may be adopted selectively according to its perceived usefulness, in line with the technology acceptance model of Davis [16].

4.2. Influence of Factors Related to the Capacities of Mobile Telephony Users

Variables related to users' capacities, particularly the ability to use mobile money services, send SMS messages, and make calls, constitute major determinants of the effective use of mobile telephony in rural areas (Table 2). The importance of these functional skills confirms the work of Van Dijk [3], who emphasizes that digital inequality is based less on access than on skills and uses, thereby defining a second-level digital divide.

From this perspective, the capacity to use mobile money appears as a central lever of economic inclusion. In rural contexts, where banking infrastructure is limited, mobile financial services make it possible to reduce transaction costs, secure exchanges, and improve market fluidity. These results are consistent with those of Aker [17], who highlights that mobile technologies improve the efficiency of rural markets by facilitating access to information and reducing information asymmetries.

Conversely, the inability to use mobile money constitutes a factor of digital and economic exclusion, revealing structural inequalities in human capital. This situation can be interpreted in light of the capability approach developed by Sen [4], according to which access to technologies is not sufficient: it is individuals' real capacities to use them that determine their impact on well-being.

Furthermore, the use of SMS messages and voice calls remains predominant due to their simplicity, low cost, and compatibility with basic phones. SMS messages, in particular, play a key role in coordinating economic and social activities.

Another result concerns the inability to communicate in French (CF-T), which appears as a significant barrier to the advanced use of mobile services. Indeed, many mobile service interfaces and instructions are presented in French, which may limit access for users with low French-language proficiency. This linguistic barrier limits access to digital interfaces and transactional services, and it reinforces inequalities of use. This finding is consistent with Castells' analysis [18], for whom inclusion in the information society depends on the capacity to master the linguistic, technical, and cognitive codes of digital networks. Thus, language becomes a structuring factor of the digital divide, in the same way as technical skills.

4.3. Evolution and Projections of SMS and Mobile Money Use

The evolution of SMS use (ES-E) and of the capacity to use mobile money (UM-E) highlights a progressive and cumulative learning process, particularly for occasional mobile user (Figure 4). This gradual improvement in digital skills falls within the logic of learning by using, a concept developed by Rosenberg [19], according to which the repetition of technological uses promotes the acquisition of skills and the sustainable appropriation of innovations. The functional integration of the mobile phone into economic activities, such as trade, market-oriented agriculture, and financial transfers, contributes to the creation of a virtuous circle: frequent use improves skills, which in turn increase perceived

benefits, thereby strengthening sustainable use. This is consistent with the technology acceptance model of Davis [16], in which perceived usefulness and perceived ease of use are the conditions for adoption and continued use.

Conversely, projections concerning other users reveal more unstable trajectories, characterized by an anticipated decline in the use of SMS and mobile money (Figure 4). This trend shows a phenomenon of disengagement or non-sustainability of uses. An increase in the use of mobile data services can be expected in these two classes, where SMS messages are gradually being replaced by instant messaging applications such as Facebook, Messenger, and WhatsApp. The improvement of digital uses in rural areas depends less on initial access than on the sustainability of capacities for use. These findings support differentiated support strategies, including continuous training, the adaptation of services to local contexts, and the strengthening of basic digital skills.

4.4. Use of Voice Services According to Classes

The evolution of voice service use, particularly the making of calls, reveals contrasting trajectories according to class (Figure 4). For occasional mobile user, the initial decline observed may be interpreted as a phase of adjustment or temporary disengagement, followed by progressive reappropriation. This type of dynamic corresponds to a non-linear learning process, in which individuals alternate between phases of use and withdrawal before reaching stabilization. According to Sen [4], capacities are built progressively and depend on real opportunities for learning and use.

However, the continuous decline in the use of calls for other users reflects a structural change in modes of communication. This evolution may be associated with the transition toward uses based on mobile data and digital platforms such as Facebook and WhatsApp, which offer richer forms of communication, including multimedia messages, videos, and broader social interactions. However, this transition is not necessarily synonymous with increased digital inclusion. DiMaggio *et al.* (2004), in a study conducted in the United States, highlight the role of socio-economic inequalities in shaping digital usage patterns. Thus, the decline in the use of voice services may reflect not only a change in preference, but also economic constraints, such as the cost of communications, as well as linguistic or technical constraints.

5. Conclusion

This research informs the reflections on the importance of human capacities in the adoption and use of a technology such as mobile telephony. The results led to the verification of the hypothesis according to which "farmers' capacities, particularly intellectual, financial, and technical capacities, constitute assets for the use of mobile services in rural areas."

The use of mobile telephony in rural areas does not depend solely on access to infrastructure, but is based on a set of functional, cognitive, and linguistic capacities. The coexistence of capacities, such as calls, SMS, and mobile money, and incapacities, such as mobile money and the French language, highlights a qualitative digital divide, in which the main issue lies in the effective appropriation of technologies. The evolution of capacities for using mobile telephony depends on a set of factors such as learning, support, technological transformation, and the socio-economic context. This highlights the need for public policies and intervention strategies aimed at supporting continuous learning and preventing the risks of digital disengagement, particularly among rural populations.

The present study opens up several research avenues, such as the modelling of a system that could optimize the impact of mobile telephony in rural areas. Other research avenues aim to strengthen the motivation of rural users to resort to mobile telephony.

Compliance with ethical standards

Acknowledgments

The authors would like to thank the farmers who participated in the survey and shared their experiences regarding the use of mobile services in rural areas.

Disclosure of conflict of interest

The authors declare that they have no conflict of interest related to this study.

Statement of ethical approval

This study was conducted in accordance with ethical principles applicable to research involving human participants. Respondents were informed about the purpose of the study before data collection. Their participation was voluntary, and informed consent was obtained before each interview. The information collected was used only for scientific purposes. The anonymity and confidentiality of the respondents were respected throughout the research process.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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