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Implementing Technology Acceptance Model to measure ICT usage by smallholder farmers

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Abstract
In the era of industry 4.0, especially in the agricultural sector, using ICT as a communication and information-gathering medium for farmers is crucial. However, the ICT adoption level by smallholder farmers varies greatly. This study investigates the elements influencing the ICT adoption level and utilization and explores the application of the TAM to smallholder farmers. Using descriptive quantitative methodology on three villages in Ngawi regency, East Java (N=53), this study indicated that smartphone usage in the research location was extremely high at 90.5%. A Spearman correlation value of 0.24 indicates a relationship between the PU and the education level of farmers. T-Test Two Means Independent was used to compare respondents' perception of ICT utilization through Perceived Use (PU) and Perceived Ease of Use (PEU); PU's average value of 17.5 was greater than PEU's average value of 13.9. It was determined that ICT perceived usefulness was felt more important than perceived ease of use by the respondents in their daily activities. Additionally, this study recommends that agriculture services development necessitates strategies to create ICT usefulness through smartphones. Such strategies will help increase the ICT effective adoption, reducing information gaps and raising the wealth of smallholder farmers.

Keywords:
Information and Communication Technology;
Smallholder Farmer;
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INTRODUCTION

Farming provides a living for 27.68 million people in Indonesia, and this industry can further be broken down into several sectors, such as rice, horticulture, palawija (crops sown as a second crop in the dry season), forestry, plantation, fishery, and animal husbandry farming [1]. While farmers have a vital role and responsibility in agribusiness, particularly in the cultivation of crops on their farms, their welfare and income are often not significantly impacted by their contributions to the industry. The weak bargaining position of farmers in the sale of crops has resulted in uncertain welfare for these individuals [2].

According to the data analysis of the NTP (Farmer Trade Rate), the relationship between GDP growth and the farmers' welfare is not straightforward. The rising production costs in the agriculture industry are responsible for the stagnated welfare of farmers. The eradication of rural poverty becomes a challenging task due to the fact that agriculture is the principal source of income for 49.4% of rural residents [3].

In this age of Industrial Revolution 4.0, when the market trade price competition is becoming more open, farmers' lack of independence contributes to their poor quality of life. Therefore, farmers must be trained and equipped to tackle the competition by emphasizing production efficiency and high-quality products. Recent research [4] has found that smallholder farmers' access to information on market pricing, early warnings, and crucial

services such as contract farming, certification, grading, and irrigation technology is the most important factor in their ability to compete in high-value market chains.

Given that agriculture is one of the sectors that contribute to the development of the nation's economy, Harjanto [5] suggested that it is important to closely monitor the welfare of farmers and the availability of food supplies in order to ensure the stability and security of the agriculture industry. According to the Regulation of the Minister of Agriculture of the Republic of Indonesia Number 18 / PERMENTAN / RC.040 / 4/2018 concerning Guidelines for the Development of Agricultural Areas Based on Farmer Corporations, the Government of the Republic of Indonesia shall ensure the well-being of farmers and the nation's ability to provide food. This rule became effective on April 4, 2018. To comply with one of the regulation's requirements, farmers can no longer sell grain directly to end-users; instead, they must do so through an agriculture corporation. The farmer corporations acted as a liaison between the buyer and seller of grain. A farmer corporation is a business entity created by farmers, for farmers, and on behalf of farmers to provide assistance to farming businesses. The setup of farmer corporations is expected to influence the agricultural supply chain and increase their productivity and income by combining their pools of resources.

The application of digital technology in agriculture has the potential to modernize and improve traditional farming practices. This shall be accomplished through various devices, systems, and data, as well as through more productive working hours. In this Industry 4.0 era, the agricultural sector must adopt digitization to create a more effective production system. The widespread deployment of digital technology in agriculture has enabled farmers to modify their mindsets to maximize and profit from their autonomy. Furthermore, adopting digital technologies will increase employment opportunities in the agricultural industry. Therefore, the term "Agriculture 4.0" will improve both the well-being and the income of farmers [6].

Implementing smart farming techniques improves the efficiency of data collection, processing, and monitoring in agricultural production. According to Salinee [7], farmer corporations should be aided by an easy-to-use technological application platform assisting farmers in making decisions, marketing the products and managing sales as crop prices fall. For farmers to fully benefit from Information and Communication Technology (ICT) in the long term, farmer corporations must be knowledgeable in improving farmers' readiness to adopt and use ICT. Additionally, ICT has also been implemented in micro and small industries [8, 9, 10].

As the level at which farmers embrace ICT varies widely, it is essential to provide education and training on its usage at the community level. Qiong et al's research found that education is the key for a solid understanding of accepting and adopting technology [11]. According to a survey by AJPII (Indonesian Internet Service Providers Association) in 2018, only 25.7% of farmers are connected to the internet. This demonstrates that internet usage in rural areas remains far below the national average of 50% [12]. Unfortunately, more recent survey data on farmers' Internet connectivity were unavailable during the editing process for this article. Farmers communicate with the community using mobile phones to obtain quality information [13]. Enhancing the use of ICT at the farmer level can facilitate farmers' access to timely and relevant information and enable the sharing of digital information [14]

The Technology Acceptance Model (TAM) is a tool that can be used to study the adoption of information and communication technology (ICT) by analyzing their perception of usefulness and ease of use. As shown in Figure 1, TAM also helps to examine user's decisions and attitudes towards new technologies. TAM is a widely-cited and frequently-used model in recent research, including [15][16].

The technique has become one of the most widely used models in a variety of situations and has been used to a vast array of technology adoption issues [17, 18, 19, 20, 21]. Since the TAM model is intended to explain the acceptability of a technology or system based on its perceived value and ease of use [22], it is a suitable choice for agriculture sector participants. Because agriculture emphasizes the practical use of technology, both in terms of simplicity of use and perceived utility, the TAM model is the best solution, as it measures both features as drivers for behavioral intention, leading to the real use of technology in agriculture. Other models that deal with digital technology have also been used in research in the agribusiness industry [23]. Additionally, a model for decision making based on qualitative data has also been utilized [24].

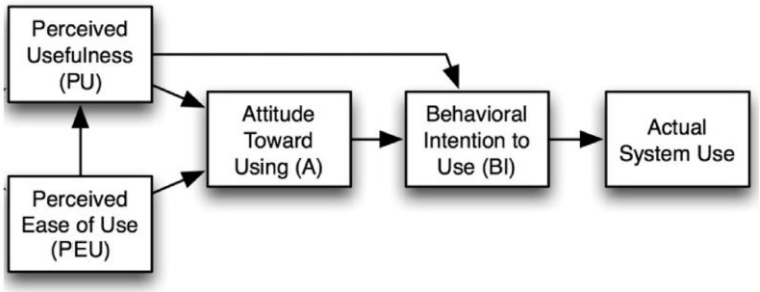

Figure 1. Technology Acceptance Model [16]

The TAM model consists of two main factors that contribute to a user's perception of acceptance: Perceived Usefulness (PU) and Perceived Ease of Use (PEOU). Perceived Usefulness (PU) refers to the extent to which a user believes that using a particular technology will enhance their job performance or overall quality of life. Perceived Ease of Use (PEOU), on the other hand, refers to the extent to which a user perceives a technology to be easy to use and understand. By examining these two factors, TAM helps to predict the likelihood of a user adopting a particular technology and facilitates the design and implementation of successful technologies [25][26].

However, even with the presence of a useful and easy-to-use technology, adoption is not always guaranteed. This is exemplified by the experience of Ngawi Tani Mandiri, an agriculture corporation in form of cooperative in Ngawi Regency, East Java, which was offered a smartphone app by a provider to assist its farmer members with recording daily transactions. Despite the potential benefits of the app, the cooperative has struggled to convince its members to adopt and use it, leading to numerous transactions being improperly recorded or lost entirely.

This issue highlights the importance of understanding the attitudes and behaviors of farmers towards the application of information and communication technology, particularly in the context of farmer cooperatives. This is the focus of the larger study that this research is a part of, which aims to analyze the adoption and utilization of digital technology applications in farmer corporations. By understanding the factors that influence the adoption of these technologies, the study seeks to identify ways to effectively support the growth and success of farmer corporations. The TAM is a method for determining the degree to which information and communications technologies are accepted or exploited. A study by Kifli et al. [26] found that rural areas in Indonesia have good cellular coverage, with 66.21% of the region experiencing strong signals. This allows farmers, traders, and agricultural entrepreneurs to easily communicate through cellular networks, improving opportunities in agriculture. This study employs two variables from the TAM Model, PU and PEU - to examine the disparity nature of farmers' access to and usage of information and communications technology (ICT), farmer behaviour, and ICT perceptions.

The purpose of this study was to understand the reasons behind the agriculture cooperative's difficulty in convincing its member farmers to use a digital mobile app. This explanation is important for implementing digital transformation in agriculture, particularly for smallholder farmers. By understanding the factors that influence the adoption of these technologies, it is possible to identify ways to effectively support the growth and success of farmer cooperatives through the use of digital tools.

METHOD

This study employs a quantitative descriptive methodology, which involves the collection and analysis of numerical data through the use of surveys, questionnaires, and interviews. To gather the data needed for the study, the research team administered surveys and conducted interviews. The collected data was then preprocessed and analyzed to identify trends and patterns.

Material

The respondents of this study consist of 53 farmers, members of farmers' groups in 3 villages, namely Beran Village, Cepoko Village, and Gentong Village, Ngawi Regency, East Java Province. The three villages were selected based on their geographic location in Ngawi. Beran in the north east, Cepoko in the southwest and Gentong in the center of Ngawi.

Methods

With a confidence level of 95% and the sample size of 53 respondents, the Slovin method resulted in an error margin of 13% as obtained from (1).

$$n = N/(1 + Ne^2) \quad (1)$$

where n is the desired sample size, N is the population size, and e is the acceptable margin of error. This study established a margin of error of 13 percent.

The number of samples utilized was highly dependent on the respondents' willingness to attend and complete the surveys and the rural location of the research sites. During our visits in March and August 2022, respondents were questioned and handed questionnaires to collect data. The questionnaire was created to capture farmers' demographic information, frequency of ICT use, and perceptions of ICT use. Before distributing the questionnaires, the farmers were informed during the meeting about the definition of "information," which includes both on-farm and off-farm information, such as pricing.

The diversity of ICT usage frequency was measured using a four-level Likert scale with the following response options: never, seldom, occasionally, and frequently. Access to the ICT devices includes mobile phones and desktop or laptop computers. On a four-point Likert scale with the following response options: strongly agree, agree, disagree, and strongly disagree, respondents' perceptions of ICT usage were then measured. This study develops statement items from the standpoint of the TAM hypothesis, which takes into account two perceptions of ICT acceptance, namely PU and PEU, both of which might influence the adoption of ICT use [15]. The research study framework is depicted in Figure 2.

Each questionnaire item in PU and PEU is evaluated for its validity and reliability. Validity test is conducted to ascertain the level of validity of the research instrument [27]. The validity test results were then compared to the table value with a 5% margin of error. If the validity coefficient of each statement is higher than 0.2706, then the statement item can be considered valid. Where from the Cronbach alpha test can be known the level of reliability for validity [28][29]. Table 1 displays the PU and PEU questionnaires together with the validity and reliability test results.

Because the validity coefficient was higher than 0.2706, the validity test for each question item indicated that it was valid and acceptable. Based on the outcomes of reliability test calculations, the Cronbach's Alpha values for PU and PEU are 0.82 and 0.77, respectively. A Cronbach's Alpha value greater than 0.70 suggests that the question's construction dependability is above average [27]. So that the five question items may be utilized individually and collectively to assess the building of PU and PEU.

In addition, the Kolmogorov normalization approach seeks to determine whether the variable data follows a normal distribution [28]. When the significance value is greater than 0.05, the data distribution can be described as normal. Both values are more than 0.05, confirming a normal distribution. The data were then evaluated with statistical tools employing an independent T-test to compare the two groups, as well as the Pearson product moment and Spearman rho correlation tests to examine the relationship between the two variables.

RESULTS AND DISCUSSION

To evaluate the perception of farmers' adoption of ICT using the TAM, researchers determined that two factors, namely PU and PEU, affect this perception (PEU). The characteristics of respondents with demographic variety in terms of education, farmer group activity status, and age are presented in Table 2. 45.6% of responders were between the ages of 40 and 50, indicating that farmers in this age group are very productive in three villages (Beran Village, Cepoko Village, and Gentong Village). In addition, as many as 45.3% of respondents had completed high school, while 39.6% had completed bachelor's degrees. This demonstrates that the education levels in the three villages studied are rather high.

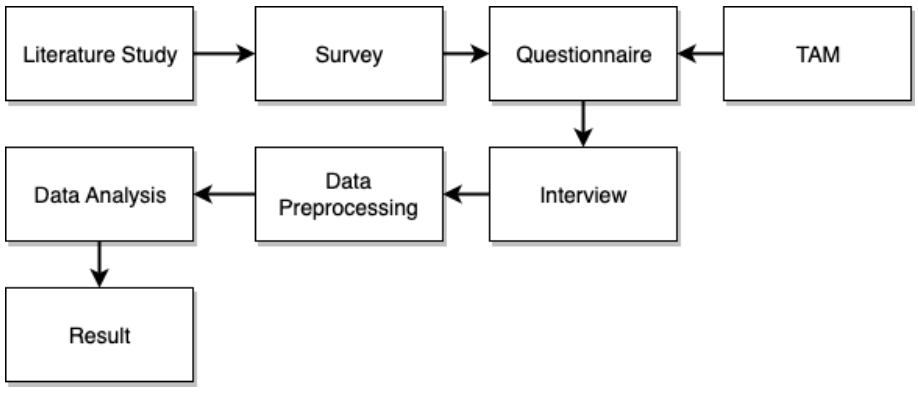

Figure 2. Research Study Framework

Table 1. Questionnaires PU and PEU

Construct	Questionnaire Item	Validity Test	Cronbach's Alpha
Perceived of Usefulness	Information and Communication Technology are helpful for locating the necessary information.	Valid	0.82
	Utilizing technology made my information search faster.	Valid	
	The use of Information and Communication Technology greatly saves time in searching for information	Valid	
	Information Technology provides access to a vast array of information.	Valid	
	Information made accessible by Information and Communication Technology is more current.	Valid	
Perceived Ease of Use	Information and Communication Technology is simple for me to use.	Valid	0.77
	I don't need to learn to use Information and Communication Technology	Valid	
	I have never encountered any issues when utilizing Information and Communication Technology	Valid	
	Information and Communication Technology has never caused me confusion.	Valid	
	I rarely make mistakes when using Information and Communication Technology.	Valid	

Table 2. Respondent Characteristics

Characteristics	Category		
Level of education	Junior High School (9.4 %)	Senior High School (45.3%)	Bachelor's Degree (39.6%)
Age group	30 - 40 (15.8%)	40 - 50 (45.6%)	50 - 60 (33.3%)
Activity status in farmer's group	Active (79.2%)		Non-Active (20.8%)

According to the data findings on the characteristics of farmer respondents, the vast majority of farmers, or 84.9 percent, have attained a very respectable level of education, including high school and bachelor's degrees. In particular, respondents with a bachelor's degree have potentially better education level and knowledge to share with others in the field. At 79.2 percent of activity status in farmer's group, the majority of farmer respondents were categorized as extremely active. This demonstrates that farmers participate actively in activities or events organized by each farmer group.

The analyzed data from the questionnaire of farmer respondents indicates that their use of ICT devices is extremely diverse, including the use of standard feature cellphones, smartphones, and laptops/PCs. As indicated in Table 3, many respondents utilized smartphones or laptops/PCs as an ICT communication device when searching for or sharing information.

The majority of farmers have access to information through ICT channels, as shown in Table 3. This survey reveals that up to 90.5 % of farmers at the study site own smartphones, indicating that their use is widespread. The smartphone ownership rate at this research site was much greater than the national rural smartphone ownership rate of 45.42 % [9]. The percentage of respondents who own laptops/PCs is 32,1 %, which is higher than the national average of 23,83 %.

Farmers can benefit from the usage of cellphones in the village's agricultural setting as a two-way communication medium that employs internet connection to gather and exchange information. With smartphone ownership nearing 90.5%, it is unlikely that any farmers lack internet connectivity.

Table 3. Respondent's Accessibility to ICT

Accessibility	*Smartphone*		*Laptop*/PC	
	N	%	N	%
Owner	48	90.5	48	90.5
Non-owner	5	9.5	5	9.5

This number indicates a very substantial potential for internet access, far beyond the results of a 2018 survey done by APJII, which found that approximately 38.4 percent of farmers have online access. Smartphones have the potential to be utilized as a communication and distribution medium for internet-based information, whereas computers have a lower potential to be used as ICT media. In light of the diversity of farmers' information and communication demands, it is crucial to identify and assess respondents' ICT requirements. In Africa, for instance, farmers utilize ICT to get data on food productivity and analyze agricultural earnings [30].

PU and PEU are two factors of the TAM approach employed in this study that are associated with the perception of ICT usage. Both variables contain five statements (constructs) directed at farmer respondents. PEU will recognize the simplicity of utilizing ICT media, while PU will identify the usefulness of ICT.

The analysis of PU and PEU perceptions had a positive value, as farmer respondents had the highest scores on both PU and PEU for the following two statements: "I can find information I need more quickly using technology" and "I find it easy to use ICT." It can be observed from the highest score that respondents ranked ICT media as extremely useful for obtaining information faster than using printed media such as periodicals, brochures, and pamphlets.

By being accessible online, it is claimed that information is also more diversified, giving farmers access to a number of information sources that can assist them in making more educated decisions. The average internet access speed measured at the study site was 17 Mbps, considered as sufficient. A fast internet connection can save farmers time when searching for information. Farmers view the usage of ICT media as straightforward and uncomplicated in terms of utility. This is demonstrated by the farmer's scores on the five questions pertaining to the PEU element of ICT media use. The majority of farmers believe that it is simple to use ICT media. When the elements of ICT media were simple to comprehend, farmers quickly learned how to use them.

When acquiring access to information via ICT media and applications, farmers prioritize usability and clarity. When farmers have access to the necessary information, they are able to make better informed decisions. The extent to which farmers have knowledge about and easy access to smart technology affects its adoption in the agricultural sector [7]. The main variables influencing the adoption of ICT tools are determined to be the demands of farmers, such as information about plants, seeds, and markets [31]. The development of new farming methods and techniques depends heavily on the variety of teaching methodologies and knowledge sources available through IT applications [32].

Table 4 presents the outcomes of data processing and analysis utilizing independent T-tests. In other words, evaluations of usefulness and usability do not differ significantly between the two groups of farmers who have access to ICT and those who do not.

Therefore, farmers who have access to ICT are neither better nor worse in term of their perception of usefulness and usability than farmers who lack of ICT. In addition, an independent T-test was conducted on farmer groups' activity levels. As a result, neither the active nor the inactive groups shown any statistically significant variations in their perceptions of the usefulness and usability. The association between farmer characteristics and perceptions of PU and PEU was also analyzed. On the perception of PU and PEU, the characteristics of farmers that are measured are age and level of education. The association between farmer characteristics and farmer perceptions is illustrated in Table 5.

Pearson correlation measurements of PU and PEU were obtained against the age characteristics of respondents. The significance value of PU was 0.12, indicating that age had a significant relationship with ICT benefits, since the obtained significance value was greater than the level of significance (0.05).

Table 4. Farmer's perspectives using T-test

Farmer's characteristics	T-test Independent	Sig	Result
Access to ICT			
- PU	-0.17	0.23	Non-Significant
- PEU	0.08	0.57	Non-Significant
Activity status on farmer's group			
- PU	0.21	0.88	Non-Significant
- PEU	-0.22	0.11	Non- Significant

Table 5. Relationship between Farmer's Characteristics and perception

Farmer's Characteristics	Technology Acceptance Model		
Age	Pearson's Correlation	Sig	Result
- PU	-0,21	0,12	Significant
- PEU	-0,01	0,92	Significant
Level of education	Spearman's Correlation	Sig	Result
- PU	0,14	0,33	Significant
- PEU	0,24	0,08	Non-Significant

Similarly, the significance value of PEU is 0.92, indicating that age and ease of use (PEU) have a significant relationship because the significance value is more than 0.05. In the age group of 40 to 50 years, the benefits and simplicity of use of ICT are appreciated strongly by farmers. The results of the Spearman correlation test between the variables of education level and perception of usefulness (PU) and perception of ease of use (PEU) in Table 5 indicate that there is a significant relationship between the education level of farmers and their perception of the usefulness (PU) of ICT media.

Nonetheless, a significance value of 0.08 reveals a non-significant positive correlation between farmers' education level and their perception of ease of use. This implies that farmers with higher levels of education are marginally more influenced by the perception of ICT usability. The score of 0.24 for Spearman's correlation coefficient between education level and perceived ease of use [33] suggests a sufficient relationship. This is consistent with the findings of Michels et al. [34], who discovered a correlation between the educational level of farmers and their perception of ease of use (PEU) when utilizing ICT media. To determine and assess how respondents view PU and PEU. Calculations and analysis are conducted using the Two-Means Independent T-Test to determine whether or not individuals have similar or dissimilar perceptions.

The average PU value (17.5) yields a greater outcome than the average PEU value (13.9). It can be stated that farmer respondents are more inclined to value the usefulness of ICT media than the convenience of utilizing ICT for daily tasks.

CONCLUSION

Based on these findings, the majority of farmers between the ages of 40 and 50 in the three villages that were the focus of the study, namely Beran Village, Cepoko Village, and Gentong Village, Ngawi Regency, East Java Province, were quite productive. 39.6 percent of farmers hold a bachelor's degree, which has a significant impact on the dissemination of farming knowledge to other farmers, beginning with activities such as purchasing rice seeds, fertilizers, and so on, and continuing through the harvesting process.

The most common sort of ICT device for communication and information gathering is a smartphone, which is incredibly fast and simple to use. The attitudes of farmers regarding the usefulness and usability of ICT media are comparable between farmers with and without access to ICT.

The results of this study indicate a strong connection between farmer characteristics and the perception of ICT media's usefulness and ease of use among individuals aged 40 to 50. Furthermore, it was found that those with higher levels of education tend to hold a more positive view of the usefulness and ease of use of ICT media in their daily activities. This suggests that education may play a role in shaping an individual's adoption and appreciation of ICT. This finding aligns with the findings of previous research [35][36] which have demonstrated that education level can impact the adoption of ICT.

In addition, the Two-Means Independent T-Test of the PU and PEU variables indicates that farmer respondents are more concerned with the usefulness of ICT media as compared to its usability in daily activities. Therefore, to encourage greater adoption of ICT media among farmers, it is necessary to develop a training approach that allows farmers to understand and experience the benefits of these technologies. This conclusion has significant implications for the agriculture sector, as it suggests that agricultural cooperatives should provide ICT training to their members in order to enable them to fully utilize the benefits of digital platforms. It is also important to design a training program that allows cooperative staff to learn how to effectively use the system and meet the needs of their members. By offering ICT training, cooperatives can help their members gain the skills and knowledge needed to effectively adopt and use these technologies, ultimately contributing to the success and prosperity of the cooperative and its members.

Future study could focus on the method design and strategy for aiding small-scale farmers

in their adoption of digital technology, which could extend to the application of IoT, Machine Learning, and other technologies to precision agriculture.

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