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Adoption of Mobile Internet and the Implication on Palm Oil Productivity: Case Study in Siak Regency

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ABSTRACT

The mobile internet has already become an important technology due to the higher internet users and the several benefits of the adoption. However, the investigation on the adoption of mobile internet and the exploration of the internet adoption on palm oil productivity is relatively rare. This study aims to determine the factors influencing mobile internet adoption and its implication on the productivity of palm oil farmers. There are two techniques used to achieve the aim of this study, namely logistic regression and linear multiple regression. This research involved 119 palm oil farmers in Siak Regency. The result is that palm oil farmers' adoption of mobile internet is determined by education, training size, ease of use, and productivity. The mobile internet adoption has not significantly affected the productivity of palm oil farmers. This research only limited in mobile internet usage due to the higher of trend in this technology. Therefore, the further research could be applied by using another technology related on internet access.

1. INTRODUCTION

Internet adoption was recently developed for various needs, including the agriculture sector. The involvement of the internet in the agriculture sector leads to the development of information and communication for users. The growing demand for food, both in terms of quantity and quality, has increased the need for agricultural intensification and industrialization through the internet [1]. Specifically, the usage internet creates various benefits for farming activity, namely information about the weather forecast, market prices, purchasing input, and product sales [2]. Moreover, the positive trend of the global population implicates the transition from traditional farming to modern agriculture techniques [3]. Many developing countries in the global world are dependent on the agriculture sector, especially Indonesia. The agriculture sector in Indonesia contributed to the national economy by 13.2% in 2021 [4]. Several agricultural products in Indonesia contribute to economic income, namely rice, tea, palm oil, natural rubber, cocoa, and coffee, by exporting them [5]. The higher export contribution of the agriculture sector in Indonesia comes from palm oil, which reached the export share to the global market at 26,6% [6]. However, agricultural production in many developing countries depends on conventional farming, such as traditional methods, and lacks technological usage, implicating the downgrade of production [7]. Therefore, the agricultural output of developing countries could be utilized more effectively.

On the other hand, internet development currently penetrates almost all countries in the world, including Indonesia. It must be considered for application in agriculture due to the positive effect of internet users and secure internet servers on the agriculture value-added [8]. The trend of internet users also increased in several countries in the last two decades [9]. However, the specific information about the adopter of the internet by job classification needs to be more frequently investigated. Most internet access from the mobile phone is the new device to access information, commonly called Mobile Internet [10]. Based on a few previous studies, the adoption of mobile internet has also been explored in various case studies. Sekabira et al. [11] found that the gender, knowledge of ICT groups, and thought of ICTs benefit agriculture, family size, and land farmed previous season, affecting farmers' adoption of Information, Communication, and Technology (ICT) based market information services in Mayuge Smallholders, Uganda. Thar et al. [12] revealed the determinant of mobile phone application-based internet in Myanmar Farmers, including age, education, number of crops, degree of mechanization, and market distance. Hoang [13] stated that age, market distance, income, gender, credit participation, and training participation influence the adoption of mobile phones for fruit marketing. Specifically, some studies found the determinant of adopting technology in palm oil in Malaysia, Indonesia, and Thailand [14-16]. However, a specific study about the determinant of internet adoption in palm oil farmers is rare to utilized. Therefore, it is interesting to find that internet technology also contributes to the higher palm oil production in Indonesia.

Currently, many scholars have already examined the effect of internet on agriculture activities, especially in productivity [17-21]. Therefore, internet could be the key variable to improving the agricultural productivity for farmers. In this study, we also investigate the implication of the internet adoption on the productivity of palm oil farmers. The use of agricultural technology may have an effect on agricultural productivity although it might influence farmers' production

practices regarding the combination and utilization of various inputs, such as capital, labor, and fertilizer [22]. Specifically, the many researchers found the positive impact of internet adoption through mobile phone on productivity of smallholders. Mwalupaso et al. (2019) discovered that the effect of ICT usage on corn production in Zambia from mobile phone access have implications for farmers' technical efficiency. Khan et al. [22] found that the adoption of mobile internet is significantly increased the productivity of wheat farmers in Pakistan. The potential of mobile internet usage could increase the information exchange in agriculture actors, indicating the improvement of infrastructure and the decline of tariff must implemented to support the internet service [23]. However, Chavula [24] found that the mobile phone is not influence on the agriculture production in Africa, regarding the role of information and communication technology (ICT) on agriculture.

The role of internet on agricultural sector performance has already discussed by Suroso et al. [8] in global world scopes, found that the positive and significant of internet on agriculture value-added. The extended result in Suroso et al. [8] revealed that the significant and positive effect of internet on agricultural sector performance in developing countries. The development of internet through Decision Support System (DSS) can support some activities such as enterprises budget, financial projection, and valuation measurement [25]. The research about the adoption of mobile internet and its effect on the productivity of palm oil farmers in Indonesia is rare. The contribution of palm oil in Indonesia is higher, resulting the highest value of agriculture export in world [6]. The competitiveness of Indonesia palm oil relatively higher in firm and country level [26, 27]. Therefore, the investigation about the implication of technology on the palm oil productivity in Indonesia is important, providing the new information about the mobile internet in Indonesia palm oil farmers as the accelerator for agriculture productivity. It could be the beneficial information for policymakers to maintain the Indonesia palm oil competitiveness in farmer scopes. Based on the introduction, there is two objectives in this study as a follow: 1) investigate the internet adoption and determinants and 2) examine the impact of mobile internet adoption on the productivity of palm oil farmers.

2. METHOD

The research was conducted in Siak Regency because the area has the largest number of independent oil palm farmers compared to other districts. Siak Regency is also the center of palm oil production in Indonesia. The data collection process for this research was carried out from September to October 2022. The data collected in this study consisted of primary data from direct interviews with independent oil palm farmers through questionnaires covering inputs and outputs of oil palm farming. The sampling method of respondents in this study was carried out by accidental sampling. The sample is oil palm farmers in Siak Regency with their willing to participate in the research through met or contact online by researchers during the data collection process. The total population of oil palm farmers in the Siak Regency is 102,347 [28]. The margin of error used is 9 percent with a 95% confidence interval.

Based on the determination of the sample through Surveymonkey (https://www.surveymonkey.com/mp/sample-size-calculator), it could be found that the number of respondents is 119 independent palm oil farmers. First, we used the binary logistic regression was applied to determine the factors affecting the MIT adoption in independent palm oil farmers. The probability of MIT adoption is defined as a following:

$$Y(INT) = \alpha + \Sigma\beta_1 X_1 + \ldots + \Sigma\beta_n X_{n+} \varepsilon_i$$

where, Y(INT) is a dummy and dependent variable showing the adoption of mobile internet or not, quantified with 1 = adopters and 0 = non-adopters. α = intercept; $\beta 1$ until βn = coefficients of the independent variables indicating the influence of these variables on the likelihood of adoption; X1 until Xn is the independent variables and ε_i is the error term.

In this research, we used the several independent variables based on previous literatures, The binary logistics model in this research is extend as follows:

$$INT_i = \alpha_0 + \beta_1 AGE_i + \beta_2 FAM_i + \beta_3 EDU_i + \beta_4 FINS_i + \beta_5 TRAIN_i + \beta_6 SAFE_i + \beta_7 USE_i + \beta_8 PROD_i + \beta_9 LAB_{i+} \varepsilon_i$$

where, AGE_i is the age of individual i, FAM is the family size individual i, EDU_i is the education of individual i, $FINS_i$ is the financial support of individual i, $TRAIN_i$ is the amount of training in individual i, $SAFE_i$ is the perceived safety in individual i, USE_i is the perceived ease of use in individual i, $PROD_i$ is the productivity, LAB_i is the amount of labour in invididual i.

In second stage, we used the multiple linier regression to examine the MIT adoption and several factors on palm oil productivity. Before to estimate, the correlation matrix was carried out for check the multicollinearity, required the value from -0.8 until 0.8 [29], showed in Table 1. The multiple regression model in this research is as follows:

$$PROD_i = \alpha_0 + \beta_1 LAND_i + \beta_2 POA_i + \beta_3 LAB_i + \beta_4 FERT_i + \beta_5 FINS_i + \beta_6 INT_i + \varepsilon_i$$

where, $PROD_i$ is the productivity of palm oil in individual i, $LAND_i$ is the amount of land for palm oil in invididual i, POA is the age of palm oil owned by individual i, $FERT_i$ is the amount of fertilizer by individual i, $FINS_i$ is the financial support in individual i, INT is the adoption of MIT in individual i.

Table 1. Correlation matrix

	LAND	POA	LAB	FERT	FINS	MIT
LAND	1.00					
POA	-0.02	1.00				
LAB	0.18	0.13	1.00			
FERT	0.50	0.09	0.00	1.00		
FINS	0.13	0.05	-0.07	0.23	1.00	
MIT	0.12	-0.01	0.11	0.13	-0.04	1.00

Based on these variables in two regressions, we summarize all variables measurement into descriptive statistics by including symbol, name of variable, measurement and expected sign are explained in Table 2. In expected sign, we also provide several hypotheses of these variables in two subsections, namely 1) factors influencing the adoption of mobile internet and 2) the effect of internet on productivity as follows:

Table 2. Variables, measurements, and expected sign

Symbol	Variables	Measurement	Expected Sign (Model 1)	Expected Sign (Model 2)
AGE	Adopter's Age	Number of years in age	-	Not Involved
FAM	Family Size	Number of family	+	Not Involved
EDU	Adopter's Education	Type of education (1 = primary school or did not finish a school, 2 = junior high school, 3 = senior high school, 4 = bachelor or diploma degree and 5 = master degree or above)	+	Not Involved
FINS	Financial Support	Dummy variable (1 = there is a financial aid, 0 = otherwise)	+	+
TRAIN	Training Size	Number of trainings attended	+	Not Involved
SAFE	Perceived Safety	Dummy variable (1 = sense of safety to internet adoption, 0 = otherwise)	+	Not Involved
USE	Ease of use	Dummy variable (1 = sense of usefulness to internet adoption, 0 = otherwise)	+	Not Involved
PROD	Palm oil productivity	The amount of production per hectare (Ha)	+	Dependent Variable
INT	Mobile Internet	Dummy variable (1 = MIT adopted, 0 = otherwise)	Dependent Variable	+
LAND	The land of palm oil production	The amount of land area (Ha)	Not Involved	+
LAB	Labour involvement in palm oil production	Number of labours	Not Involved	+
POA	The age of palm oil	Number of years in palm oil age	Not Involved	+
FERT	Fertilizer	The amount of fertilizer usage	Not Involved	+

Factors influencing the adoption of mobile internet

Age of farmers (AGE) is expected to negatively influence on the adoption mobile internet of palm oil farmers. The intention to adopt a new technology has comes from farmer with younger age [30]. Moreover, the younger farmers are more likely adopted the mobile internet than older farmers [31]. The similar result also found in wheat farmers with age is correlated with mobile internet adoption [32]. The family size of farmers is expected to positively influence on the adoption of mobile internet. The farmer size has found that it could implicates on intention to adopt mobile internet [32]. The farmily with larger size also coordinate through internet due to monitor the information, including the agriculture market [11]. Education of the palm oil farmers (EDU) is hyphotesized to positively affect on the internet adoption. The higher education could increase the digital literacy through learning activities. The previous results also found the correlation of education and the adoption of internet [33-35]. In agriculture scopes, the educated farmers through secondary and tertiary education tend to adopt the new technology to improve the production [24].

Financial support (FINS) is expected to positively influence on the mobile internet adoption of palm oil farmer. Farmer with financial support could increase the expenditure due to larger income. The higher expenditure could implicate on the adoption of internet due to limitation for adoption are household expenditure and service price [36]. Training Size (TRAIN) is expected to positively affect on the mobile internet adoption. The farmer with higher participation in training more likely to adopt the mobile internet. The important role of training size contributed for adoption ratio of internet [37]. Furthermore, the several previous results revealed that the positive effect of training and the adoption of internet [38-40].

Perceive Safety (SAFE) is hyphotesized to positively influence on the adoption of mobile internet in palm oil farmers. The adoption of new technology is depended on the perceived safety of individual [41]. Cafer and Rikoon [42] discovered that 18% of farmers' performance was negatively impacted by a lack of training. The effectiveness of training could implicate the adoption of new practices in farmers [16]. It could be the mobile internet adoption of palm oil farmers. Ease of Use (USE) is expected to positively affect on the adoption of mobile internet in palm oil farmers. The ease of use is one of the main indicators for individual to accept the adoption of technology in farmers scope [43, 44]. The easy access to technology implicates the farmer likely to adopt in higher intensity for production due to less constraints to gain an internet adoption.

Productivity (PROD) is expected to positively influence on the mobile internet adoption in palm oil farmers. The higher productivity through the expansion of inputs could provide the income for the farmers, implicating on the higher expenditure [45]. The adoption of new technology needs several costs, including the mobile phone and monthly cost to subscribing. The size of labour (LAB) is hyphotesized to positively affect on the adoption of mobile internet in palm oil farmers. The higher involvement of labour caused the uncontrolled monitoring in production activities. The adoption of mobile internet provides the monitoring and control activity [46]. Therefore, the higher size of labour could implicate on the mobile internet adoption. Based on these expected results, the hyphotheses are showed as a follows:

H1: There is a negative impact from age on mobile internet adoption

H2: There is a positive impact from family size on mobile internet adoption

H3: There is a positive impact from education on mobile internet adoption

H4: There is a positive impact from financial support on mobile internet adoption

H5: There is a positive impact from training size on mobile internet adoption
H6: There is a positive impact from perceived of safety on mobile internet adoption
H7: There is a positive impact from ease of use on mobile internet adoption
H8: There is a postive impact from productivity on mobile internet adoption
H9: There is a positive impact from labour on mobile internet adoption

The Effect of Internet on Palm Oil Productivity

Land, palm oil age (as a two capital of production input) and labour are expected to positively influence on the productivity (called as LAND, POA and LAB). Commonly, it is the main input for farmer to produces output based on Cobb-Douglas production function [47]. The previous studies shown that these inputs are influence positively on the productivity of farmers [48, 49]. The other input, namely fertilizer (FERT) also expected to affect on farmer productivity, including palm oil farmers. The involvement of fertilizer in production can implicate on the higher production [50]. The consumption of fertilizer is one of the three indicators to affecting on agricultural productivity in Pakistan farmers [51].

Finance support (FINS) is expected positively to influence on agricultural productivity of palm oil farmers. The access of financial institutions or the other financial support can create the chance of farmer to increase the input variables. It could implicate the higher productivity due potential to optimize the input in production by providing the financial capital. The mobile internet adoption (INT) is hyphotesized to influence on agricultural productivity in palm oil farmers. The adoption of internet provides the advantages for farmer productivity through the new method for farming activities [52]. There is difference efficiency in farmers between internet adopted and non-adopted, indicating the internet can increase the production of banana [53]. The promotion of internet of thing (IoT) could increase the productivity of small farmers in Mexico [54]. Khan et al. [22] revealed that the impact of mobile internet technology on wheat productivity is positive and significant. Therefore, the adoption of mobile internet has a positive effect on the productivity. Based on the comparing of previous results, the hyphotheses are showed as a follows:
H10: There is a positive effect from the amount of land on the palm oil productivity
H11: There is a positive effect from the age of palm oil on the palm oil productivity
H12: There is a positive effect from labour on palm oil productivity
H13: There is a positive effect from fertilizer on palm oil productivity
H14: There is a positive effect from financial support on palm oil productivity
H15: There is a positive effect from mobile internet adoption on palm oil productivity

3. RESULTS

Descriptive Statistics

Table 3 shown that the descriptive statistics of palm oil farmer in Siak, including the demographic variables and mobile internet adoption.

Table 3. Descriptive statistics

Variables	Number	%
Age		
20-40	43	36.13%
41-60	54	45.38%
61-80	22	18.49%
Family Size		
0-4	91	76.74%
5-9	27	22.69%
>10	1	0.84%
Education		
Not Accomplished or Elementary School	34	28.57%
Junior High School	16	13.45%
Senior High School	44	36.97%
Bachelor or Similar degree	20	16.81%
Master or Doctoral Degree	5	4.20%
The Adopter of Mobile Internet	91	76.74%
The Non-Adopter of Mobile Internet	28	23.53%

The result of table revealed several information about farmers, including age, family size, education and the adopter of mobile internet. In age, the majority farmers are dominantly in 41-60 classification with 54 respondents or 45.38%. Furthermore, the family size from 0 until 4 is higher than other classifications with 91 respondents or 76.74%. In education, we found that the majority of palm oil farmers being our respondents is dominantly passed the senior high school with 44 respondents or 36.97%. The adopter of mobile internet in palm oil farmers from Siak is 91 respondents or 76.74%. On the other hand, the non-adopter is 28 respondents or 23.53%. Therefore, our sample relatively used the internet with dominant respondents.

In regression result, Table 4 and Table 5 are providing the logistic and multiple linier regression for achieving the research objectives, respectively. These results were distinguished into two subsections as a follow:

Factors Influencing the Adoption of Mobile Internet

Table 4 shown that the determinant factors in mobile internet adoption is education, training size, ease of use and productivity. However, age, family size, financial support, perceived of safety, and labour are not influence significantly on mobile internet adoption. This model could predict the effect of independent variable with Nagelkerke R-Square reached in 59% from four out of nine independent variables.

These effects are discussed by comparing with several previous results and sample condition. Education has found that this variable is influence positively and significant on the adoption of mobile internet. This result is similar with previous studies about the positive and significant effect [34, 35]. The previous result also noticed that the marginal effect of education on technology adoption significantly larger in large farms, indicating the formal education could be a barrier for technology adoption [55]. Furthermore, the role of education could increase the participant of smallholder to adopt the new practices, including the technology as the input for the productivity [56, 57].

The training size has found that the negative and significant on the mobile internet adoption in palm oil farmers, meaning that the higher training attended implicate the less intention to adopt the mobile internet. Technology provides several assistances for the farmer activities, implicating on the decline of training participation. Internet also provides the growing number of small-scale farmers to marketing our products [58]. In Production, there are several tutorials for farmers to

practically adopt from information through internet. The involvement of big data could increase the farmer production significantly in case of poultry industry [59].

Table 4. The logistic regression results

Variables	Coefficient	Standard error	P-value
Constant	-4.15*	2.45	0.09
AGE	-0.00	0.03	0.95
FAM	0.12	0.22	0.60
EDU	1.04**	0.50	0.04
FINS	-0.87	0.71	0.22
TRAIN	-0.23*	0.13	0.08
SAFE	1.15	0.81	0.16
USE	1.93**	0.85	0.02
PROD	0.01*	0.01	0.10
LAB	0.11	0.19	0.55
-2 Log Likelihood	70.52		
Chi-Square	15.70**		
Nagelkerke R-Square	0.59		

Notes: *, ** and *** are significant at 10%, 5% and 1%

Ease of use also found as one of the variables to influence positive and significant on the adoption of mobile internet. This result supported by comparing with several previous studies with similar results [60, 61]. The easy access in technology could implicate the likelihood to adoption in internet. The technology that is easier to use will cause users to be more interested in using it, including palm oil farmers. Ease of use also being the main variables for acceptance the technology [62].

The productivity in this research is found as the one of the variables to positively and significant influence on the adoption of mobile internet in palm oil farmers. The higher of productivity lead the higher income for farmers, implicating the higher opportunity to access the internet. The previous study also found the inverse effect with the internet could generate the productivity in many sector [63]. The involvement of new technology practices in farming activities also lead the adoption of mobile internet, indicating the concern of palm oil farmer productivity be required.

The Impact of Internet on Productivity

In Table 5, we found that the input variables such as land, palm oil age and fertilizer are positive and significant on productivity. Furthermore, the labour and financial support are not significant. Surprisingly, we found that the adoption of mobile internet has no significant effect on productivity. The model also predicted the effect of independent variable with R-Square reached in 54% from three out of six independent variables. Furthermore, this model is fit with F-statistic value significant at 1%.

The main indicator of output based on the three inputs, comprising the capital, labour and technology. In this study, we found that the two capital variables (land and palm oil age) and agriculture technology (fertilizer). This result also similar with previous studies about the positive impact of land on productivity [64-66]. Moreover, we also revealed that the palm oil age as one of the variables influenced on the productivity of palm oil farmers. Based on previous evidence, the age of seed or plant affected on the plant production [67, 68]. In Fertilizer, we also found the significant effect on the productivity of palm oil farmers. This result inline with previous studies with similar findings, indicating the usage of fertilizer could increase the productivity [69, 70].

Table 5. The multiple linier regression results

Variables	Coefficient	Standard error	P-Value
Constant	6.68	12.63	0.60
LAND	4.74***	0.61	0.00
POA	1.87***	0.71	0.01
LAB	0.24	0.24	0.33
FERT	0.11*	0.04	0.10
FINS	-13.28	10.13	0.19
INT	3.55	10.21	0.73
F-Statistics	22.29***		
R-Square	0.54		

Notes: *, ** and *** are significant at 10%, 5% and 1%

The adoption of mobile internet has no significant effect. This result is different from these previous studies [22, 54]. However, the adoption of mobile internet could classify into various scope of activities such as the marketing activities (price monitoring or selling activity) and the production activities (digital farming, related with the improvement of production). Through our survey in Siak, we found that the dominant farmers are non-adopters of internet on production activities with 67%. Furthermore, the adopters of internet for production only 33%, including the monitoring of palm oil and the digital farming application. Therefore, the activities of internet adopters are not related directly on production, implicating the adoption of mobile internet is not found on the productivity of palm oil farmers in Siak Regency. Internet could be the main object for supporting infrastructure, implicating on the implementation of palm oil industrial cluster [71]. The application of internet for palm oil (e-government) has been proposed by using the structural path analysis of the influences from smallholder oil palm plantation toward household income [72].

4. CONCLUSIONS

This study aimed to examine the adoption of mobile internet by palm oil farmers by identifying its determinants and implications on palm oil productivity. We addresed this issue due to higher production in Indonesia palm oil. It is means that does the mobile internet also contributed for this production and otherwise. In our research, we found that the adoption of mobile internet in palm oil farmers is dominant with 76.74% of our sample. The positive determinants of the adoption of mobile internet are education, ease of use, and productivity. However, the training size is determined negatively and significantly on the adoption of mobile internet. Moreover, we also found that mobile internet adoption does not influence the productivity of palm oil farmers in the Siak Regency. The majority of internet adopter is not related to production directly, indicating only 33% of adopters consider the mobile internet to improve the productivity.

Ease of use become the higher factor to increase the adoption of mobile internet due to accessible in the internet provides the interest to adoption. Furthermore, palm oil farmers relatively used the internet for other activities, exclude the production. There were three implications in this study. First, the consideration of infrastructure related on internet for boosting the internet adopter in palm oil farmers. The supporting of education and productivity also increase the adoption of mobile internet in farmers. Second, the promotion

of mobile internet for direct production activities due to improvement of adopters-related with this activity also found the positive and significant effect from previous studies. Third, the assistance of local government is needed by improving the infrastructure-related internet and utilizing the digital farming to increase the internet adopter for production activities. There is a limitation further direction in this research such as 1) the small sample used in this study based on the calculation of sample size, 2) only one regency is observed due to financial and time obstacles and 3) the exploration only based on socio-economic and factors related palm oil production. Therefore, the future research will be applied by investigating the acceptance of internet in palm oil farmers. For detail information about the adoption of mobile internet, we suggest the replication of this study in other country or region in Indonesia to gain the new insight about the determinant of adoption of mobile internet and its implication on palm oil productivity. Moreover, the exploration about palm oil productivity over time as the amount of Internet use changes must be considered in futher research.

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