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Factors affecting farmers' willingness to adopt a mobile app in the marketing of bamboo products

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ABSTRACT

Although the advent of new technologies and online platforms has revolutionized the face of marketing in agriculture sector, little study exists to assess the farmers' willingness to adopt (WTA) such technologies for their products. Here, we assessed this WTA for a mobile app – the Bamboost for marketing bamboo products and determined the related factors in municipality of Maasin in Iloilo province of Philippines, where 112 farmers were interviewed using the purposive sampling method. Extended Technology Acceptance Model was used to assess the WTA through the analysis of farmers' perceived usefulness (PU), ease of use (PEOU), innovativeness (PI), social influence (SI), Information Awareness (IA), cost (PC), and socio-demographic factors. We found that PU, PEOU, PI, SI, and farm size had positive correlation and statistically significance at 1% ($p < 0.001$). However, the perceived cost had significant negative influence on farmers' WTA because of their concerns about the overall cost such as costs for mobile data, transaction, and downloading. To promote the use of the mobile app such as Bamboost to farmers, it is important that government develop enabling policies to reduce the costs of the technology adoption, which could result in rural poverty reduction. Nevertheless, to increase wider adoption beyond the study area, study on farmers' perceptions at different locations and after the app is introduced can provide the needed information for a better-informed decision making that is beneficial to farmers as well as the technology suppliers.

1. Introduction

Agriculture remains one of the most important drivers of the economy. It provides food, income and employment opportunities particularly in the countryside where vast tracts of lands are cultivated. As a key sector in most developing countries, agriculture provides food for growing population, supplies essential raw materials and products for manufacturing services, serves as a major link in the input-output value chain, and supplies surplus labor to the industry service sector (Aquino et al., 2012). For developing and low income countries, small holder farming significantly contributes to food production and people's livelihood (Fan and Rue, 2020; Rapsomanikis, 2015). Although these farms account only for 12% of the world's farmland, they contribute 80% of the total food production in Asia and Sub-Saharan Africa (Lowder et al., 2016). As such, enhancing their productivity could reduce rural poverty, improve food security and nutrition at different levels, and contribute to the attainment of multiple Sustainable Development Goals (SDGs). However, smallholder farmers in most developing countries are beset with challenges in accessing market information, knowledge and skills that could improve their income (Chapagain and Raizada, 2017; Misaki et al. 2018; Petcho et al. 2019).

One way to effectively manage and address issues that hamper agricultural productivity and development is through the use of Information and Communication Technology (ICT), such as mobile phone applications by farmers (Krell et al., 2020; Mandi and Patnaik, 2019; Sharma et al., 2020) . ICT has also been regarded as one of the forces for positive change in agriculture and rural development. Studies by Khan Tithi et al., (2021), Ramli et al., (2019) and Verdier-chouchane and Karagueuzian (2016) showed that in areas where ICT was well utilized in agriculture, farmers are able to access agricultural information such as weather, recommended agronomic practices, and price information. With the advent of the internet and global interconnectedness, there is a great potential now to accelerate farmers' livelihood through technological innovation like mobile applications. Unfortunately, most farmers

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have not fully exploited these benefits. Challenges such as shortfalls in knowledge and skills to use mobile phones and applications, inability to afford mobiles, foreign languages used in applications, and network problems, among others hinder the effective use of ICTs in developing countries (Emeana et al., 2020; Hoang, 2020; Misaki et al., 2018; Sadekur Rahman et al., 2020). While mobile phone industry targets agriculture farmers, most studies focused on providing weather updates, information on pest and diseases, crop nutrients requirements, plant physiology, early warning systems and others. Studies on technology adoption and diffusion in the context of marketing of products are currently limited and there is almost none for the bamboo subsector. Along with an established market for bamboo products, the bamboo sub-sector has also been recognized for its potential as a building material (Kaur, 2018), feedstock for bioenergy, and for rehabilitation of degraded land (Sharma et al., 2018).

The Philippines is the sixth largest bamboo exporter in the world (INBAR, 2019). The country has more than 12 genera of bamboos (Razal et al., (2009)). Recently declared as a high-value crop by the Philippine government, bamboo resources provide a sustainable source of livelihood to people in the countryside. Philippine bamboo handicrafts include bamboo wooden products, baskets, purses, handbags and wallets . Locally, the main traded in the country are bamboo poles and sticks, bamboo shoots, bamboo woven products, engineered bamboo, bamboo furniture and fixtures, bamboo mats, and bamboo seats. However, despite the wide range of bamboo products that can be produced, bamboo supply chains are plagued with various challenges. According to the bamboo supply chain analysis conducted by Brown et al., (2015), the absence of market information is the essential problem confronting the industry. This in turn results in weak integration of operational relationships among economic actors in the bamboo supply chain. The report also revealed that bamboo farmers lack adequate information on the location of suppliers and specific requirements more favorable to the market, such as pole characteristics, volume and species of bamboo they need. On the other hand, farmers are unaware of the bamboo pole characteristics and quality needs of customers, forcing them to depend on the pole agents who dictate price and get much of the market margin. Kabbiri (2018) also noted that farmers, being at the upstream, are likely to be exploited by the other chain actors, especially the middlemen as they accept any price offered by them for their produce/commodity. If farmers, like others actors in the supply chain can keep themselves connected with direct and different markets, exploitation can be avoided.

Recently in the Philippines, there has been a proliferation of mobile phone-based apps and services in the agriculture sector (Bhattacharjee, 2013; Dormido and Malicdem, 2019; Qiang et al., 2012). This initiative is intended to help the farmers and increase their productivity. However, despite the fact that these technologies have a great potential in enhancing the farmers' marketing strategies as evidenced in the literature, this does not denote automatic adoption and usage by rural farmers. Hence, development of a pro farmer mobile application is needed to help the farmers in marketing their products. To do this, a thorough understanding of the farmers' willingness to adopt a mobile app is needed. So far, no research has been conducted in the country that looks at the perception and willingness of local bamboo farmers to adopt mobile application technology. Therefore, the objective of this study was to assess the willingness of farmers to adopt a mobile app in the marketing of agricultural products through the analysis of farmers' perceived usefulness (PU), Perceived Ease of Use (PEOU), and perceived innovativeness (PI) of the app; social influence (SI); information and awareness (IA); perceived cost (PC); and the factors affecting farmers' respective perceptions.

2. Technology acceptance model

Assessment of the user acceptance of a new technology has become an interest by the scientific communities (Mercurio and Hernandez, 2020; Pfeiffer et al., 2021). Several theories have been put forward to explain intention to use or adopt a technology. For example, Technology Acceptance Model (TAM), which was proposed by Davis (1989) has been widely used and empirically tested across studies on technology adoption. TAM is one of the most popular and accepted models in studying technology diffusion and acceptance due to the wealth of recent empirical support (Chuttur, 2009; Kabbiri, et al., 2018; Luarn and Lin, 2005; Rezaei et al., 2020). TAM was developed to inform the technology implementers whether or not targeted individuals would accept the new technology (Kabbiri et al. 2018). The main constructs of TAM include the PU and PEOU, attitude and behavioral intentions to use a new technology (Davis, 1989).

TAM was based from the psychological Theory of Reasoned Action (TRA) and Theory of Planned Behavior (TPB) and has evolved to become a key model in understanding predictors of human behavior toward potential acceptance or rejection of the technology. It has been widely adopted due to its simplicity and robustness, and extended by several researchers in the field of technology uptake. Several studies on technology adoption and information technology have concluded that TAM is valid in predicting individual's acceptance of technology (Kabbiri 2018). Nevertheless, researchers have stressed that TAM's constructs do not fully reflect the specific influences of technological and usage-context factors that may influence user's acceptance of technology (Wang et al., 2003; Luarn and Lin, 2005; Malhotra and Galletta, 1999). Kabbiri et al., (2018) stressed that main two constructs of TAM may not fully explain user's behavioral intention towards the use of mobile phones. Eventually, many studies were undertaken to examine for other factors which can predict uptake of mobile phones, especially in the agri-food sector (Luarn and Lin, 2005). Some studies assessed key factors of adoption, behavioral intention, and usage of a technology by individual users (Park and Pobil, 2013).

Extension of the original TAM by adding more constructs has been done in several studies to gain an even better idea on the likelihood of technology adoption. Researchers have extended the TAM and added constructs like trust, perceived playfulness, cognitive absorption, product involvement, and perceived enjoyment. Jeong and Yoon (2013) extended the model by adding perceived financial cost, self-efficacy and credibility in a mobile banking context. Along with trust (Muñoz-Leiva et al., 2017; Thanabordeekij et al., 2020), social image and perceived risk (Muñoz-Leiva et al., 2017) have also been added as new constructs of TAM. Hence, addition of other variables can help and enhance the prediction power of TAM (Rind et al., 2017). Since online marketing needs technologies related to mobile application use in agri-food sector, this study extended TAM by adding five measurement variables, namely perceived innovativeness (Tang and Chihui, 2009), perceived cost (Rind et al., 2017), socio-demographic characteristics (Luarn and Lin, 2005; Kabbiri et al., 2018), innovating factor for mobile phone technology in the agri-food sector (Mittal and Tripathi, 2009; Tadesse and Bahigwa, 2015), social influence, and information awareness, as additional constructs to analyze motivating factors for mobile app adoption of farmers in marketing bamboo products.

3. Study materials and methods

3.1. Study area and sampling technique

Selection of the study area was based on the abundance of bamboo resources and the extent of bamboo industry in the area. The municipality of Maasin in Iloilo Province, popularly known as the Bamboo Capital of the Philippines, was purposively selected for the research. Maasin Watershed is considered as a critical watershed and has been proclaimed as a watershed forest reserve. The area is dominated with *Bambusa blumeana* (commonly known as Kawayan tinik), hence, majority of the residents make their living out of bamboo resources. Bamboo is the main crop of the farmers in Maasin, and thus, their source of income. Bamboos are being transformed into products such as

charcoal briquette, barbecue sticks and toothpicks while some are on using bamboos for furniture and handicrafts. Farmers also use traditional practices in weaving bamboos into bamboo mats. The skills in weaving and propagating bamboo plantations for pole production were passed on from generation to generation. Based on the record of the Department of Environment and Natural Resources (DENR, 2018), there are about 1600 hectares of bamboo plantation found inside and outside the watershed area. These areas have also been a subject of many government programs and projects including DENR and Department of Science and Technology-Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development (DOST-PCAARRD) to assure the sustainability of bamboo resources and community development (Fig. 1).

3.2. Bamboost app and the household survey

Bamboost app is a mobile platform or online marketplace designed and developed for this study. Through the app, bamboo farmers can market their products right on the palm of their hands. It was being developed to connect bamboo farmers to local and international markets, impact investors who want to buy carbon credits to be carbon neutral and vice versa. The beta version was demonstrated using android smartphones. With this app, farmers can post and upload their bamboo products to attract more buyers and customers. With this application, farmers could get more profit and increase their income by eliminating the role of the middlemen who get most of the margin. They could also transact directly to the buyers and traders and negotiate fair prices for their products.

Prior to conducting the household survey, demonstration of the basic functions of the beta version of Bamboost app, a mobile app developed for the study, was done for the farmers in the targeted locations. Four meetings cum demonstration were conducted with the local farmers to demonstrate the features of the beta version of Bamboost app. Farmers with smartphones were selected as part of the study. Demonstration was done with the objective to provide the farmers with a closer look and get familiar with the feels and functions of the app. However, in times when the internet was weak, which posed a challenge in the area, the prototype version was also utilized. We were able to demonstrate the Bamboost app to 155 bamboo-farmer households. For the survey, purposive sampling method was used. Yamane (1973) formula with 10% error margin was used to determine the sampling size, which was 112 farmers. Farmers who own smartphones or share smartphones with the household members for all four barangays became part of the study. The sampling method was not done per "barangay" (the village or a smallest administrative unit in Philippine society) since not all 155 farmers who attended the meeting for demonstration possess smartphones.

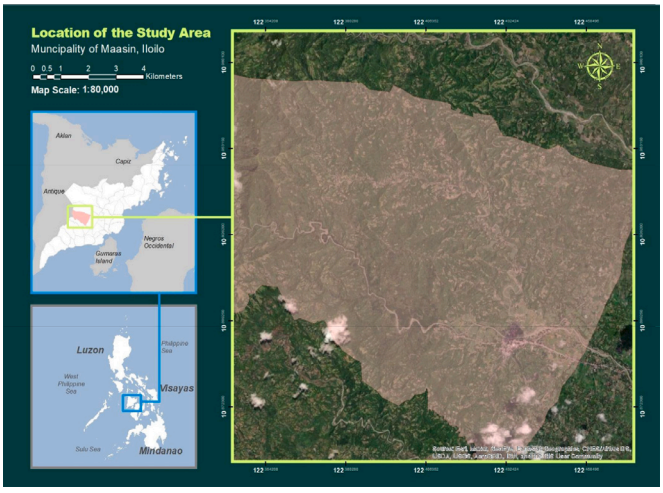

Fig. 1. Location map of the study area.

The respondents of this study included bamboo farmers who are members of the Katilingban sang Pumuluyo nga naga Atipan sa Watershed sang Maasin' (KAPAWA), a federated People's Organization (PO) at Maasin, Iloilo, Philippines. It is composed of upland communities and is formed under the Community-Based Forest Management Program of the DENR. The PO plays an important role as the government's partner in the establishment, conservation, management and protection of forest resources in Maasin Watershed. The KAPAWA-PO is the primary distributor of *Sawali (*bamboo mat*)* made by its member-cooperators. Around 1200 bamboo mats are sold by the PO monthly to different nearby provinces.

Based on the reviewed literature, a questionnaire was designed specifically for this study. This was utilized to determine and measure local farmers' willingness to adopt mobile app in marketing their products. The questionnaire consisted of two parts (see Supplementary Information). The first part captured the demographic and socio-economic characteristics of farmers while the second part assessed farmers' willingness to adopt, PU, PEOU, PI, SI, IA and PC. It consisted of open-ended and close-ended questions targeted to collect more detailed information regarding the research topic. Items and statements were based on existing literature on technology adoption and modified to fit the study area. Likert scales (1–5), ranging from "strongly agree" to "strongly disagree" were employed for most of the statements. Socio-demographic variables in the study included sex, age, educational level, income, farm size, farm ownership, number of smartphones, and internet usage, each with corresponding measurement type. These socio-demographic variables were measured as follows: disagree or neutral = 1, agree = 2, and strongly agree = 3.

3.3. Research model and hypotheses

This research model posits that willingness of farmers to adopt Bamboost app are jointly determined by PU, PEOU, PI, SI, IA, and PC and the socio-demographic factors that affected the farmers' perceptions. TAM's main constructs – the PU and PEOU were used as a baseline model while PI, SI, PC, IA, and socio-demographic factors were added as independent variables. Similar to other studies with the extended TAM, we eliminated the construct on attitudes (Chuttur, 2009).

Davis (1989) defined PU as the degree to which a person believes that using a particular system would enhance individual's job performance. As PU is one of the key constructs of TAM, an innovation of introduced technology with higher rate of PU, is more likely to have a positive use-performance relationship. PI construct identifies who among the farmers are relatively earlier adopters of technology compared to their counterparts. It helps to identify who tends to adopt to technological innovations early, which, in this case, the willingness to adopt mobile app (Agarwal and Prasad, 1998). SI was also used in several studies as a determinant factor that influences an individual to adopt or use the new technology. In the context of this study, SI is the perception that if most of the farmer's friends, relatives and those who are close would use the technology, he or she would also be influenced to use it.

Referring to the farmers' knowledge of the existence of the technology, IA is also a very important construct included in the extended TAM. The information and awareness of the famers could either be from the extension workers that assist the farmers and the different media platforms available to them. PC is also one of the important constructs in extending TAM. Most studies on technology adoption revealed that PC has negative influence to the actual usage of such technology (Wu and Wang, 2005). Lastly, socio-demographic factors such as the age, education level and farm size of farmers influence the adoption of smart phones (Michels et al. 2020). Factors such as education, farm size could also create discrepancies between small holder farmers and their counterparts in technology adoption (Caffaro and Cavallo, 2019).

3.4. Data analysis

Chi-square test of independence was used to determine the association between the local farmers' willingness to adopt the Bamboost app and categorical variables, such as sex and farm ownership. While Spearman's rank-order correlation was used to determine the association between the levels of the willingness to adopt (WTA) the mobile app and ordinal independent variables. Before performing logistic regression, the assumption of the absence of perfect multicollinearity was considered. The tolerance value and the variance inflation factor (VIF) were calculated based on the ordinary least squares model.

4. Results

4.1. Socio-demographic characteristics of local farmers

With 112 respondents, 68.7% were female, 39.3% completed the secondary school, about 57.2% spent more than 3 hours da^{-1} for internet usage. The detailed demographic profile of respondents is shown in Table 1.

The results showed that there are no variables significantly associated with the levels of WTA based on the corresponding *p*-values of the Pearson Chi-square.

Among the socio-demographic variables, age group and educational level have moderate positive correlation which was statistically significant at 1% level of significance while average monthly income and number of owned/shared smartphones have moderate correlation with the willingness to adopt mobile app. PU, PEOU, PI, SI, and IA have positive correlation which was statistically significant at 1% level of significance (*p-value* < 0.0001) (Table 2). Other variables such as farm size, number of smartphones, internet usage, and perceived cost are found to have no significant correlation with the willingness to adopt mobile app (Table 2).

To further assess how much the behavior of an independent variable has influenced or inflated the other independent variables, the tolerance value and the variance inflation factor (VIF) were calculated based on the ordinary least squares model. The results suggested no significant multicollinearity since there are no tolerance values less than 0.1 or no VIF greater than 10.

Table 1
Demographic profile of respondents.

Variable	Frequency	Percent
Sex		
Male	35	31.3
Female	77	68.7
Total	**112**	**100.0**
Age		
18-35 years old	39	34.8
36-55 years old	45	40.2
56 years and above	28	25.0
Education level		
Primary	46	41.1
Secondary	44	39.3
Tertiary	22	19.6
Average monthly income		
<USD200	94	83.9
≥USD200	18	16.1
Farm size		
1-3 hectares	92	82.1
3-5 hectares	17	15.2
More than 5 hectares	3	2.7
Farm ownership		25
Yes	28	
No	84	75
Internet usage per day	48	42.9
1-3 hours	56	50.0
3-5 hours	8	7.1
>5 hours		
No. of smartphones owned/shared per household		
1 unit	67	59.8
More than 1 unit	45	40.2

Table 2
Results of Spearman's rank-order correlation between local farmers' willingness to adopt mobile App and independent variables.

Variables	Correlation Coefficient	*p-value*
Age Group	-0.389**	0.000
Educational Level	-0.435**	0.000
Average Monthly Income	-0.195*	0.040
Farm Size	-0.910	0.342
Number of smartphones	-0.102	0.286
Internet usage	-0.028	0.713
Perceived Innovativeness (PI)	-0.493**	0.000
Information/Awareness (IA)	-0.308**	0.000
Social Influence (SI)	-0.339**	0.000
Perceived Usefulness (PU)	-0.352**	0.000
Perceived Ease of Use (PEOU)	-0.349**	0.000
Perceived Cost (PC)	-0.129	0.177

** Significant at $\alpha = 1\%$;
* Significant at $\alpha = 5\%$

After checking for multicollinearity, the ordinal response variable (i.e., WTA) was regressed to the independent variables using ordinal logistic regression. The proportional property of cumulative logit model was satisfied with perceived innovativeness of farmers, social influence of friends, co-farmers and relatives, perceived usefulness of the Bamboost app, perceived ease of use of the Bamboost app, perceived cost of mobile data, downloading and transaction cost, and farm size as significant predictors of the model. The model is fit at $p < 0.0001$.

4.2. Farmers' perceptions on PI, SI and PU

The ordinal independent variables were converted to a set of dummies before inclusion into ordinal regression. The ordinal regression has the following results, to wit: a farmer who is either neutral or disagrees about PI is estimated to be 0.055 times more likely to intentionally use the mobile app than when he/she strongly agrees about PI. Moreover, a farmer who is either neutral or disagrees about SI is estimated to be 0.990 times more likely to intentionally use the mobile app than when he/she strongly agrees about SI. Furthermore, a farmer who is either neutral or disagrees about PU is estimated to be 0.004 times more likely to intentionally use the mobile app than when he/she strongly agrees about PU. A farmer who is either neutral or disagreed about PEOU is estimated to be 0.010 times more likely to intentionally use the mobile app than when he/she strongly agrees about PEOU. A farmer who is either neutral or disagreed about PC is 0.033 times more likely to intentionally use the mobile app than when he/she agrees about PC. Finally, a farmer who has 1 to 3 hectares of farm is estimated to be 0.013 times more likely to intentionally use the mobile app than when he/she has 5 hectares or more of farm.

The data and the model predictions are similar and there is a good model. The pseudo R^2 values (e.g. Nagelkerke = 80.3%) also indicates that significant variables explain a relatively large proportion of the variation between respondents' WTA. The high R^2 indicates that the model containing these variables are likely to be good predictors of the WTA.

The proportional odds property of cumulative logit model was satisfied with PU, PEOU, PI, SI, PC and farm size as significant predictors of the model (Table 3).

5. Discussion

5.1. Perceived usefulness of the Bamboost app

Notions of increased profit and time savings of farmers were incorporated and associated with the perceived usefulness of Bamboost app in terms of marketing their products. The PU of Bamboost ($p = 0.004$) is

Table 3
Factors influencing farmers' willingness to adopt Bamboost app.

Variable	Coefficient		Std. Error	*p-value*
Sex (Male vs. Female)	-0.788		0.723	0.276
Age (36-55 years old vs. 18-35 years old)	-1.171		0.795	0.141
Age (56 years old & above vs. 18-35 years old)	-0.409		0.881	0.642
Educational attainment (Secondary vs. Primary)	-1.220		0.848	0.150
Educational attainment (Tertiary vs. Primary)	-0.146		1.101	0.894
Income (US$200.00 & above vs. less than US$200.00)	0.590		1.041	0.571
No. of Smartphones (More than 1 smartphone vs. 1 smartphone)	-1.025		0.746	0.170
Daily internet usage (3-5 hours vs. Less than 3 hours)	0.212		0.620	0.733
Daily internet usage (More than 5 hours vs. Less than 3 hours)	0.093		1.576	0.953
Farm size (3-5 hectares vs. Less than 3 hectares)	-0 .841		0.819	0.305
Farm size (More than 5 hectares vs. Less than 3 hectares)	-4.288	**	1.721	0.013
Farm ownership (Own a farm vs. Not own a farm)	-0.585		0.754	0.438
Perceived Innovativeness (agree vs. neutral/disagree)	-1.633	*	0.851	0.055
Perceived Innovativeness (strongly agree vs. neutral/disagree)	-19.723		0.000	.
Information Awareness (agree vs. neutral/disagree)	-1.003		0.783	0.200
Information Awareness (strongly agree vs. neutral/disagree)	0.277		2.160	0.898
Social Influence (agree vs. neutral/ disagree)	-2.042	**	0.801	0.011
Social Influence (strongly agree vs. neutral/disagree)	-0.023		1.763	0.990
Perceived Usefulness (agree vs. neutral/ disagree)	-1.669		1.573	0.289
Perceived Usefulness (strongly agree vs. neutral/disagree)	-5.586	***	1.955	0.004
Perceived Ease of Use (agree vs. neutral/ disagree)	-1.418	*	0.807	0.079
Perceived Ease of Use (strongly agree vs. neutral/disagree)	-3.223	**	1.252	0.010
Perceived Cost (agree vs. neutral/ disagree)	-1.986	**	0.946	0.036
Perceived Cost (strongly agree vs. neutral/disagree)	-2.780	**	1.303	0.033
Cut-off [1, 2]	-43.689	***	5.008	0.000
Cut-off [2, 3]	-37.059	***	4.249	0.000
Dependent variable: Willingness to adopt = Farmers' willingness to adopt Bamboost in the marketing of their products measured on scale of 1-3 (1=neutral/disagree, 2=agree, 3=strongly agree) Likelihood Ratio Test $\chi^2 = 135.717$ ($p < 0.0001$); $n = 112$				

*** - Significant at α = 1%.
** - Significant at α = 5%.
* - Significant at α = 10%.

statistically significant predictor variable of willingness to adopt of famers based on the results of logistic regression. Spearman's rank order correlation (*p-value* < 0.0001) also revealed that PU has statistically significant association with WTA. The findings corroborate with previous studies on technology adoption which provide evidences that people take up technology if they find it useful (Kabbiri et al 2018). This was somehow anticipated because some of the farmers were already marketing their other products in the KAPAWA Facebook Page and some of them have a first-hand experience in marketing online and most of the interviewed farmers know the usefulness and effectiveness of some mobile applications such as Lazada, Shopee, and Facebook in extending their reach to a wider market. However, some of the farmers also expressed their reservation in using the mobile app due to the absence or weak internet connectivity in the study area, indicating the urgent need to provide the intervention and action from the concerned stakeholders to accelerate farmers' uptake of this technology. Generally, farmers believed that by using Bamboost, they could effectively sell their products, reach wider market, and gain more income.

5.2. Perceived ease of use of Bamboost app

Based on the results of the ordinal logistic regression (p= 0.079), PEOU of Bamboost has a positive significance to the willingness of farmers to adopt in marketing their bamboo products. Spearman's rank-order correlation test also revealed that PEOU has significant association with WTA with *p-value* < 0.0001. Most farmers found Bamboost as easy and convenient to use in terms of account registration, uploading of product photos, and exploring navigation keys. The positive and significant results for the PEOU variable in the model indicate that the greater the degree of ease of use of Bamboost, the greater the likelihood that those bamboo farmers are willing to adopt the mobile app. They also believe that it would be more effective if they use Bamboost when they market their products online. The word "Bamboost", according to some respondents connotes that the products that they are marketing are from bamboo, hence, customers would have a so called "recall" for the products and the mobile app itself. Other farmers also shared that using a specific mobile app for niche products like Bamboost would be more effective in marketing. Some also narrated that it would help them attract more customers at the same time compared when using Facebook in selling online.

Our results corroborate with past empirical works conducted by Kabbiri et al. (2018) on the use of mobile phone in Sub-Saharan Africa farmers in agri-food sectors. PEOU of technology was also found to have significant and positive effect on both PU and behavioral intention (BI) to adopt mobile banking and internet banking (Chuttur 2009; Wu and Wang 2005). This implies that for the technology to be adopted, it must be easy to use. This perception is very important for all stakeholders especially for the government and the mobile phone industry by working together to provide local farmers with pro-farmer mobile apps that would help them in their marketing activities. Interview with farmers and narratives from focused group discussions also suggest that they prefer a user-friendly mobile app since some of them are not really tech-savvy and some need assistance in terms of exploring and using mobile apps and the internet. A pro-farmer app like Bamboost would therefore be essential so other farmers could participate.

5.3. Perceived innovativeness of farmers

For the PI of farmers (p=0.055), the results of ordinal regression show that it is statistically significant to the willingness of farmers to adopt. Spearman's rank order correlation also signifies that PI has significant association with WTA ($p < 0.0001$). This is consistent with the studies of Agarwal and Prasad (1998), Hung et al., (2003), and Alalwan et al. (2018) who argue that PI is a vital factor that mediates perception in the decision to adopt ICT. These authors found that the higher the PI of farmers, the higher is the probability that the farmers would adopt the technology. This could be attributed to the demographic characteristics of the respondents whose majority of the respondents belong to age group 18-35 years old (35%) and 36-55 years old (40%), and 59 percent of them reached secondary school and tertiary level of education. Most interviewed farmers belonging to these age groups responded positively on using the mobile App once it becomes available. This could be because younger and more educated individuals are by nature more willing to take the risk of trying out an innovation while others are suspicious of a new idea and hesitant to change their current practice.

5.4. Social influence

The results show that SI has a positive significance to the willingness of farmers to adopt Bamboost with a p=0.011 based on ordinal logistic

regression. In addition to this, Spearman's rank-order correlation test generated a $p < 0.0001$. The results are consistent with the study of Aker (2011) and Hakkak (2013) who found that SI had significant influence on farmers' intention to use mobile apps and its actual usage. The opinion and views of their friends, co-farmers and relatives or people close to them are important for the decision of farmers to adopt. In this study, majority of the interviewed respondents stated that if their co-farmers and friends were willing to use the technology, they tend to follow suit.

5.5. Perceived cost of using Bamboost app

Based on the results of this study, PC of using Bamboost app had a significant negative influence to the willingness of farmers to adopt mobile app. At 5% significance level, the *p-value* generated was 0.033 which means that farmers will not likely adopt Bamboost app in the marketing their products because of the cost attached to it. Most farmers had apprehensions about the cost of mobile data or internet that may incur while using it. As mentioned earlier, this also pertains to the monetary price attached to the app that will be paid by the farmers before downloading the app from an app store. Studies on ICT adoption reported that most smallholder farmers are cost wary and most of them tend to be sensitive to the slight fluctuations on services fees of certain commodity or technology (Okoroji 2019). Some farmers still expressed their willingness to use Bamboost since they could find a way to connect to the internet for free. The local government unit provides free Wi-Fi in public places where everyone, especially students can connect at no cost.

5.6. Information awareness

Most farmers have gained trust on government extension workers who have been assisting them for several decades already, from community organizing activities to protection of the watershed. As mentioned previously, respondents are members of KAPAWA Peoples' Organization who were recipients of several government programs since early 1990s. DENR is the main government office which leads project implementation within the Maasin Watershed. Among these are watershed rehabilitation, forest maintenance and protection, riverbank rehabilitation, reforestation, nursery establishment and many others. Meanwhile, DOST-PCAARRD has also supported several programs on bamboo production, marketing and ecotourism showcasing bamboo plantation and products of the farmers. Hence, in terms of correlation, it is not surprising that IA in the context of this study, had significant positive relationship with the WTA levels of Bamboost based on Spearman's rank order test.

The findings of this study are consistent with the works of Arslan et al. (2014), Jumbe and Nyambose (2016) and Ntshangase et al., (2018) who stressed that farmers who were frequently visited and assisted with extension workers are more likely to adopt technologies or farming practices. In this case, opinions, views and reviews of extension workers about mobile apps are important to the farmers and would influence their decision making regarding their adoption of the mobile app. The result could also be attributed to the strong influence of different online platforms to the farmers. Since most of the interviewed farmers are aware of the different mobile Apps like Facebook, Lazada, YouTube, they are willing to adopt the technology. They are aware of the existence of KAPAWA Facebook Page which the PO is utilizing as a platform in marketing their bamboo mats to different provinces. This study further highlights that the as the IA increases, the likelihood of installing and using it by farmers also becomes higher, hence, the positive significance. However, when IA variable was regressed to the levels of WTA, the results show that it is not one of the predictors of outcome variable WTA.

5.7. Socio-demographic characteristics of farmers

In this study, age of farmers, education level and income were significantly correlated with the willingness to adopt Bamboost mobile app, while gender, farm ownership, farm size, internet usage and number of smartphones was not significantly correlated with the willingness to adopt the app. This result is consistent with the study of Poushter (2016) and Alampay (2006) who affirmed that there's a significance influence of age on the use of ICT. According to Poushter (2016), groups belonging to Millenials of Generation Y and Generation X tend to own and use smartphones that their older counterpart. With respect to education and income study by Alampay (2006) in the Philippines, the results emphasized that the use of ICT is more pronounced to those who are well-educated and have higher income than those who have less.

However, when these variables were regressed to the levels of WTA, the results show that only farm size (p0.013) appeared as one of the predictors of outcome variable WTA. Farmers in the study area who possess more than 5 hectares of land are more likely to adopt Bamboost than those farmers who possess smaller land area. This result is consistent with the work of Mittal and Mehar (2016) who investigated the factors that influence farmers' adoption of ICTs for marketing in India. They found out that farmers with higher education and larger farm size tended to use ICTs for marketing than those with a lower education level and smaller farm size.

6. Conclusion and recommendations

This study assessed the willingness to adopt a new mobile App by bamboo farmers in Maasin, Iloilo, Philippines using the Technology Acceptance Model. We found that farmers were willing to adopt the bamboo mobile app. Their adoption is positively affected by the perceived ease of use of the technology, perceived innovativeness, and social influence of friends, co-farmers, and relatives. On the other hand, farmers' willingness to use Bamboost is negatively affected by the cost attached to the use of technology in terms of mobile data, transaction, and downloading costs. Smallholder farmers are cost wary and most of them tend to be sensitive to the slight fluctuations on services fees of certain commodity or technology.

Therefore, access to internet and improvement of existing mobile ecosystem in the area need to be the focus of the government's programs and policies in order to successfully implement farmers' adoption of mobile app as well as to reduce the rural poverty through the increased access of the local products to the market. Through a Public-Private Partnership (PPP) program, the concerned stakeholders could work hand-in-hand with the private sector to provide efficient and affordable internet infrastructure for the farmers. It is also important that the policy makers formulate relevant plans that would empower the smallholder farmers in the rural areas by maximizing the benefits of advanced technology like mobile apps in marketing their produce to increase their market access. Modern and digital technology, if properly adopted, promises a transformative impact in agriculture from farm production to marketing. It is also a critical enabler that can translate agricultural challenges into economic benefits. Harnessing these benefits would also enhance the gains of Republic Act number 8792, otherwise known as the Electronic Commerce Act (ECA) which aims to facilitate domestic and international dealings, including marketing, transactions, arrangements, agreements, contracts and exchanges and storage of information through the utilization of advanced technologies.

While this study advances the knowledge in the area of technology adaption in agriculture, it is not without limitations. First, assessment was done prior to actual selling and marketing of the farmers' bamboo products. Their perceptions would be different after they use the Bamboost app as they might encounter other issues. Future study of farmers' perceptions after Bamboost is introduced to use would provide clearer conclusion on their perceptions for future improvement. Second, more study sites and larger sampling size could provide more accurate assessment of the farmers' perceptions to aid a better-informed decision making toward introduction of the Bamboost app for real-world

applications.

CRediT authorship contribution statement

Analiza C. Diaz: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Visualization, Writing – original draft, Writing – review & editing. **Nophea Sasaki:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Visualization, Writing – original draft, Writing – review & editing. **Takuji W. Tsusaka:** Supervision, Software, Validation, Writing – review & editing. **Sylvia Szabo:** Supervision, Software, Validation, Writing – review & editing.

Declaration of Competing Interest

There are no conflicts of interest to declare.

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Supplementary materials

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