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ICT ADOPTION BY SOUTHERN THAI RUBBER PLANTATION SMALLHOLDERS

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Abstract: *The ASEAN economies of Thailand, Vietnam and Indonesia account for about two-thirds of the world's rubber output, with Thai rubber production being only second to rice as an important economic component of GDP. As such, government agencies have made many efforts to introduce ICT technology into the agricultural sector including technology transfer programs, e-services and e-libraries with limited success. Additionally, given the continued plunge in global rubber prices and the associated hardships being encountered by rubber farmers, the importance of understanding ICT's role and use in this sector cannot be overstated. This research therefore was undertaken to explore the components hindering or enhancing the ability of Information and Communication Technology adoption with Thai rubber farmers. This study aimed to examine empirically whether socio-economic variables and farmer's perception have a systematic link with the adoption of ICT services by employing the Technology Acceptance Model (TAM). Data were gathered from a questionnaire distributed to three adjoining provinces in rural southern Thailand between December 2013 and May 2014 of which 264 small rubber farmers were surveyed. The findings reveal that socio-economic variables have indirect effects on ICT adoption via the perceptions of rubber smallholder's households. Significant perceptions include the perception of usefulness, perceived quality, social influence and facilitating conditions. Possible policies to promote more ICT adoption among rubber smallholders are also discussed.*

Keywords: *ICT adoption, perceived usefulness, perceived quality, rubber smallholders, Thailand*

1. INTRODUCTION

Agriculture can serve as an important engine for economic growth in developing countries with Thailand being no exception. Today, rubber is only second to rice as an economic crop and at the end of 2011, Thailand had become the world's leading producer of natural rubber (OAE, 2011) as well as the world leader in rubber wood production and export. Rubber plantation areas have been increasing in Thailand in recent years with more and more plantations appearing in areas not normally associated with rubber production such as Thailand's east and northeast regions.

Thailand however continues to ever increase its rubber plantations and today these farms exceed the areas of forest plantations in the country. According to

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Thailand's OAE (2011), the total area of rubber plantations in Thailand was 3,001,760 hectares (ha) in 2011 with the majority of rubber farmers being 'smallholders' making up nearly 95% of total rubber plantations in the country (RRIT, 2010).

All is not well however in this agricultural space as in 2013, natural rubber futures prices in China plummeted by 41.2% over 2011 (Reportstack, 2014). Since 2011, the global natural rubber global market has remained oversupplied with surplus amounting to 220,000 tons in 2011, 410,000 tons in 2013. According to IRSG (2014), a Singapore-based organization that includes 36 producing and consuming countries, 2014's production surplus will exceed last year's 714,000 tons (a higher estimate than Reportstack). Additionally, The Rubber Economist Ltd., a London-based industry adviser, estimated the glut at 652,000 tons, or 78 percent larger than what it expected in December. While Thailand probably will cut production by 80,000 tons to 4.06 million tons this year, the combined output of Indonesia and Vietnam will rise by 97,000 tons to 4.13 million tons, The Rubber Economist estimates. The three countries account for about two-thirds of world output (The Rubber Economist, 2014) and affected by this, global natural rubber prices will continue to fall.

In this study, the term smallholding is used to refer to family-owned small rubber plantations. The Department of Agriculture (DOA) of Thailand has classified smallholdings, medium-sized holdings and estates as those where rubber area is less than 8 hectares, 8-40 hectares and more than 40 hectares, respectively (Pratummintra, 2005). According to Courtenay (1979) , the smallholding is usually family-owned, managed by the family head and worked by family labor. The plantation in turn is frequently owned by a company or a government enterprise, and usually professionally managed (Courtenay, 1979). These statistics follow the global trend in 'smallholder' farms with an estimated 500 million *smallholder* farms now located around the world supporting almost 2 billion people (IFAD, 2014). For this research, the term plantation is, however, used to refer to any organized planting regardless of size and management.

The rubber tree is a major crop for smallholders in Thailand and an important commercial crop everywhere in Southeast Asia. It is grown for latex production, while rubber wood is considered as a secondary product. Therefore rubber is regarded as an agricultural crop. However, recent improvements in wood technology have led to rubber tree becoming increasingly important as a source of wood products (Evans and Turnbull, 2004). Rubber wood has enjoyed an environmentally friendly reputation as a raw material, because it is a by-product of latex production, and when grown in renewable plantations, it can substitute timber from natural forests.

In addition to the existing oversupply problem, rubber prices can be affected by other factors such as uncertain socio-economic and environment conditions.

These factors can include rubber price oscillation and climatic variation. Even as recent as September 2014, Thai farmers were told to prepare for severe drought during the upcoming dry season (The Nation, 2014).

Other factors beyond the environment and climate that affect Thai rubber farmer smallholders households are labor constraints in terms of both quality and quantity which can also be higher that other ASEAN (Association of Southeast Asian Nations) members. The rubber smallholder is also currently supported by the Thai government, in forms of technology and production inputs including seedlings, land preparation and fertilizer. Moreover, the government has attempted to overcome some of the perceived information failures related to adoption via agricultural extension services, i.e. technology transfer programs, e-services, e-libraries, etc., but unfortunately Thailand is still very young in terms of agricultural ICT adoption.

Bailee, Chockchaisawadee, Putthongsri, Jitthaisong and Bailee (2008) showed that the most common form of ICT use by a Thai rubber planter was to access news and information from traditional media such as television and radio. Nikomborirak and Pongsukcharoenkul (2011) also confirmed that productivity of the agricultural sector is low due to four main factors including deteriorating soil quality, an insufficient water source, a suboptimal scale of operation and logistics cost. In each product supply chain case, ICT is applied to enhance the productivity or cut production costs borne by farmers. The water management case does not focus on the use of ICT in any specific agricultural supply chain but rather, illustrates the use of ICT to improve the management of agricultural production.

Another important step is education in the use of ICT and according to Nikomborirak and Pongsukcharoenkul (2011), almost 85% of Thai farmers have only completed primary education. Which such little education, Thai farmers are easily exploited by the middleman or other parties in the supply chain. For example, rubber is sold in multiple forms and the determination of its prices depends upon a multitude of factors. The information on prices is often passed down the value chain and cheating is easy during this process but according to De Silva and Ratnadiwakara (2008), mobile telephony can help make farmers better off.

Thailand's National Statistical Office (NSO, 2012) also reported large gaps between people who work in the agriculture industry and other industries in term of using computers and internet usage. NSO research determined that urban mobile phone consumers in Bangkok had a higher percentage of mobile phone ownership (80.0%) compared to southern and northern region consumers which only had 67.8% and 64.1% respectively.

Hence, this study aims to examine empirically whether socio-economic variables and farmer's perception have a systematic link with the adoption of ICT services, in particular mobile phones, by employing the Technology Acceptance

Model (TAM) model. The findings should be of interest both to academics and practitioners. From a theoretical perspective, this study provides a model for identifying antecedents of user intentions as a contribution toward the larger effort to adopt ICT in the agricultural sector. From a practical standpoint, the findings should guide an industry that is promoting ICT as a tool to attract farmers by enhancing usability and accessibility, as well as ensuring quality. The findings offer insights into the implications of farmer's adoption of ICT as a tool in their job as well as helping government and policy makers face their challenges and find opportunities in developing new forms of ICT that will better promote ICT solutions and adoption in the agricultural sector.

2. PRIOR STUDIES

There are various competing theories in existing literature used by information systems researchers to assess a user's intention to adopt and accept new technologies. Among the models that have been proposed probably the best known is the Technology Acceptance Model (TA) which was originally proposed by Fred D. Davis in 1986 (Davis, 1989), whose model and variants are still widely used by many authors today. The TAM has corroborated a theoretical model to help explain and predict user behavior towards information technology (Legris and Collerette, 2003) and is considered an extension of the Theory of Reasoned Action (TRA) proposed by Ajzen and Fishbein (1975, 1980). In fact, TAM was an adaptation of the TRA, proposed as an explanatory model for why a user accepts or rejects information technology.

Several theories, specifically over the conceptualization of the technology acceptance model (TAM) have emerged and they have been applied in different contexts to investigate new insights into the acceptance behavior at individual and organizational levels. However, despite TAM's maturity and validity in different contexts, very little published literature strives to extend its capability to predict farmer's acceptance behavior about ICT. A possible rational for this gap may be conceptualization of the TAM under which individuals' acceptance behavior can only be predicted with two beliefs: perceived ease of use (PEOU) and perceived usefulness (PU) (Legris, Ingham & Collerette, 2003). The evidence in literature shows that PU and PEOU beliefs are not sufficient; hence, they may not explain farmers' ICT acceptance behavior in emerging contexts, such as in a developing nation such as Thailand. The key purpose of TAM is to provide a basis for tracing the impact of external variables on internal beliefs, attitudes and intentions. It suggests that perceived ease of use (PEU), and perceived usefulness (PU) are the two most important factors in explaining a systems use.

Flett, Alpass, Humphries, Massey, Morriss and Long (2004) sought to determine whether TAM could adequately explain adoption and use of dairy farming technologies. Their finding revealed that perceived usefulness (PU) and perceived

ease of use (PEU) are significantly greater for farmers using technologies compared to those that are not.

Similarly, De Silva, Ratnadiwakara and Zainudeen (2011) showed evidence for the importance of social influence in mobile adoption in two modes: one that exerts pressure on individuals to adopt, and another that helps to generate benefits via social networks that are tied in with economic and business networks. The research elaborates on the resulting social policy implications for using mobile telephone services to fight poverty at the BoP in these and similar countries.

The TAM has been continuously studied and expanded-the two major upgrades being the TAM 2 (Venkatesh & Davis, 2000 & Venkatesh, 2000) and the Unified Theory of Acceptance and Use of Technology (or UTAUT, Venkatesh, Morris, Davis and Davis, 2003). A TAM 3 has also been proposed in the context of e-commerce with an inclusion of the effects of trust and perceived risk on system use (Venkatesh & Bala, 2008).

The UTAUT model states that the key determinant factors of usage intention and adoption are performance expectancy, effort expectancy, social influence and facilitating conditions. At the same time demographic factors such as age, gender, experience and voluntariness of use are mediating factors in the impact of usage intention and adoption. Van Biljoin and *Kotzé* (2008) employed the UTAUT model to examine mobile adoption and concluded that mobile adoption is influenced by demographic, social, cultural and contextual factors.

Zhou (2012) studied the use of location-based services (LBS) drawing on both perspectives of Unified Theory of Acceptance and Use of Technology (UTAUT) as well as privacy risk to examine user adoption. The results indicated that usage intention is affected by both enablers such as performance expectancy and inhibitors such as perceived risk. This implies that service providers need to concern both perspectives of technological perceptions and privacy risk in order to facilitate user adoption of LBS.

Lai and Lai (2014) examined the positive and negative factors that can significantly explain user acceptance of mobile commerce (m-commerce) in China. A technology acceptance model for m-commerce with five factors was constructed and concluded that the acceptance of m-commerce is influenced by the factors including performance expectancy, social influence, facilitating conditions, and disturbance concerns; while effort expectancy is insignificant in this case.

In addition, Touray, Salminen and Mursu (2014) identified relevant elements of Internet adoption at the user level in Gambia through UTAUT. Results suggested that Internet adoption at the user level in Gambia can be viewed as a three-layered pyramid. It consists of seven moderating factors (age, gender, experience, voluntary use, friends' influence, Internet service providers and regulators), four indirect

determinants (performance expectancy, effort expectancy, social influence (SI) and facilitating conditions (FC) and three direct determinants (education, behavioral intention and income).

Shin (2012) examined consumer acceptance of technological innovations and determined that it is crucial to marketing strategy and policy development. Using a context-specific extension of the Technology Acceptance Model, mVoIP acceptance was investigated based on the salient belief of perceived usefulness, perceived ease of use and facilitating factors. The results showed that quality factors of mVoIP significantly influence the usefulness and ease of use, which subsequently affect the adoption of the technology. Call and service quality were found to be significant factors as well, followed by mobility and coverage.

In summation, the prior studies show that TAM and UTAUT provide an extremely useful theoretical tool for understanding how peoples' technology acceptance level impacts their intention to use. There have been various models developed for integrating TAM and TAM has gained popularity across many sectors, but there is a gap for applying TAM in the agriculture sector. This study therefore discovers the adoption of ICT, in particular mobile telephony, by investigating southern Thailand ICT usage by rubber plantation smallholders.

3. HYPOTHESIS DEVELOPMENT

The farmer perceptions of technology characteristics significantly affect their adoption decision (Adesina, Baidu-Furson, 1995). De Silva and Ratnadiwakara (2008) found that the total transaction costs are 15 percent of total cost that smallholder vegetable farmers in Sri Lanka confront with. They analyzed further and also found that the information search cost amount to 70 percent of total transaction cost. It is possible to assume that if the farmers use ICT by simple phone call, the transaction cost would reduce substantially. Similarly, Jensen (2009) presented that price dispersion was dramatically reduced with introduction of mobile phone in fisheries sector while the fisherman's' profit increased. However, Wijerathna (2011) noted that despite the farmer had access and familiar with the telephone, their level of awareness on various existing telephone based agrarian service was low.

Aubert, Schroeder and Grimaudo (2012) tested a model explaining the difficulties of precision agriculture technology adoption. The model draws on theories of technology acceptance and diffusion of innovation and is validated using survey data from farms in Canada. Findings highlight the importance of compatibility among PA technology components (PU and PEU) and the crucial role of farmers' expertise. Pick, Gollakota and Singh (2013) employed TAM framework to understand factors that influence adoption and use of information technology by farmers. Their results support the dimensions suggested by Rogers: relative advantage, compatibility, low complexity, and observability, while also

supporting the TAM factors of usefulness and ease of use. Accordingly, the hypotheses are;

H1: PU has positive effect on ICT adoption

H2. PEU has positive effect on ICT adoption

Interestingly, De Silva *et al.* (2011) showed that social influence (SI) plays a key role in mobile adoption in developing countries including Thailand. This confirmed that mobile provide a direct channel to provide services and have significant potential to extend social policy initiatives to the most rural and/or excluded group in society. As the study of Islam and Grönlund (2011), they investigated the factors influencing the adoption of mobile telephony among farmer in Bangladesh. Their findings confirmed that SI plays a bigger role than technology at the early stage of adoption. López-Nicolás *et al.* (2008) confirmed that SI encourages people to use a technology, though it has indirect impact on their adoption, via PU and PEU. Based on this, the hypotheses are;

H3a: SI has a positive effect on PU

H3b: SI has a positive effect on PEU

Dey *et al.* (2013) examined the factors that influence Bangladeshi farmers' acceptance of mobile telephony. The findings suggest that the intention to accept a new technology is determined by users' positive perceived value (PU), perceived ease of use (PEU) and the availability of social (SI) and infrastructural support (PEQ). Shin (2010) analyzed that perceived of quality (PEQ) in mobile phone service, i.e. call, service, mobility and coverage, affect on the Intention to use the mVoIP service. Shin (2010) considered context-specific as a part of external variables since several previous studies confirmed that relevant quality variables (call, service, mobility and coverage) can be proposed as ICT-specific factors (Mallat *et al.*, 2008; De Reuver, Bouwman, De Koning & Lemstra, 2009; Negi, 2009; Teng & Yu, 2009). Thus, the hypotheses are posited as following;

H4a: PEQ has a positive effect on PU

H4b: PEQ has a positive effect on PEU

TAM was developed for organizations where infrastructure and cost did not concern the user (Pedersen, 2005). As for farmer, availability of technology training programs, knowledge, supporting services could be counted as facilitating conditions (FCs). FCs play an important role on both diffusion and adoption of new information systems (Jain and Hundal, 2007; Seneler *et al.*, 2008). For example, in a study exploring WAP services adoption behavior in Taiwan, it is found that facilitating conditions are one of the critical factors influencing the adoption behavior (Lu, Chun-Sheng, & Chang, 2005). Similarly, Kim (2008) found that the FCs in term of funding play an important role for Smartphone adoption.

H5. FC has a positive effect on ICT adoption

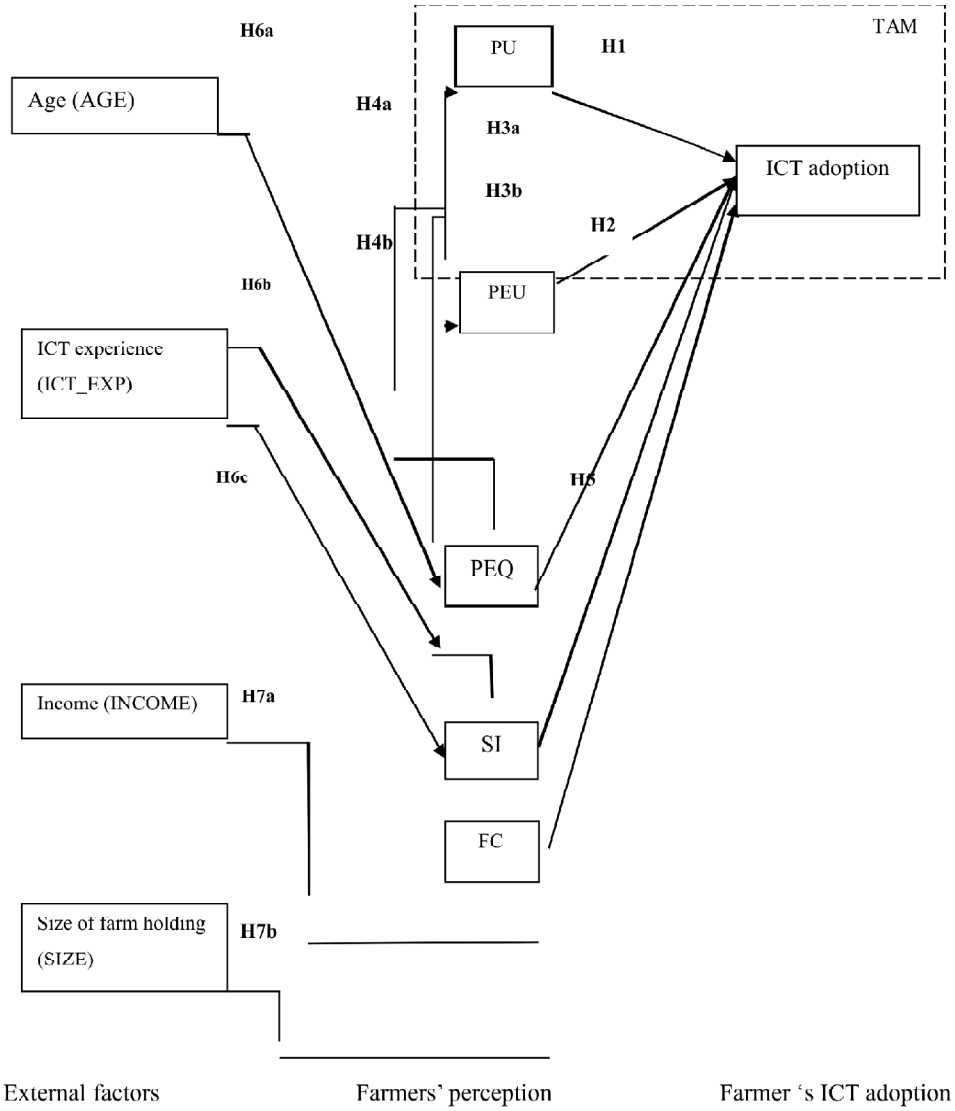

Figure 1: Conceptual Framework of determinates of ICT adoption by southern Thai rubber plantation smallholders

There are studies that claimed that demographic factors (gender, age and IT experience) and socio-economic factors (income and size of farm holding) acted as either determining factor or mediating factor on TAM and adoption. These factors influence the adoption vary from sector to sector and investigated country as well. Specifically, the influencing of demographic factors (gender, age, education and IT experience) on technology adoption not only ICT have been found and confirmed by many studies.

The impact of gender, age and ICT experience on adoption has been discussed by (Venkatesh *et al.*, 2003) that these factors have indirect effect via SI and FC. Morris and Venkatesh (2000) found that gender also had a significant link with PEU and age had negative effect on technology adoption. Moreover, these three demographic factors (gender, age and IT experience) have different indirect impacts on the adoption, via SI, FC and PEU. Based on this, the hypotheses are;

H6a: Age has influence on SI

H6b: ICT experience has influence on SI

H6c: ICT experience has influence on FC

Next, prior studies indicated that socio-economic factors (income and size of farm holding) are acted as either determining factor or mediating factor on TAM and adoption. Income has been found to influence mobile usage in several studies (Rice & Katz, 2003; Kalba, 2008) and not only in ICT sector but also for adopting of new technology in agriculture sector (Bosma *et al.*, 2012; Kakuru et al, 2014). Moreover, earlier research established the important of size of farm holdings on technology adoption by indicating that the larger farm size tended to adopt technology faster than others (Yengoh et al, 2009; Poolsawas & Napasintuwong, 2013; Kakuru *et al.*, 2014).

H7a: Income has positive influence on ICT adoption

H7b: Size of farm holding has positive influence on ICT adoption

From the theoretical and empirical background research, the following research model was developed that empirically examines whether socio-economic variables and perceptions have a systematic link with the decision of rubber smallholders households to adopt ICT solutions by integrating the TAM model and UTAUT model as illustrated in Fig. 1.

4. METHODOLOGY

4.1. Data

The population of rubber smallholders' household is the rubber smallholders' households who are member of Office of the Rubber Replanting Aid Fund (ORRAF) and located in the South of Thailand since majority of rubber plantation in Thailand is in the south of Thailand. Focus was given to rubber smallholder's households in the three adjoining provinces of Surat Thani, Songkhla and Nakorn Si Thammarat as shown in Fig.2. These selected provinces are top three provinces in terms of rubber plantation area and number of rubber farmers.

The size of population is 35,856 households. the sample size is calculated by using Taro Yamane formula at the level of precision is 0.05. Then, the sample size is 396 rubber smallholders' household.

Figure 2: Southern Thailand Map showing the area from which quantitative data was developed

Table 1
Sample size of this study in each selected provinces

Region	*Province*	*District/ Sub-district /Village*	*Number of rubber smallholders household*	*Sample*
Southern	Surat Thani	19/13/1028	13,515 (0.38)	150
	Songkhla	16/127/987	16,358 (0.45)	178
	Nakhon Si Thammarat	23/165/1428	2,511 (0.07)	28
	Total	58/423/3443	35,856 (100)	396

A survey was conducted through a semi-structured interview process comprising of three primary components including a) socio-economic factors, b) ICT experience and c) ICT perceptions and acceptance by rubber farmers. A 5-point Likert scale was employed with anchors ranging from "strongly disagree" to "strongly agree" which was used for all belief items to ensure statistical variability among survey responses for all the items measured. A questionnaire was designed to measure the reliability and consistency and distributed to collect data from small rubber farmers in the selected provinces in the rural southern areas of Thailand through a semi-structured interview process. Finally, of the 435 surveys distributed, 264 were deemed usable with complete responses or 61.0 percent of the response rate. A pre-test was performed to validate the instrument. The Cronbach's á value

of pre-test questionnaire with 30 respondents were well above the commonly accepted threshold value of 0.70.

4.2. Data analysis

In analyzing the collected data, reliability, multicollinearity and the overall goodness-of-fit were employed.

Cronbach's α is utilized to assessing reliability scale of the distributed questionnaire. The estimated Cronbach's α co-efficient of investigated variable is 0.802, which exceeding the reliability estimates (α=0.70) recommended by George and Mallory (2003). This shows the overall of good internal consistency of the items in the scale as shown in Table 2.

Table 2
Reliability statistics

Cronbach's α	*N of Items*
0.802	6

Table 3 demonstrates excellent internal consistency of surveyed items. The results indicate that the scales are not only reliable, but also valid for the factor under study.

Table 3
Cronbach's α reliability coefficient

	Corrected Item-Total Correlation	*Cronbach's α if Item Deleted*
PU	0.695	0.739
PEU	0.790	0.719
SI	0.759	0.723
PEQ	0.747	0.735
FC	0.580	0.767
ICTadopt	0.024	0.894

An assessment of the normality of data is a prerequisite for many statistical tests because normal data is an underlying assumption in parametric testing. The numerically results are measured from both skewness and kurtosis. Skewness is a measure of symmetry while kurtosis is a measure of whether the data are peaked or flat relative to a normal distribution. From Table 4, it shows that almost variables have a normal distribution pattern, except income and ICT experience, which has the skewness values greater than 1 (1.86 and 1.67 respectively), and kurtosis value is also greater than 1 (3.39 and 3.37 respectively).

Table 4
Normal distribution test

	Statistics					
	Minimum	*Maximum*	*Mean*	*Std. Deviation*	*Skewness*	*Kurtosis*
AGE	21.00	79.00	47.92	11.21	.13	-.27
INCOME	2000.00	70000.00	14420.45	12982.99	1.86	3.39
SIZE	1.00	10.00	5.18	2.68	.43	-.71
ICT_EXP	0.16	31.00	7.63	5.32	1.67	3.37
PU	1.00	5.00	4.05	.92	-1.03	.52
PEU	1.00	5.00	4.09	.88	-1.08	.67
SI	1.00	5.00	4.02	.93	-1.19	1.16
PEQ	1.00	5.00	4.08	.80	-.88	.49
FC	1.00	5.00	3.96	1.09	-.92	.14
ICTadopt	1.00	5.00	4.17	.99	-.93	-.01

Note: n = 264, standard error of skewness = 0.150 , standard error of kurtosis = 0.299

Correlation analysis is employed without a priori assumption as to whether one variable dependent on the other(s) and it not concerned with the relationship between variables. Instead, it gives an estimate as to the degree of association between the variables. This analysis tests for interdependence of the variable, according to Field (2006). The correlation between independent variables should not exceed 0.75. Otherwise, it may create bias estimated results. Table 5 shows that the relationship between each variable range between -0.245 to 0.750 which not exceed the criteria. The association between FC and size had the lowest value, while the PEU and PU have highest relationship.

A Confirmatory Factory Analysis (CFA) to determine the adequacy of model fit to the data is employed via path analysis to test model fit. CFA relies on several statistical tests, e.g., Chi-square, Comparative Fit Index (CFI) and Root Mean Squared Error of Approximation (RMSEA). If an unacceptable model fit is found, the model could be revised when the modifications are meaningful. Model modification involves adjusting a specified and estimated model by either freeing parameters that were fixed or fixing parameters that are free. The proposed model is found to be not fit; therefore, the modified model or alternative model is proposed. The alternative model shows the validity as evidenced by the adequacy indices. Table 6 shows a summary of the overall alternative model fit measures. Chi-square (χ^2) is a "badness-of-fit" index; smaller values indicate the better fit. Other fit indices, e.g. GFI, AGFI, CFI, NFI and RMSEA are "goodness-of-fit" indices where larger values mean better fit. These fit indices confirmed that the alternative model exhibited a good fit with the data collected. Thus, the analysis step could proceed to examine the path coefficients of the model.

Table 5
Correlation analysis

	AGE	*INCOME*	*SIZE*	*ICT_EXP*	*PU*	*PEU*	*SI*	*PEQ*	*FC*	*ICTadopt*
AGE	1									
INCOME	.041	1								
	.508									
SIZE	.112	.345**	1							
	.070	.000								
ICT_EXP	-.150*	.339**	.231**	1						
	.015	.000	.000							
PU	.128*	.083	-.210**	.090	1					
	.037	.178	.001	.144						
PEOU	.034	.090	.243**	.081	.750**	1				
	.586	.143	.000	.188	.000					
SI	-.008	.119	.218**	169**	.695**	.711**	1			
	.891	.054	.000	.006	.000	.000				
PEQ	.008	.069	.219**	.113	.653**	.701**	.667**	1		
	.898	.267	.000	.067	.000	.000	.000			
FC	.005	-.099	.245**	-.151*	.447**	.634**	.523**	.637**	1	
	.935	.108	.000	.014	.000	.000	.000	.000		
ICTadopt	.160**	.039	.055	.048	.036	.040	.088	.026	.079	1
	.009	.533	.374	.439	.563	.514	.155	.676	.201	

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

Table 6
Results of goodness of fit measures

Goodness of fit measures	*Recommended value*	*Structural model (result)*	*References*
χ^2-test statistics/df	≤ 3.00	1.58 (p value = 0.075)	Hair *et al*. (2010)
GFI	≥ 0.90	0.980	Hair *et al*. (2010)
AGFI	≥ 0.90	0.949	Hair *et al*. (2010)
CFI	≥ 0.90	0.985	Schumaker and Lomax (2004)
NFI	≥ 0.90	0.962	Hair *et al*. (2010), Bentler (1990)
RMSEA	≤ 0.08	0.047	Hair *et al*. (2010)

5. FINDINGS

The survey results showed that there are three main services available for respondents in the use of ICT services by Thai rubber smallholder's households. Far and away, access by mobile phone (98.1%) was the greatest, followed by the Internet (14.0%) and last, fixed telephony (11.4%) respectively. Respondents have the same degree of usage experience in both fixed telephony (6.8 months) and mobile telephony (6.9 months), while the Internet usage experience(4.5 months) is

less than the two other services. The overall ICT experience usage among small rubber farmers is 7.9 months.

Overall, adoption of ICT services is low. Findings reveal that rubber farmers rarely use ICT services related to their farming activities. Interestingly, the attributes that rubber farmer use most on average are exchanging information with other farmers, followed by searching for prices of products from a middleman and product prices. At the same time, they never or rarely use a service to search and obtain news on agriculture technology from government agencies as well as contacting and exchanging information with the government offices and following input prices.

This study employed a path analysis using the TAM framework to develop a model that represents the relationship of external factors on rubber smallholder household's perception towards ICT adoption. The final fit model is presented in Figure 3 and shows that the external factors which have influence on ICT adoption. These external factors are age, ICT usage experience and farm size. These factors revealed and indirect influence on ICT adoption through the perceptions of rubber smallholders' households. The significant perceptions are PU, PEQ, SI and FC.

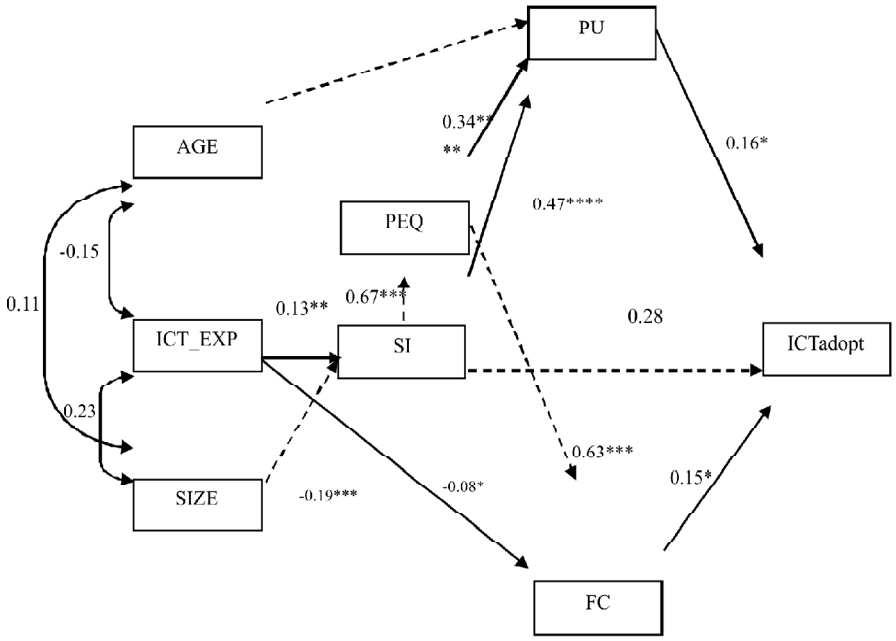

Figure 3: Fitted model of ICT adoption

6. DISCUSSION

The results of this study (Fig. 3) are consistent with previous studies on technology adoption and the findings show that perceived usefulness (PU) has a considerable impact on ICT adoption (Flett *et al.*, 2004; Aubert, Schroeder and Grimaudo, 2012). In particular, it was demonstrated that perceived usefulness (PU) is greatly influenced by the age of the rubber farmer as well as PEQ (Perceived Quality) and SI (Social Influence) which was also confirmed by Shin (2012).

Additionally, the effects of PU (Perceived Usefulnes), PEQ (Perceived Quality) and SI (Social Influence) are found to be valid and significant in the study. Furthermore, facilitating conditions (FCs) also reveals its role on ICT adoption in the study which is consistent with the study by Jain and Hundal (2007) and Seneler, Basoglu and Daim (2008). The results warrant a consistent model for the drivers of ICT adoption among rubber farmers.

Some of the hypotheses do not show the expected relationships, for example, the relationship between PEU and ICT adoption, PEQ and PEU and SI and PEU. This may due to the ICT service that is most used by the majority of rubber farmers is mobile telephony. Additionally, mobile services are not as complicated to use compared to Internet use with rubber farmers able to learn by themselves or through the help of friends or family. Moreover, income and size of farm holdings did not have influence on ICT adoption as the literature suggested. One possible reason could be the cost of using mobile phones is not expensive. Age and income is also not a main obstacle to adoption of services. While the size of farm holdings has no direct relationship with ICT adoption as earlier research has established (Yengoh, Ato and Svensson, 2009; Poolsawas & Napasintuwong, 2013; Kakuru, Doreen and Wilson, 2014), it does however have an indirect influence through other variables.

Interestingly, there are unexpected relationships from the path analysis. Firstly, the relationship between AGE and PU (Perceived Usefulness) shows that age has a negative direct effect on perceived usefulness. This implies that the younger the rubber farmer, the greater perceived usefulness of ICT services which also impacts ICT adoption. Secondly, size of farm holding has a negative influence on social influence (SI). This may imply that rubber farmers who own a smaller plot of land need more support from society, including friends and colleagues. Third, the impact of SI (social influence) on perception of quality (PEQ) shows a positive and significant relationship. This suggested that PEQ, i.e. calls, service, mobility and coverage, is determined by the social influence of the user. Friends or colleagues also have an impact on the ICT service selected by a farmer that services their needs. Fourth, PEQ (perception of quality) has a positive and significant impact on facilitating conditions (FC). This may indicate that farmers still need the facilitating means in order to adopt ICT service even though the quality of service

is good. Lastly, SI (social influence) has the both a positive and significant effect on ICT adoption. This suggests that ICT adoption by the rubber farmers depends on friends and colleagues. It may also reflect the network effect phenomena. If farmers use the same service under the same service provider, the more valuable the service is to each owner. Specifically, the direct, indirect effect and total effect of each variable can be shown as Table 7.

Table 7
Effect of variables on ICT adoption from path analysis

Variable	*Direct effect*	*Indirect effect*	*Total effect*
AGE	-	-0.02	-0.02
ICT_EXP	-	0.06	0.06
SIZE	-	0.07	0.07
PEQ	-	0.14	0.14
PU	0.16	-	0.16
SI	0.28	-	0.28
FC	0.15	-	0.15

Considering the significant of the variables, the role of policy makers and regulators need to be examined. The government along with other agencies and enterprises needs to encourage and support ICT usage among farmers. This additional support could help rubber farmers realize the advantages and benefits of using ICT services along with increasing their yields, profitability and performance.

Increasing the availability of ICT services through the public community and allowing the sharing of these resources could also be another alternative. Accessibility can also be enhanced by creating more facilitating environments along with ICT training courses. In addition, it was determined that older farmers need special assistance on using ICT and therefore, facilitating conditions are important in these cases. At the same time, regulators also play an important role in guaranting the quality of service while protecting consumer interests through promoting fair, efficient and sustainable network competition. Findings confirm that quality of service is a crucial factor for adoption, though it has an indirect effect on ICT adoption in this case. Regulators should also be well-prepared to address and consider the following issues including signal network coverage, price plan changes without notification and Internet speed guarantees. This will ensure that ICT adoption is beneficial to the Thai rubber farmer.

7. CONCLUSION

This study aimed to examine empirically whether demographic variables and farmers' perception has a systematic link with the decision of rubber smallholders'

households on ICT service adoption by integrating the TAM model and UTAUT model. The questionnaires were distributed to collect data from the small rubber farmers in three rural provinces in Southern Thailand through a semi-structured interview process during December 2013 to May 2014. There was a total of 264 completed questionnaires representing a 61.0 % response rate with path analysis being utilized for hypotheses testing.

Findings showed that the external factors which have the greatest influence on ICT adoption are age, ICT usage experience and farm size. These factors revealed indirect influences on ICT adoption through the perceptions of rubber smallholders' households. The significant perceptions are perception of usefulness, social influence, facilitating conditions and perception of quality. These factors affect ICT adoption among rubber farmers and governments need to consider their policies while promoting more ICT adoption among rubber smallholders.

Future research is also needed to supplement the findings of this study. It is also suggested that availability of *longitudinal* data would help researchers to development of adoption. This study provides an overview of ICT adoption, which is mainly represented by mobile phone adoption. Future studies could elaborate more on this issue by focusing on specific services such as mobile Internet which might be considered as an emerging technology that better suit the lifestyle of rubber farmers rather than other technologies.

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