Thailand and The World Economy
P-ISSN: 2630-0931
E-ISSN: 2651-0529
Homepage : https://www.tci-thaijo.org/index.php/TER
Vol. 38, No.2, May- August 2020 Page [88-118]

E-commerce Adoption for Rice Selling in Thailand: An Empirical Study

Jesada Arromdee[*]
International College, National Institute of Development Administration (NIDA), Thailand
Sid Suntrayuth
International College, National Institute of Development Administration (NIDA), Thailand

Received 11 January 2020, Received in revised form 30 March 2020,
Accepted 30 March 2020, Available online 15 July 2020

Abstract

The objective of this research was to analyze the factors that influence the adoption of e-commerce (EC) by Thai rice farmers. The study employed a conceptual model, based on four main constructs of the unified theory of acceptance and use of technology (UTAUT) model (i.e., performance expectancy [PE], effort expectancy [EE], social influence [SI], and facilitating conditions [FC]), as well as four additional constructs (perceived implementation cost [IC], perceived risk [PR], sufficient information technology knowledge [IT], and government support [GOV]), to test Thai rice farmers' behavioral intention (BI) and their acceptance and adoption (AA) of EC for rice selling. In the context of EC adoption for rice selling in Thailand, the study found that behavioral intention (BI) tended to have a significant relationship with acceptance and adoption (AA) of EC for rice selling. Statistical supporting evidence demonstrated that performance expectancy (PE), sufficient IT knowledge (IT), and government support (GOV) (independent variables) have a positive influence on the behavioral intention (BI) to adopt EC for rice selling, while effort expectancy (EE) has a negative influence. Consequently, this study's results are expected to provide initial guidance for Thai rice farmers in the further adoption of EC for rice selling. These outcomes are also expected to guide relevant government agencies in adjusting their corporate strategies and plans to not only encourage greater focus by Thai rice farmers on EC adoption for rice selling, but also to assist them in successful EC adoption.

Keywords: Thai rice farmer, E-commerce (EC) adoption for rice selling, Unified theory of acceptance and use of technology (UTAUT)
JEL Classifications: L26, L81, M10, M15

[*] **Corresponding Author:** Address: 118 Moo3, Serithai Road, Klong-Chan, Bangkapi, Bangkok 10240. Email: jesada.arr@gmail.com.

1. Introduction

With the worldwide expansion of internet usage in trade and the rapid growth of electronic technology, most business sectors must constantly pay attention to the transformation of trade and transactions. E-commerce (EC), which literally refers to business trading through the internet, is reshaping many fundamental aspects of the ways that businesses operate and the changes that occur in the behavior of buyers and sellers in the wider society's new way of life. It also seems to be an economy-wide phenomenon that many business industries increasingly adopt EC as a tool to expand their market, and to enhance their capability and productivity in ways such as reaching consumers, buying inputs, and finding and comparing competitor information, etc. EC can also provide adopters with improvements in operational performance and competitive advantage through cost savings resulting from the consumer search process, subsequent inventory, and the reduction of paper transactions (Ghobakhloo & Tang, 2013). Indeed, the growth in EC adoption in many businesses not only provides great opportunities, but also impacts on businesses which face the unforeseen challenge of fundamental change to their business models and practices. Hence, to survive in the new business economy and not be left behind by EC adopters, many business sectors, including the agricultural sector, by necessity, have probably had to adopt this philosophy and practice.

Thailand's economy is mainly based on food and agricultural sectors which generate several billion baht each year, through activities such as farming, crops, livestock, forestry, and fisheries, etc. In 2017, approximately 47 percent of Thailand's total geographical area was used for agricultural purposes, particularly for rice cultivation which accounted for an area of roughly 46 percent of the country's total agricultural area, or approximately 21 percent of Thailand's total geographical area (Office of Agricultural Economics, 2019). In other words, rice is one of Thailand's major agricultural products. Not only does it generate an extremely high export value and represent an important percentage of the country's gross domestic product (GDP), but it also creates a significant amount of employment. Therefore, any problem related to rice, such as uncertainty about rice demand and supply or a rice-price recession, apparently has a massive effect on the country's economy as most of the Thai population are engaged in agricultural practices, especially with many being rice farmers. Furthermore, the rice supply chain in Thailand is quite sophisticated as rice passes through many activities from the paddy processing level through to reaching consumers' hands. The key players in these midstream activities are rice millers, traders, wholesalers, and retailers, etc. (Titapiwatanakun, 2012). Generally, Thai rice farmers sell their crop as early as possible after harvesting as they do not have good storage warehouses or effective post-harvest technologies, and they also have limited financial resources (Sahavacharin & Srinon, 2016). It is most likely that the price of rice is manipulated along the whole supply chain process.

The adoption of EC for rice selling is of interest as a way to address these points as it could contribute to the creation of a new form of rice selling, providing great opportunities to directly reach all potential buyers at any time and in all areas. The adoption of EC for rice selling could facilitate the simultaneous roles of both rice producer and rice seller for Thai rice farmers, thus helping them to gain more profit, have more opportunities for rice selling, expand their market to various potential buyers, as well as reducing their costs and the extent of middleman activities. Even though EC adoption is

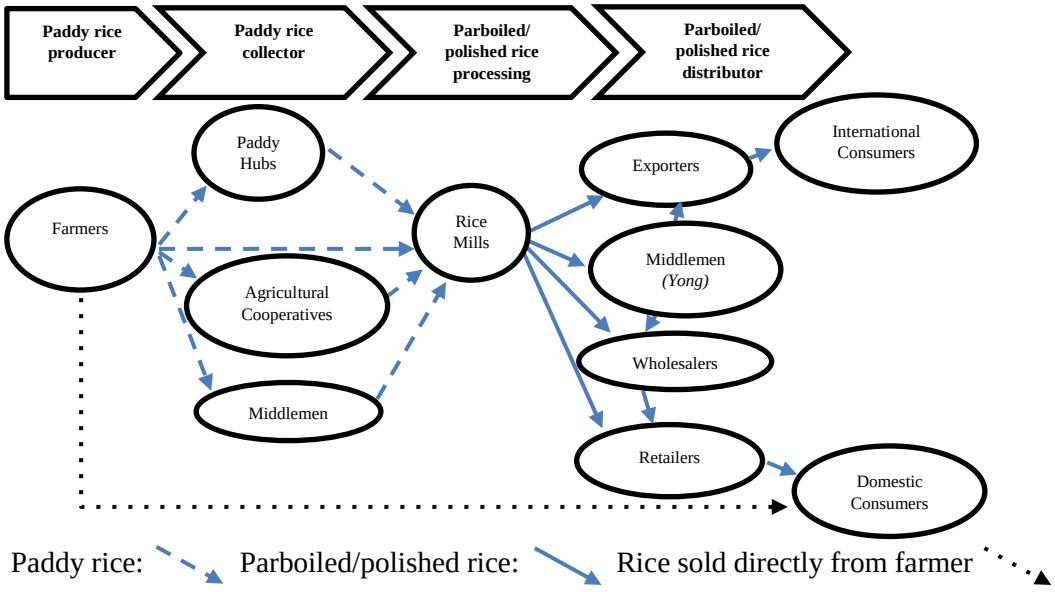
generally accepted as a powerful tool used by many businesses to expand their market and improve their capability and productivity, EC adoption in Thailand's agricultural sector is relatively small in proportion to its overall potential. Some Thai rice farmers have initiated placing their product on online channels, such as Facebook, a mobile application, or private or public websites. At this juncture, it should be stated that rice middlemen in Thailand are undeniably still important and indispensable for rice trading. However, the adoption of EC for rice selling would facilitate direct access by rice farmers to consumers, thus increasing profits and incomes, expanding trading opportunities, and reducing some costs. It should be noted that EC adoption for rice selling is not intended to replace traditional selling methods. Instead, it introduces an additional rice selling channel; alternatively, EC adoption for rice selling works alongside traditional sales methods.

This research mainly focuses on Thai rice farmers' perceptions on the adoption of EC for rice selling, while also identifying influencing factors that could affect this adoption. The main theory is a modification and extension of the unified theory of acceptance and use of technology (UTAUT) in the context of rice selling in Thailand. This theory provides a solid base for explaining why Thai rice farmers accept or reject EC adoption from a specific perspective, together with allowing significant potential for enhanced understanding of the acceptance of EC adoption. The main objective of this study is twofold: firstly, it identifies the factors that influence Thai rice farmers' intentions to adopt EC for rice selling; and, secondly, it seeks to find ways to encourage Thai rice farmers to adopt EC for rice selling and for them to see the importance of this selling platform.

2. Literature review

2.1 Rice supply chain in Thailand

Figure 1: Thai rice supply chain



Source: Adapted from Wattanutchariya, Tansuchat, and Ruennareenard (2016); Sahavacharin and Srinon (2016)

The rice supply chain in Thailand is generally comprised of many related sectors, which are engaged in the process depicted in Figure 1, as adapted from the works of

Wattanutchariya, Tansuchat, and Ruennareenard (2016) and Sahavacharin and Srinon (2016). In the initial stage of paddy rice production, paddy rice is cultivated and harvested by farmers. They then choose to either mill their own paddy rice in their local village or to sell it to paddy rice hubs, farmer institutions or agricultural cooperatives, middlemen, or nearby milling factories (Sahavacharin & Srinon, 2016). These paddy rice collectors, acting as middlemen, are crucial players in this process, collecting paddy rice from farmers in the same area and selling it to rice mills for the rice parboiling or polishing process at prices achieved through bargaining (Wattanutchariya et al., 2016). The paddy rice enters the rice processing line, which consists of cleaning, parboiling, husking, and polishing. The output of the processing line is parboiled and/or polished rice which is sold and distributed through various market channels, such as exporters (international market), wholesalers, retailers (domestic market), and other middlemen, known as *Yong* (Sahavacharin & Srinon, 2016). In this stage, *Yong* seem to be influential players who normally gather rice from rice mills and distribute it to exporters and wholesalers. Thus, in Thailand's rice market, significant numbers of middlemen or intermediaries buy rice from rice farmers, then process and sell the rice to make a profit, so EC adoption should be a potential gateway through which to reduce and eventually eliminate these intervention activities.

2.2 E-commerce in agriculture

E-commerce (EC) for agricultural products can play an important role as a new marketplace and information resource (Jamaluddin, 2013). In addition, it is believed that EC will create more competition, transparency, and profitability in this market sector. Asadihkoob and Ebrahimi (2014), in their research findings on EC for agricultural products, revealed that EC adoption can bring many advantages for farmers, such as gaining higher profitability, eliminating intermediaries' activities, enhancing the quality of agricultural products, increasing their awareness of the market price, more easily accessing markets, and increasing competitiveness. EC also provides transaction flexibility, with transactions able to be processed over the internet, without the limitations of place, distance, or time (El-fitouri, 2015). Interestingly, as different districts in Thailand produce different varieties and flavors of rice, EC could make the various types of rice easily reachable. Not only would EC attract more consumers as it has no geographical restrictions, but it could also reduce transaction costs through the system and be a way to offer products at a lower price (Carpio, Isengildina-Massa, Lamie, & Zapata, 2013). Furthermore, EC can be a tool for rice farmers to create product differentiation, such as adding organic labeling, indicating the specific types of rice (e.g. Rice-berry and Sang-yhod rice), providing special packaging, or proceeding with marketing strategies (e.g. advertising, branding, and storytelling).

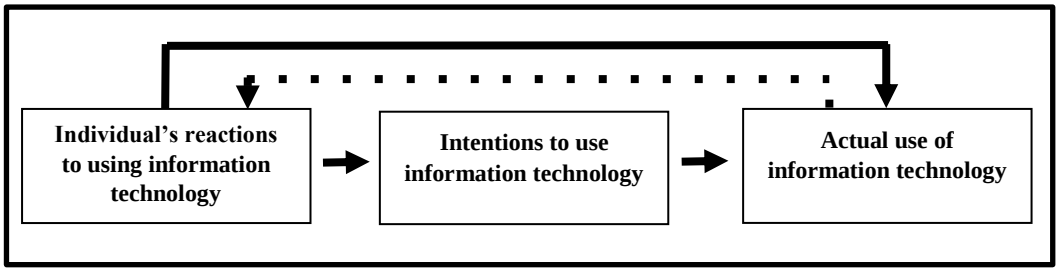
In terms of the benefits of EC adoption for rice selling, it would contribute to the creation of a new form of rice selling and provide great opportunities to directly reach all potential buyers at any time and in all areas. In other words, it could facilitate the dual and simultaneous roles of Thai rice farmers as both rice producer and rice seller. This would help them to gain more profit, have more opportunities for rice selling, and expand their market to various potential buyers, as well as reducing their costs and the extent of middleman activities. Therefore, to further encourage Thai rice farmers to utilize EC, alongside their traditional sales method which relies on middlemen, it is necessary to

understand the influencing factors that determine their behavioral intention (BI) to adopt EC for rice selling.

2.3 Theoretical background

Technology acceptance is defined as an individual's psychological state, related to their voluntary intention to use a particular technology. The objectives of the technology acceptance model are to investigate how to promote technology usage and to explore the related factors that affect the acceptance and adoption of technology (Alshehri et al., 2012). Basically, this begins with the user's reaction to using the technology which could contribute to his/her intentions to use and his/her actual use of that technology (see Figure 2 below). Several models/theories have been developed in this research field, with their degree of influence varying depending on the evaluation of user acceptance.

Figure 2: Basic concept underlying user acceptance models



Source: Venkatesh, Morris, Davis, & Davis (2003)

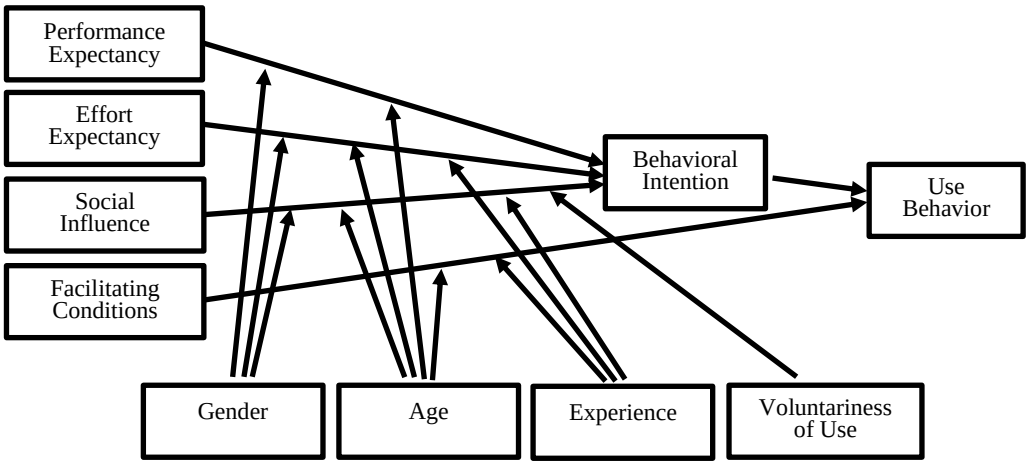
Venkatesh et al. (2003) proposed the comprehensive synthesis of technology acceptance models, namely, the unified theory of acceptance and use of technology (UTAUT) model, capturing the essential elements of the different models. In fact, this theory is accepted as the most comprehensive individual acceptance model for overcoming the limitations of technology acceptance models (Tan, Chong, & Lin, 2013). The UTAUT model is formulated by comparing and conceptualizing empirical similarities across eight models (summarized in Table 1) of the determinants of intention and usage of information technology (IT) models consisting of innovation diffusion theory (IDT), theory of reasoned action (TRA), technology acceptance model (TAM), theory of planned behavior (TPB), combined TAM and TPB (C-TAM-TPB), model of personal computer (PC) utilization (MPCU), motivational model (MM), and social cognitive theory (SCT) (Wu, Tao, & Yang, 2007). This model consists of four key constructs, comprising performance expectancy (PE), effort expectancy (EE), social influence (SI), and facilitating conditions (FC) that determine the behavioral intention (BI) to use technology and/or the actual use, and four moderators in the acceptance of technology (i.e., gender, age, experience, and voluntariness of use) (Figure 3).

Table 1: Four core determinants of UTAUT

UTAUT Determinant	**Sub-Determinant**	**Source of Integrated Model**
Performance Expectancy	Perceived Usefulness	TAM/TAM2/C-TAM-TPB
	Extrinsic Motivation	MM
	Job Fit	MPCU
	Relative Advantage	IDT
	Outcome Expectations	SCT
Effort Expectancy	Perceived Ease of Use	TAM/TAM2
	Complexity	MPCU
	Ease of Use	IDT
Social Influence	Subjective Norm	TRA/TAM2/TPB/DPTB/C-TAM/TPB
	Social Factors	MPCU
	Image	IDT
Facilitating Conditions	Perceived Behavioral Control	TPB/DTPB/C-TAM-TPB
	Facilitating Conditions	MPCU
	Compatibility	IDT

Source: Wu et al. (2007)

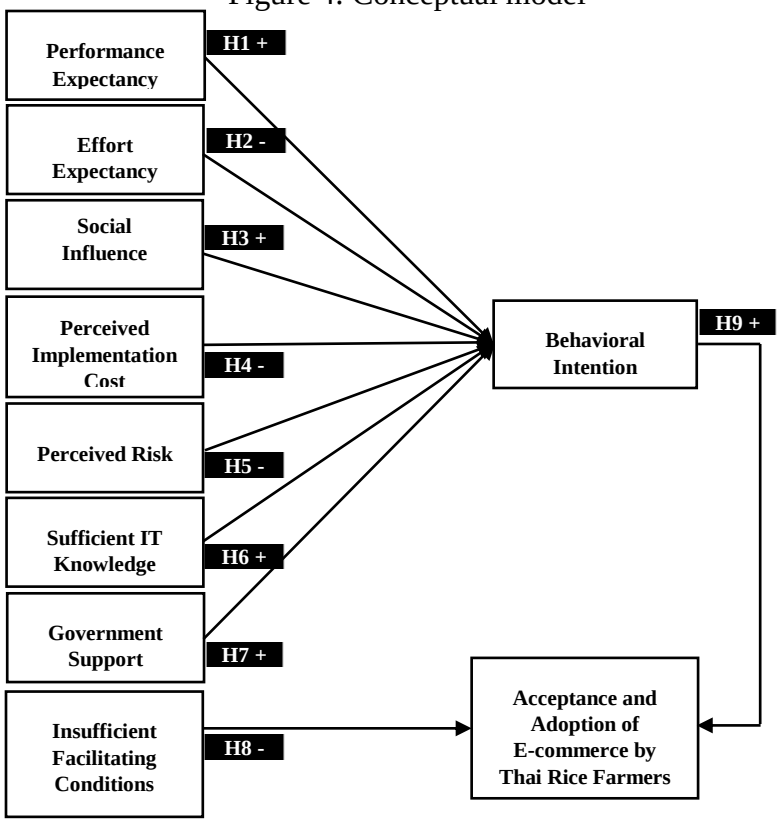
Figure 3: Unified theory of acceptance and use of technology (UTAUT)



Source: Venkatesh et al. (2003)

2.4 Research model

Figure 4: Conceptual model



Source: Author's explanation.

The research model of the current study is a modification and extension of the UTAUT model with four additional factors. The model is used to examine the influencing factors that could affect Thai rice farmers' behavioral intentions to adopt EC and their acceptance and adoption (AA) of EC for rice selling. This research used four main variables in the UTAUT model, consisting of: performance expectancy (PE) (new technology will improve job performance); effort expectancy (EE) (the technology is effortless to use); facilitating conditions (FC) (infrastructure exists to support the use of the technology); and social influence (SI) (other opinions will influence the behavior to use the technology) (Venkatesh et al., 2003). Four important variables that could affect an online scenario and make the model more suitable to the rice sector in Thailand were added to the model: these consisted of perceived risk (PR), especially when cybercrime is involved; perceived implementation cost (PC), especially when EC adoption could lead to additional investment cost; sufficient IT knowledge and skills (IT) as EC adoption is mostly related to IT usage capability; and government support (GOV) which may be an essential requirement for encouraging EC adoption in a developing country. The research model is designed to test the effects of performance expectancy (PE), effort expectancy (EE), social influence (SI), insufficient facilitating conditions (FC), perceived risk (PR), perceived implementation cost (IC), sufficient IT knowledge (IT), and government support (GOV) on Thai rice farmers' behavioral intention (BI) to adopt EC for rice selling and their acceptance and adoption (AA) of EC for rice selling. Therefore, the study's conceptual

model is created through extension and modification of the UTAUT model, as illustrated in Figure 4.

2.5 Research hypotheses

Performance expectancy (PE) is defined as "the degree to which an individual believes that using the system will help him/her to attain gains in job performance" (Venkatesh et al., 2003, p. 447). To be concise, it focuses on task accomplishment, indicating that people are more likely to adopt a new technology when they believe that it is useful and can provide advantages for performing their job. In the current study's context, this determinant is used to predict behavioral intentions to adopt EC for rice selling (Wang & Wang, 2010), with this possibly based on how it would help Thai rice farmers who adopt EC to perform their jobs. If farmers perceive that EC is unable to enhance their job performance, they may decline EC adoption. Hence, the current study assumes that EC adoption in rice selling can enhance farmers' performance through the capability to expand their market, reduce intermediaries' activities, increase price negotiation, lower transaction costs, and gain–profit from supply chain shortages, etc. Accordingly, it is expected that a high level of performance expectancy (PE) of EC's positive influence on rice selling would possibly contribute to a positive relationship with the behavioral intention to adopt EC. The following hypothesis is proposed:

H1: The performance expectancy of e-commerce adoption for rice selling is positively related to Thai rice farmers' behavioral intention to adopt e-commerce (+)

Effort expectancy (EE) is defined as "the degree of ease associated with the use of the system" (Venkatesh et al., 2003, p. 450). To elaborate further, it is the degree to which the individual believes the new technology will be easy or effortless to use (Alhilali, 2013). In the context of the current study, it is assumed that if Thai farmers found EC easy to use, they would be more likely to have an EC adoption intention. On the other hand, if they found EC not easy to use and that it was, in fact, difficult to use, they would be less likely to have an EC adoption intention. Consequently, this study expects that many Thai rice farmers, at this moment, might consider that EC is not easy to use, so effort expectancy (EE) might cause difficulties in their EC adoption intentions. Accordingly, this study postulates the following hypothesis:

H2: The effort expectancy of e-commerce adoption for rice selling negatively affects Thai rice farmers' behavioral intention to adopt e-commerce (-)

Social influence (SI) is defined as "the degree to which an individual perceives that important others believe he/she should use the new system" (Venkatesh et al., 2003, p. 451). To be more concise, the social pressure exerted from the external environment and the opinions of others, for example, the perceptions and opinions of their superiors, family members, peers, and even their online community (Tan et al., 2013; Tarhini, El-Masri, Ali & Serrano, 2016) are a significant factor in the decision to use the technology. Interestingly, due to the consumer behavior trend that has changed their preferences to buying products and services through EC, rice farmers may have to make this adjustment themselves to prepare for consumer behavior in the digital era. Thus, it is assumed that social influence (SI) can contribute positively to Thai rice farmers' intentions to adopt EC, as proposed in the following hypothesis:

H3: The social influence on Thai rice farmers' e-commerce adoption for rice selling positively affects their behavioral intention to adopt e-commerce (+)

Perceived implementation cost (IC) refers to the initial costs as well as subscription, transaction, and communication costs that could arise when implementing or adopting technologies (Abrahão, Moriguchi, & Andrade, 2016). Bhatiasevi (2016) described this variable as the extent to which users believe that utilizing or adopting the technology will cost money. Individuals might be reluctant to adopt the technology if they thought that adoption would either cost a large amount of money or impose a financial burden. The rationale of the current study recognizes that although many people in cities in Thailand can afford the expense of IT equipment, many people in rural areas, especially farmers, still cannot afford its expense and, in addition, they lack the ability to access telecommunication devices and computer equipment. To adopt EC, rice farmers would have to cover all costs related to rice production and to EC adoption for rice selling as they would be growing rice in the field, transforming paddy rice to parboiled/polished rice, and placing rice on the e-market. As a result, the perceived implementation cost (IC) would have a negative effect on Thai rice farmers' behavioral intention to adopt EC, as proposed in this hypothesis:

H4: High perceived e-commerce implementation cost negatively affects Thai rice farmers' behavioral intention to adopt e-commerce (-)

Perceived risk (PR) is defined as uncertainty or concern which could influence individuals' confidence in their decisions (Im, Kim, & Han, 2008). In relation to EC adoption, the perceived risk of Thai rice farmers could arise from the disclosure of important personal information, such as the seller's identification, or from the disclosure of financial, product, or other private information though an insecure online payment port which could result in the possibility of fraud, misuse, or intrusion of information (Biucky, Abdolvand, & Harandi, 2017). Although EC has been adopted in many sectors, most rice farmers are still new players and may be in doubt about the security or reliability of the system, so the perceived risk (PR) of EC adoption could have a negative effect on their intentions to adopt EC, as proposed in the following hypothesis:

H5: The perceived risk of e-commerce adoption for rice selling negatively affects Thai rice farmers' behavioral intention to adopt e-commerce (-)

Information technology (IT) knowledge and skills refer to the individual's perception of his/her capacity to use an IT system, with this adapted from the definition of computer self-efficacy used in the study by Terzis and Economides (2011). The adoption of EC would relate to capabilities in IT usage and computer literacy, whereas, in contrast, limitations in this knowledge, in these skills, and in awareness of EC's benefits were viewed as major concerns hindering EC adoption (Kapurubandara & Lawson, 2006). Thus, it is assumed that if Thai rice farmers have sufficient IT knowledge and skills (IT), this would contribute positively to their intentions to adopt EC, as proposed in this hypothesis:

H6: Sufficient IT knowledge and skills positively affect Thai rice farmers' behavioral intention to adopt e-commerce (+)

Government support (GOV) refers to the extent to which the government provides any assistances or promotions that could encourage the EC adoption by, for example, providing robust secure online payment systems, ensuring solid information and communications technology (ICT) infrastructures, providing educational programs, building up awareness using different means, and enacting EC-related laws and regulations (Kabango & Asa, 2015). Kapurubandara and Lawson (2006) further mentioned that government support and intervention were necessary for encouraging EC adoption and for addressing external barriers. In this regard, if government support (GOV) was available for EC adoption, such as providing EC training, a financial subsidy, creation of a free public EC website, and enacting laws and regulations to secure EC usage, etc., it is believed that these measures would increase the behavioral intention of Thai rice farmers to adopt EC, as proposed in the following hypothesis:

H7: Government support positively affect Thai rice farmers' behavioral intention to adopt e-commerce (+)

Facilitating conditions (FC) are defined as "the degree to which an individual believes that an organizational and technical infrastructure exists to support the use of the system" (Venkatesh et al., 2003, p. 453). The underlying aspect of this variable is the inclusion of technological and organizational environment perspectives that would be available to support EC adoption and/or to diminish the barriers to adoption (Martín & Herrero, 2012). To drive effective EC adoption, basic IT infrastructural requirements must be adequately available (Kyobe, 2011). Simultaneously, lack of these requirements would be a strong impediment to successful EC adoption and implementation, especially factors such as unavailability of the internet and IT infrastructure in rural areas, limited bandwidth, lack of an online transaction system, and limited electricity supply and transportation (Lawrence & Tar, 2010). In Thailand, some rural areas probably do not have adequate infrastructure, with internet access also continuing to be restricted. For these reasons, insufficient facilitating conditions (FC) would have a direct negative effect on EC acceptance and adoption by Thai rice farmers, as proposed in the following hypothesis:

H8: Insufficient facilitating conditions for e-commerce adoption negatively affect Thai rice farmers' acceptance and adoption of e-commerce (-)

Behavioral intention (BI) refers to the factor that captures the extent to which individuals are willing to try to perform a behavior (Ajzen, 1991). As a psychological model, individual behavior is predictable and influenced by individual behavioral intention (Yu, 2012). In the current study, acceptance and adoption (AA) of EC refers to an actual behavior which is the manifest and observable response in a given situation associated with the given target (Tarhini et al., 2016). Hence, this study assumes that the positive behavioral intention (BI) to adopt EC will contribute to acceptance and adoption of EC as proposed in the following hypothesis:

H9: Behavioral intention to adopt e-commerce positively affects Thai rice farmers' acceptance and adoption of e-commerce (+)

3. Research methodology

3.1 Population and study sample

The population of the study comprised rice farmers in Thailand. According to Thailand's agricultural census statistics from the National Statistical Office (2014), the total number of Thai rice farmers who hold areas for rice cultivation was approximately 3.78 million people. However, as the current study relates to the adoption of EC for rice selling, the selected sample for the data analysis consists of Thai rice farmers who already adopt or take part in EC either by selling or advertising via their own websites, public websites, Facebook, a mobile application, or other online channels. The sample size was determined by applying Taro Yamane's (1973) formula with a significance level of 95 percent. It was calculated by using 3.78 million as the total population (N) of rice farmers holding areas for rice cultivation. Thus, the number of rice farmers used as the sample for this research was 405, with this number being above the appropriate sample size of 400, based on Yamane's (1973) probabilities sampling method.

3.2 Research instrument

This research applied the quantitative method by conducting a survey using a structured questionnaire which was distributed to Thai rice farmers to test the variables in the conceptual model. The survey questions were developed based on an adaptation of the instrument developed by Venkatesh et al. (2003). In the current study, a back-translation process was used to ensure the validity of the questionnaire. This process enabled the identification, discussion, and modification of some ambiguity in the questionnaire, so it was easier to understand the questions and respondents could correctly infer the meaning of each question.

The questionnaire was divided into two parts: (1) demographic information of respondents in the sample consisting of age, gender, education level, monthly household income, and internet usage per day, and (2) the 10 main constructs of the study. The constructs comprised: (1) performance expectancy measured with four items (PE1-PE4); (2) effort expectancy with four items (EE1-EE4); (3) social influence with four items (SI1-SI4); (4) insufficient facilitating conditions with four items (FC1-FC4); (5) perceived implementation cost with four items (IC1-IC4); (6) perceived risk with three items (PR1-PR3); (7) sufficient IT knowledge and skills with four items (IT1-IT4); (8) government supports with eight items (GOV1-GOV8); (9) behavioral intention of EC adoption with four items (BI1-BI4); and (10) acceptance and adoption of EC with four items (AA1-AA4). Each construct was measured with multiple items using a five-point Likert-type scale.

The complete questionnaire (i.e., the survey instrument) was pre-tested and modified through the pilot study. This was conducted by distributing the questionnaire to 30 Thai rice farmers who had already adopted EC for rice selling, requesting that they complete the survey. This pre-testing process was undertaken to see if certain modifications were needed in the following aspects: to improve and resolve any ambiguity in the questions; to conduct an initial check on respondents' understanding of the instructions and to clarify the content; and to test the reliability and validity of the survey before the data collection method was administered and the final questionnaire was launched to targeted respondents (Saunders, Lewis & Thornhill, 2009).

3.3 Collection of data

Potential respondents in the targeted sample were reached by face-to-face conversation or telephone communication, or via an online chatting channel, such as Facebook, LINE, WeChat, or other website channels. This group of respondents was selected by the probability sampling technique. The snowball sampling technique was also applied to select respondents in the sample. The reason is that the snowball sampling technique or chain-referral sampling of a hidden population can help to find the network of a hidden population, with these techniques recommended when the population cannot be strictly delimited or detailed (Etikan, Alkassim, & Abbakar, 2016). As Thai rice farmers who have adopted EC for rice selling cannot be precisely estimated, this technique was useful for reaching the targeted sample. After obtaining the expected number of research respondents, outcomes from the statistical data analysis were calculated using the IBM Statistics SPSS program (version 25) and the Analysis of Moment Structures (AMOS) program (version 24).

3.4 Data analysis

After the research method and data collection requirements were completed, the data analysis was conducted. The reliability and validity of the questionnaire were first assessed to check the data's overall sufficiency. To ascertain the reliability of the concepts, Cronbach's alpha (α) coefficients were used to test the internal consistency, or the average correlation, of items in the survey instrument. Exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) were also performed in this research as statistical methods for testing validity. This research applied structural equation modeling (SEM) using the AMOS program to test the hypotheses. Hair, Black, Babin, and Anderson (2010) defined SEM as a multivariate technique, in which the features of multiple regression and factor analysis are combined to simultaneously estimate multiple networking relationships. This technique seeks to represent the observed data related to several structural parameters that are defined by a hypothesized underlying model. The SEM technique has been used to model the complex relationships of multiple endogenous (independent) and exogenous (dependent) variables (Gefen & Straub, 2000). It is a variance-based technique focused on maximizing the variance of the dependent variable that is explained by the independent variables in the model. Therefore, SEM allows a set of interrelated hypotheses to be tested in a single systematic analysis (Gefen & Straub, 2000).

4. Results

4.1 Demographic profile of respondents

Table 2: Demographic profile of respondents

Variables	**Levels**	**Frequency**	**Percent (%)**
Ages	20–30 years	27	6.77
	31–40 years	106	26.2
	41–50 years	157	38.8
	51–60 years:	82	20.2
	Over 60 years	33	8.1
Gender	Male	191	47.2

	Female	214	52.8
Education level	Less than secondary school	45	11.1
	High school	73	18.0
	Vocational certificate/diploma	117	28.9
	Bachelor's degree	147	36.3
	Master's degree	23	5.7
Monthly household income	Below 5,000 baht	9	2.2
	5,000–9,999 baht	44	10.9
	10,000–14,999 baht	83	20.5
	15,000–19,999 baht	107	26.4
	20,000 baht or above	162	40.0
Internet usage per day	Less than 2 hours	115	28.4
	2–5 hours	192	47.4
	6–10 hours	86	21.2
	More than 10 hours	12	3.0

Source: Author's calculation.

Table 2 presents the demographic profile of all respondents. The largest group of respondents were in the 41–50 age group, comprising 157 respondents (38.8 percent). This was followed by the 31–40 age group, comprising 106 respondents (26.2 percent); the 51–60 age group, comprising 82 respondents (20.2 percent); the group aged over 60 years, comprising 33 respondents (8.1 percent); the 20–30 age group, comprising 27 respondents (6.7 percent); with no respondents aged less than 20 years. Male respondents numbered 214 (52.8 percent), whereas 191 respondents (47.2 percent) were female. With regard to respondents' education level, the largest respondent group comprised those who held a Bachelor's degree (147 people; 36.3 percent); followed by vocational certificate or diploma holders (117 people; 28.9 percent); and those with a high school education (73 people; 18 percent).

In terms of respondents' monthly household income, this was categorized into five groups. The largest group of 162 people (40 percent) were those with a monthly household income of 20,000 baht or above. Next were the 107 people (26.4 percent) whose monthly household income ranged from 15,000–19,999 baht. The third largest group were the 83 people (20.5 percent) whose monthly household income ranged from 10,000–14,999 baht. Next were the 44 people (10.9 percent) whose monthly household income ranged from 5,000–9,999 baht. The fifth group were the 9 people (2.2 percent) whose household income was below 5,000 baht. As for the average internet usage per day, the largest group of respondents (192 people; 47.4 percent) used the internet on average for approximately 2–5 hours per day. This was followed by the next group of 115 people (28.4 percent) who used the internet on average less than 2 hours per day, whereas 86 people (21.2 percent) used the internet on average for approximately 6–10 hours per day, while 12 people (3 percent) used the internet on average for more than 10 hours per day.

4.2 Sampling adequacy, construct validity and reliability tests

The study presented and analyzed the results of tests for sampling adequacy, content and construct validity, and reliability as follows:

Sampling adequacy

The Kaiser–Meyer–Olkin (KMO) index provides a statistical measure that indicates the proportion of variance in the variables that might be affected by underlying factors. It measures sampling adequacy, with a high KMO index value (H1) showing that the factors of the items could be applicable, whereas a low KMO index value (≈ 0) shows that the process of grouping the items into factors is irrelevant. A KMO index value greater than 0.6 is deemed acceptable (Pett, Lackey, & Sullivan, 2003). Bartlett's test is based on using a chi-square to check sphericity by testing the null hypothesis to see if the correlation matrix is an identity matrix. Hence, the null hypothesis rejection indicates that the factor model is appropriate.

Table 3: Kaiser–Meyer–Olkin (KMO) index and Bartlett's test for sphericity

KMO index and Bartlett's test		
Kaiser–Meyer–Olkin measure of sampling adequacy.		0.836
Bartlett's test of sphericity	Approx. chi-square	7870.788
	Degree of frequency (*df*)	903
	Significance (Sig.).	0.000

Source: Author's calculation.

Table 3 presents the test results for the survey sampling's adequacy. As shown on the table, the KMO index value is 0.836, which is greater than the minimum recommended value, so the survey sampling can be accepted as having high validity. The result for Bartlett's test of sphericity is significant ($\chi^2[df = 903] = 7870.788$, 0.000 [$p < 0.05$]) showing that considerable common variance exists between survey items. The test diagnostic confirms that the collected data satisfy the assumption, so factor analysis can proceed.

Factor analysis

Prior to the data analysis, factor analysis was applied to explore the patterns between sets of correlated variables to ensure the reliability and validity of the study's model. As stated by Vogt, Gröger, and Zimmermann (2007), factor analysis is mostly used to cluster variables into the appropriate group of variables. The two major types of factor analysis are: exploratory factor analysis (EFA) and confirmatory factor analysis (CFA). To be specific, EFA is applied to explore the possible underlying structures behind correlations between different factors, whereas CFA is conducted to extract the score of each variable taking into account the loading of items, with cross-loading items not assigned to any factor. The main objective of factor analysis is to link each item with factors, so items within the same factor should relate to each other. To verify construct validity, factor analysis was conducted based on principal component analysis (PCA) with the Varimax rotation method. Prior studies suggest that the minimum recommended value in research for the correlation coefficient should be greater than 0.4 (Straub et al., 2004). In the current study, if the item had a correlation coefficient with a value lower than 0.4 and was not related to any factor, it was removed from further analysis. In addition, the researcher ensured that the correlation matrix did not possess the highly undesirable

properties of multicollinearity or singularity as this would imply a condition in which variables were highly correlated.

Exploratory factor analysis (EFA)

Exploratory factor analysis (EFA) aims to determine the nature of the influences of constructs on a set of responses. The current study's conceptual model hypothesized that the survey should have 10 uncorrelated factors (latent variables). EFA was conducted on the survey items to test these hypotheses. The factor naming and interpretability of the latent variables were set by the theoretical model constructs. However, it needs to be noted that latent variables with item loading values lower than 0.5 were omitted from further analysis. Only factors with values higher than 0.5 were retained for further analysis. Two items, EE1 and BI4, had values lower than 0.5, with EE1 and BI4 supposed to load only to their own factor but having cross-loadings to other factors. Hence, EE1 and BI4 were removed; as a result, 41 items represented the 10 uncorrelated factors in the analysis.

Confirmatory factor analysis (CFA)

Confirmatory factor analysis (CFA) was conducted to extract the loading scores of each of the 10 factors. In each run, this analysis was conducted only with groups of items that contributed to the given factors. Therefore, as previously mentioned, EE1 and BI4, which had cross-loadings, were excluded from the CFA testing. Factor loadings of all 41 items had values above the recommended value of 0.50 (Hair et al., 2010). In addition, the composite reliability (CR) values of the constructs ranged from 0.75 to 0.89, satisfying the standard of at least 0.7, while the average variance extracted (AVE) values for each construct also met the threshold of AVE $\geq$ 0.5, thus suggesting good convergent validity (Fornell & Larcker, 1981). Table 4 presents a summary of the CFA results. Furthermore, to test for discriminant validity, the square roots of AVE values and their correlation with the other factors were compared. As shown in Table 5, the square roots of AVE values were greater than the correlation between the variables, revealing good discriminant validity (Fornell & Larcker, 1981).

Reliability test and internal consistency

After conducting factor analysis, the reliability of the concept needed to be tested to check the internal consistency of the ten constructs (latent variables). To test a concept's reliability, Cronbach's alpha (α) coefficient values are used to test the internal consistency of the average correlation of items in a survey instrument. Cronbach's alpha (α) coefficient values should be higher than 0.7 to be recognized as indicating reliability (Field, 2009). As shown in Table 4, the values of Cronbach's alpha (α) coefficients of each variable are greater than 0.7 (performance expectancy [PE] 0.706; effort expectancy [EE] 0.706; social influence [SI] 0.747; perceived implementation cost [IC] 0.711; perceived risk [PR] 0.846; sufficient IT knowledge and skills [IT] 0.788; government support [GOV] 0.908; insufficient facilitating conditions [FC] 0.787; behavioral intention [BI] of EC adoption 0.857; and acceptance and adoption [AA] of EC 0.822). Thus, the overall consistency of the survey can be confirmed, and all variables are accepted as reliable.

Table 4: Item loadings on related factors

No.	Variables	Items	Factor	AVE	CR	Cronbach's alpha
1.	PE	PE1	0.505	0.67	0.80	0.706
		PE2	0.537			
		PE3	0.687			
		PE4	0.600			
2.	EE	EE2	0.709	0.59	0.81	0.706
		EE3	0.663			
		EE4	0.599			
3.	SI	SI1	0.646	0.52	0.77	0.747
		SI2	0.774			
		SI3	0.536			
		SI4	0.677			
4.	IC	IC1	0.636	0.55	0.78	0.711
		IC2	0.882			
		IC3	0.551			
		IC4	0.637			
5.	PR	PR1	0.797	0.65	0.85	0.846
		PR2	0.806			
		PR3	0.825			
6.	FC	FC1	0.668	0.63	0.89	0.787
		FC2	0.775			
		FC3	0.726			
		FC4	0.618			
7.	IT	IT1	0.790	0.62	0.83	0.788
		IT2	0.784			
		IT3	0.625			
		IT4	0.668			
8.	GOV	GOV1	0.666	0.54	0.75	0.908
		GOV2	0.767			
		GOV3	0.769			
		GOV4	0.825			
		GOV5	0.783			
		GOV6	0.654			
		GOV7	0.655			
		GOV8	0.689			
9.	BI	BI1	0.780	0.61	0.82	0.857
		BI2	0.815			
		BI3	0.825			
10.	AA	AA1	0.701	0.70	0.87	0.822
		AA2	0.727			
		AA3	0.777			
		AA4	0.825			

Note: AA = acceptance and adoption of e-commerce; EE = effort expectancy; FC = insufficient facilitating conditions; GOV = government support; IC = perceived implementation cost; BI = behavioral intention; IT = information technology (IT) knowledge and skills; PE = performance expectancy; PR = perceived risk; and SI = social influence

Source: Author's calculation.

Table 5: Correlation coefficient matrix and square root of AVEs

	PE	EE	SI	IC	PR	IT	GOV	FC	BI	AA
PE	**0.819**									
EE	0.326	**0.768**								
SI	0.359	0.340	**0.721**							
IC	0.352	0.338	0.310	**0.742**						
PR	0.347	0.357	0.332	0.398	**0.806**					
IT	0.385	0.333	0.438	0.395	0.304	**0.787**				
GOV	0.336	0.404	0.381	0.460	0.323	0.396	**0.735**			
FC	0.309	0.408	0.365	0.360	0.491	0.393	0.309	**0.794**		
BI	0.334	0.338	0.304	0.450	0.455	0.338	0.388	0.334	**0.781**	
AA	0.497	0.405	0.537	0.442	0.487	0.419	0.451	0.423	0.440	**0.837**

Note: AA = acceptance and adoption of e-commerce; EE = effort expectancy; FC = insufficient facilitating conditions; GOV = government support; IC = perceived implementation cost; BI = behavioral intention; IT = information technology (IT) knowledge and skills; PE = performance expectancy; PR = perceived risk; and SI = social influence.
Source: Author's calculation.

4.3 Results of structural equation modeling (SEM)

To test the research hypotheses, structural equation modeling (SEM) was employed using the AMOS statistics software program which is compatible with the IBM Statistics SPSS software program. SEM is a combination of both factor analysis and path analysis. It was chosen as the primary tool for testing the model because, unlike linear regression or analysis of variance (ANOVA), testing the relationships between independent and dependent variables can be accomplished simultaneously. With the results presented in Table 6, the model fit was assessed using a combination of various types of fit indices in different categories (Hair et al., 2010). Following are the results for the model's fit: CMIN (x^2) = 681.939; *df* = 625; *p*-value = 0.057; CMIN/*df* = 1.091; GFI = 0.928; AGFI = 0.992; CFI = 0.992; NFI = 0.914; RMSEA = 0.020; and RMR = 0.015. Hence, the results of all the fit indices for the final model met the recommended level of an acceptable fit.

Table 6: Model fit indices of structural model

Fit indices	Recommended	Model	Results
Chi-square/degrees of freedom (CMIN/*df*)	≤ 3.00	1.091	Acceptable
p-value	P ≥ 0.05	0.057	Acceptable
Goodness-of-fit index (GFI)	≥ 0.90	0.928	Acceptable
Adjusted goodness-of-fit index (AGFI)	≥ 0.90	0.901	Acceptable
Comparative fit index (CFI)	≥ 0.90	0.992	Acceptable
Normed fit index (NFI)	≥ 0.90	0.914	Acceptable
Root mean square error of approximation (RMSEA)	≤ 0.05	0.020	Acceptable
Root mean square residual (RMR)	≤ 0.05	0.015	Acceptable

Source: Applied the recommended values from Hair et al. (2010)

Overall, the structural model explained approximately 37.1 percent (0.371) of variances in behavioral intention and 27.4 percent (0.274) of variances in acceptance and adoption of EC, as shown in Table 7 below. The SEM path analysis findings supported the assumption that four predictors had a statistically significant effect on behavioral intention (BI) at an 0.05 significance level. These predictors comprised performance expectancy (PE) (β = 0.190, CR = 2.585, *p*-value = 0.010); effort expectancy (EE) (β = -0.176, CR = -2.154, *p*-value = 0.031); sufficient IT knowledge and skills (β = 0.298, CR = 3.080, *p*-value = 0.001); and government support (β = 0.218, CR = 3.089, *p*-value = 0.002). The findings revealed no statistical significance support for the impact of social influence (SI) (β = 0.125, CR = 1.564, *p*-value = 0.118); perceived implementation cost (IC) (β = -0.039, CR = -0.658, *p*-value = 0.510); and perceived risk (PR) (β = 0.036, CR = 0.509, *p*-value = 0.611) on behavioral intention (BI). With regard to impact on acceptance and adoption (AA) of EC, the findings indicated statistical significance for the impact of behavioral intention (BI) on acceptance and adoption (AA) of EC (β = 0.524, CR = 8.345, *p*-value = 0.001), whereas insufficient facilitating conditions (FC) had no statistically significant impact on acceptance and adoption (AA) of EC (β = -0.007, CR = -0.132, *p*-value = 0.895).

Table 7: SEM results: Path estimates

			Estimate	CR	*p*-value	Results
BI	**<---**	**PE**	**0.190**	**2.585**	**0.010**	**Supported**
BI	**<---**	**EE**	**-0.176**	**-2.154**	**0.031**	**Supported**
BI	<---	SI	0.125	1.564	0.118	Not supported
BI	<---	IC	-0.039	-0.658	0.510	Not supported
BI	<---	PR	0.036	0.509	0.611	Not supported
BI	**<---**	**IT**	**0.298**	**3.080**	*******	**Supported**
BI	**<---**	**GOV**	**0.218**	**3.089**	**0.002**	**Supported**
AA	<---	FC	-0.007	-0.132	0.895	Not supported
AA	**<---**	**BI**	**0.524**	**8.345**	*******	**Supported**

Notes: R^2 of behavioral intention = 0.371; R^2 of acceptance and adoption = 0.274;
**p*-value < 0.05; ** *p*-value < 0.01; ****p*-value < 0.001
Source: Author's calculation.

4.4 Summary of final hypotheses and significant values

Table 8 presents the summary of results from testing the nine hypotheses. Statistical evidence from the SEM path model can confirm five of these hypotheses (H1, H2, H6, H7, and H9). Statistical support is found for the positive influence of performance expectancy (PE), sufficient IT knowledge and skills (IT), and government support (GOV) on the behavioral intention (BI) to adopt EC for rice selling, whereas effort expectancy (EE) has a negative effect. Through the statistical evidence, hypotheses H1, H2, H6, and H7 can be confirmed, as results are consistent with these assumptions. Furthermore, statistical support is found for the relationship between behavioral intention (BI) and the acceptance and adoption (AA) of EC; thus, the statistical confirmation of hypothesis H9 is consistent with the assumption. Unfortunately, the findings are unable to provide statistical support for the significance of the relationships of social influence (SI), perceived implementation cost (IC), and perceived risk (PR) with behavioral intention (BI), nor for the significance of the relationship of insufficient facilitating conditions (FC) with the acceptance and adoption (AA) of EC for rice selling, as their respective *p*-values are greater than 0.05. Therefore, hypotheses H3, H4, H5, and H8 are found to have no statistical significance, thus leading to acceptance of the null hypotheses. The summary of the model's hypotheses and significant values is portrayed in Figure 5.

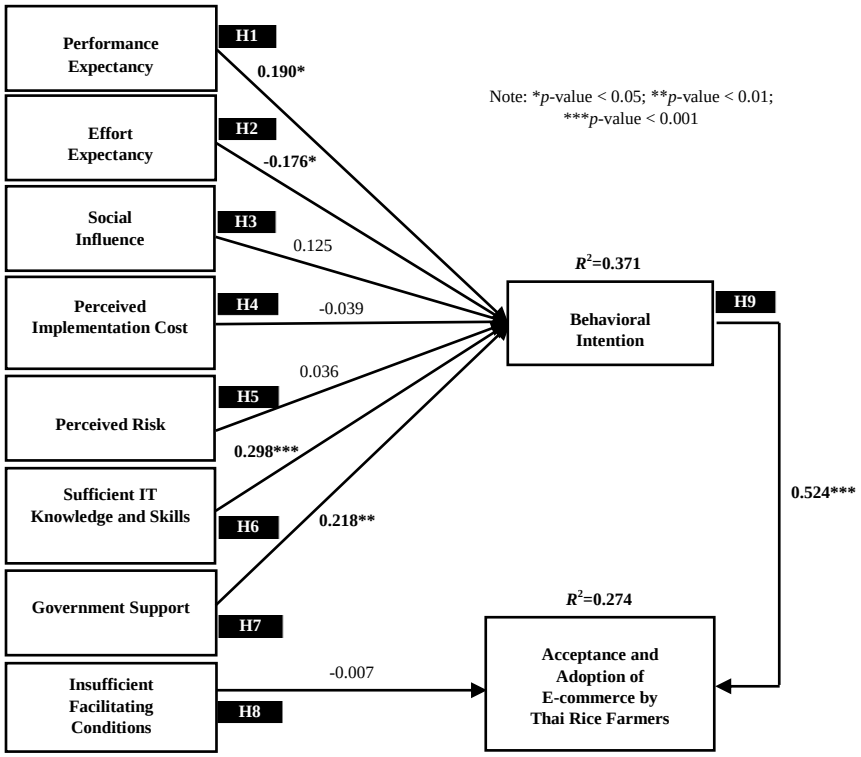
Table 8: Summary of hypotheses and significant values

No.	Relationship tests	Results
H1	The performance expectancy of e-commerce adoption for rice selling is positively related to Thai rice farmers' behavioral intention to adopt e-commerce (+)	Alternative hypothesis is **supported** ($p < 0.05$) as the relationship between the two variables is positive with statistical support (β = 0.190; *t*-value = 2.585; *p*-value = 0.010).
H2	The effort expectancy of e-commerce adoption for rice selling negatively affects Thai rice farmers' behavioral intention to adopt	Alternative hypothesis is **supported** ($p < 0.05$) as the relationship between the two variables is negative with statistical support (β = -0.176;

No.	Relationship tests	Results
	e-commerce (-)	*t*-value = -2.154; *p*-value = 0.031).
H3	The social influence on Thai rice farmers' e-commerce adoption for rice selling positively affects their behavioral intention to adopt e-commerce (+)	Null hypothesis is **supported** ($p > 0.05$) as the relationship between the two variables is positive with no statistical support ($\beta = 0.125$; *t*-value = 1.564; *p*-value = 0.118).
H4	High e-commerce implementation cost negatively affects Thai rice farmers' behavioral intention to adopt e-commerce (-)	Null hypothesis is **supported** ($p > 0.05$) as the relationship between the two variables is negative with no statistical support ($\beta = -0.039$; *t*-value = -0.658; *p*-value = 0.510).
H5	The perceived risk of e-commerce adoption for rice selling negatively affect Thai rice farmers' behavioral intention to adopt e-commerce (-)	Null hypothesis is **supported** ($p > 0.05$) as the relationship between the two variables is positive with no statistical support ($\beta = 0.036$; *t*-value = 0.509; *p*-value = 0.661).
H6	Sufficient IT knowledge and skills positively affect Thai rice farmers' behavioral intention to adopt e-commerce (+)	Alternative hypothesis is **supported** ($p < 0.05$) as the relationship between the two variables is positive with statistical support ($\beta = 0.298$; *t*-value = 3.080; *p*-value = 0.001).
H7	Government support positively affects Thai rice farmers' behavioral intention to adopt e-commerce (+)	Alternative hypothesis is **supported** ($p < 0.05$) as the relationship between the two variables is positive with statistical support ($\beta = 0.218$; *t*-value = 3.089; *p*-value = 0.002).
H8	Insufficient facilitating conditions for e-commerce adoption negatively affect Thai rice farmers' acceptance and adoption of e-commerce (-)	Null hypothesis is **supported** ($p > 0.05$) as the relationship between the two variables is negative with no statistical support ($\beta = -0.007$; *t*-value = -0.132; *p*-value = 0.895).
H9	The behavioral intention to adopt e-commerce positively affects Thai rice farmers' acceptance and adoption of e-commerce (+)	Alternative hypothesis is **supported** ($p < 0.05$) as the relationship between the two variables is positive with statistical support ($\beta = 0.524$; *t*-value = 8.345; *p*-value = 0.001).

Source: Author's calculation.

Figure 5: Path diagram and hypotheses testing results



Source: Author's calculation.

5. Discussion

The current study explores the influencing factors on EC adoption by Thai rice farmers for rice selling. The study findings supported five of the total nine hypotheses. In a psychological model, the individual's behavior is predictable and influenced by the individual's behavioral intention. It was assumed that if Thai rice farmers have a positive behavioral intention to adopt EC for rice selling, they would tend to have a high chance of accepting and adopting this platform. The results confirmed a statistically positive relationship between behavioral intention (BI) and acceptance and adoption (AA) of EC for rice selling. This finding is consistent with studies by Venkatesh et al. (2003); Casey and Wilson-Evered (2012); Alkhunaizan and Love (2012); Yu (2012); Tan et al. (2013); Tarhini et al. (2016); and Bhatiasevi (2016) which indicated that the relationship between behavioral intention and actual use of technology was significant and straightforward.

Thus, to encourage more Thai rice farmers to adopt EC for rice selling, it is vital to understand the influencing factors that could affect their behavioral intention. If rice farmers could develop a high level of behavioral intention to adopt EC for rice selling, their acceptance and adoption of EC would be more likely. A positive relationship was also found between performance expectancy (PE) and Thai rice farmers' behavioral intention (BI) to adopt EC for rice selling. This indicated that rice farmers tended to have a positive attitude towards EC adoption for rice selling as it would allow them to achieve better

performance. For example, they would have the capability to expand their market, and would be able to reduce intermediaries' activities, increase price negotiation, lower transaction cost, gain profit from supply chain shortages, etc. The results also confirmed, with statistical support, that effort expectancy (EE) had a negative effect on Thai rice farmers' behavioral intention (BI) to adopt EC for rice selling which is consistent with studies by Venkatesh et al. (2003); Wang and Wang (2010); Casey and Wilson-Evered (2012); Alkhunaizan and Love (2012); and Bhatiasevi (2016) that revealed a relationship between effort expectancy (EE) and behavioral intention (BI). This could indicate that Thai rice farmers tended to have negative attitudes towards the ease of EC adoption for rice selling, implying that, to them, the adoption of e-commerce appeared difficult.

Of the four constructs added to the existing UTAUT model, the findings supported two, that is, sufficient IT knowledge and skills (IT) and government support (GOV) that were supported by the study's hypotheses. A positive relationship was found between sufficient IT knowledge and skills (IT) and Thai rice farmers' behavioral intention (BI) to adopt EC for rice selling. This was consistent with findings from previous studies by Wang and Wang (2010); Alenezi, Karim and Veloo (2010); and Zhao and Khan (2013) showing that computer self-efficacy can influence the behavioral intention to adopt technology. This inferred that Thai rice farmers with more capability in using IT would be more likely to adopt EC for rice selling. This study also found a positive relationship between government support (GOV) and Thai rice farmers' behavioral intention (BI) to adopt EC for rice selling. This finding from the current study was similar to the findings of Looi (2005) and Ilin, Ivetić, and Simić (2017) in which government support was found to influence the adoption of technology.

In the current study, government support was found to be a factor influencing Thai rice farmers' EC adoption, especially at this early stage, with many rice farmers still lacking many resources and needing strong guidance and policies to follow. Active involvement of the government and relevant competent authorities is required to initiate master plans and policies that consider all critical factors for the sustainable deployment of EC adoption by Thai rice farmers for rice selling.

Notwithstanding the supported hypotheses, this study did not find statistical support for the other four hypotheses. Many studies have highlighted that perceived risk (PR) influences the behavioral intention (BI) of the technology adopter, whereas the current study was unable to find a significant relationship between these variables. The perceived risk or uncertainty about adoption of the technology is subjective for each adopter and, in this case, is possibly differentiated according to their educational background, EC experience, and IT capabilities, etc. The respondents in this study were Thai rice farmers who had already adopted EC, so it is possible they were familiar with and had a clear understanding of the EC system.

This study's results showed that no statistical support was found for the relationship between perceived implementation cost (IC) and behavioral intention (BI) to adopt EC for rice selling. However, technology adoption is inevitably related to implementation cost which could be burden to the adopter. In reality, Thai rice farmers appear to have massive differences in their financial readiness. At this juncture, EC adoption appears to be suitable for Thai rice farmers who have their own capital and do not rely on support for the implantation cost and agricultural tools from rice middlemen. A surprising revelation was the insignificant relationship between social influence (SI) and rice farmers' behavioral intention (BI) to adopt EC for rice selling. This was in contrast to other findings, such as

those in the work of Venkatesh et al. (2003); Yu (2012); and Slade, Dwivedi, Piercy, and Williams (2015), in which it was asserted that social influence was an influencing predictor of behavioral intention. Although the present study's results cannot confirm the significance of the impact between these two variables, the opinions or notions of their communities, especially those of rice farmers who were successful in EC adoption, were still considered to be important factors along with encouragement from the government, competent authorities, and agricultural cooperatives, as well as buyer behavior.

This study also did not find a relationship between insufficient facilitating conditions (FC) and the acceptance and adoption (AA) of EC for rice selling which is contradictory to the previous findings of Venkatesh et al. (2003); Yu (2012); and Tarhini et al. (2016) which found facilitating conditions to be an important predictor that directly affects actual use of technology. In fact, facilitating conditions for EC adoption in Thailand have probably improved significantly over the past decade through the government's allocation of a budget to construct a nationwide broadband network for villages and to create digital application platforms, including an e-marketplace, e-payments, and e-government. However, the low availability of facilitating conditions may persist in some districts, in Thailand, especially in rural areas and the countryside.

6. Conclusion

This research aimed to explore the factors that could influence Thai rice farmers' behavioral intentions to adopt EC for rice selling. The study proposed modification and extension of the UTAUT model to include the use of EC for rice selling in Thailand. This research, based on the perceptions of Thai rice farmers who have already adopted EC for rice selling, produced several interesting findings, providing statistical evidence that rice farmers' behavioral intentions (BI) contribute to the acceptance and adoption (AA) of EC for rice selling. Performance expectancy (PE), effort expectancy (EE), sufficient IT knowledge and skills (IT), and government support (GOV) were also found to have significant relationships with the behavioral intention (BI) to adopt EC for rice selling. These findings indicate that Thai rice farmers tend to adopt EC for rice selling as it could help them to improve their selling performance, although it would require an amount of effort. Sufficient IT knowledge and skills seem to be a significant factor for Thai rice farmers' behavioral intention to adopt EC for rice selling. Furthermore, government support for the adoption of EC for rice selling seems to be an influencing factor on behavioral intentions to accept and adopt EC for rice selling. Unfortunately, no statistical support was found for the impact of social influence (SI), perceived implementation cost (IC), and perceived risk (PR) on behavioral intention (BI), nor of the influence of insufficient facilitating conditions (FC) on the acceptance and adoption (AA) of EC for rice selling.

The contributions of this study are twofold, the first of which is initiating EC practice for rice products in Thailand's market. Rice must pass through many processes before it reaches consumers' hands, with the price definitely manipulated along the whole process. Therefore, EC adoption could be an alternative rice selling channel which would allow Thai rice farmers to directly contact potential consumers in all areas at any time. Moreover, although many business sectors make enormous use of EC, in relation to rice selling in Thailand, the practice of EC is still in its infancy. This study's findings are expected to provide an important pathway for Thai rice farmers to adopt EC as a rice

selling channel. The findings could also assist relevant government agencies to provide suggestions to and ways in which to persuade Thai rice farmers to use the EC platform more in the future.

The second contribution is the study's theoretical implications as it has modified and extended the UTAUT model in the agricultural products sector in Thailand. This model framework could ultimately be used as a model providing guidance to other business sectors, especially those involving other agricultural products and perishable goods.

Regarding policy recommendations, it is highly recommended that the country's policy makers should seriously consider the many influencing factors that affect Thai rice farmers' EC adoption. The following policy recommendations provide initial guidance and a pathway, with these derived from the various research findings. Firstly, policy makers should initiate programs to assist Thai rice farmers to understand relevant laws and regulations concerning EC adoption. At this early stage, rice farmers should be fully assisted and protected by the law with regulatory issues addressed which would provide them with legal certainty so they can be secure and confident to proceed with the adoption of EC for rice selling. Secondly, it is strongly recommended that policy makers consider designating competent authorities as the main focal point for the country, specifically addressing all issues related to rice farmers' EC adoption in the long term. This focal point is expected to play a significant role by being responsible for Thailand's development of rice farmers' EC adoption. The establishment of EC service centers, situated in many provinces around Thailand, would also be significant in promptly providing information and suggestions as well as helping rice farmers to solve any problems regarding EC adoption.

Nevertheless, this research also has some limitations. The initial reason is that most Thai rice farmers still rely on the traditional way of rice selling, while a lesser number have already adopted EC for rice selling. This research was based on the perceptions of Thai rice farmers who had already adopted EC for rice selling. This was in line with the study's intention to investigate the factors that influence Thai rice farmers' behavioral intentions and their actual behavior of adopting EC for rice selling. Therefore, other Thai rice farmers who had not yet adopted EC for rice selling were excluded in the data analysis, probably leading to some bias in the study's results. Even though Thailand has an extremely sophisticated rice supply chain, this research model only focused on the four main constructs of the UTAUT model as well as four additional constructs. Consequently, other important factors that could have a direct or indirect effect on the behavioral intentions of, and EC adoption by, Thai rice farmers may have been omitted.

Further research could build on the proposed research model, for example, by investigating a different agricultural product or perishable goods, or in the context of a different country. The current study used a quantitative method to collect data from 405 Thai rice farmers who had already adopted EC for rice selling. The study could be extended by surveying other farmers who have not yet adopted EC for rice selling, or by adding a qualitative method to conduct in-depth interviews. In addition to these suggestions, other important variables, such as legal issues, collaboration among Thai rice farmers, trust, or culture, as well as other control variables, such as age, gender, and education, could be integrated into the conceptual model to obtain a better and more in-depth understanding of EC adoption by Thai rice farmers for rice selling.

References

Abrahão, R.D.S., Moriguchi, S.N., & Andrade, D.F. (2016). Intention of adoption of mobile payment: An analysis in the light of the Unified Theory of Acceptance and Use of Technology (UTAUT). *RAI Revista de Administração e Inovação*, 13(2016), 221-230.

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, 50(2), 179-211.

Alenezi, A.R., Karim A.M.A. and Veloo, A. (2010). An empirical investigation into the role of enjoyment, computer anxiety, computer self-efficacy and internet experiment in influencing the students' intention to use e-learning: A case study from Saudi Arabian Governmental Universities, *The Turkish Online Journal of Educational Technology*, 9(4), 22-34.

Alhilali, A. (2013). Technology adaptation model and road map to successful implementation of ITIL. *Journal of Enterprise Information*, 26(5), 553-576.

Alkhunaizan, A., & Love, S. (2012). What drives mobile commerce? An empirical evaluation of the revised UTAUT model. *International Journal of Management and Marketing Academy*, 2(1), 82-99.

Alshehri, M., Drew, S., Alhussain, T., & Alghamdi, R. (2012). The effects of website quality on adoption of e-government service: An empirical study applying UTAUT model using SEM. *Proceedings of the 23rd Australasian Conference on Information Systems*, Geelong, Australia.

Bhatiasevi, V. (2016). An extended UTAUT model to explain the adoption of mobile banking. *Information Development*, 32(4), 799-814.

Biucky, S.T., Abdolvand, N., & Harandi, S.R. (2017). The effects of perceived risk on social commerce adoption based on the TAM model. *International Journal of Electronic Commerce Studies*, 8(2), 173-196.

Casey, T., & Wilson-Evered, E. (2012). Predicting uptake of technology innovations in online family dispute resolution services: An application and extension of the UTAUT. *Computer Human Behavior*, 28, 2034-2045.

Carpio, C.E., Isengildina-Massa, O., Lamie, R.D., & Zapata, S.D. (2013). Does e-commerce help agricultural markets? The case of market maker. *The magazine of food, farm, and resource issues 4th Quarter*, 28(4).

El-fitouri, M.O. (2015). E-commerce in developing countries: A case study on the factors affecting e-commerce adoption in Libyan companies. *International Journal of Engineering Research and Applications*, 5(1), 102-115.

Etikan, I., Alkassim, R., & Abbakar, S. (2016). Comparison of snowball sampling and sequential sampling technique. *Biometrics & Biostatistics International Journal*, 3(1), 1-2.

Field, A. (2009). *Discovering statistics using SPSS* (3rd ed.). London, UK: Sage Publication Ltd. Fornell, C., & Larcker, D. (1981). Structural equation models with unobservable variables and measurement error. *Journal of Marketing Research*, 18(1): 39–50.

Gefen, D., & Straub, D. (2000). The relative importance of perceived ease of use in IS adoption: A study of e-Commerce adoption. *Journal of the Association for Information Systems*, 1(8), 1-28.

Ghobakhloo, M., & Tang, S.H. (2013). The role of owner/manager in adoption of electronic commerce in small businesses: The case of developing countries. *Journal of Small Business and Enterprise Development*, 20(4), 754-787.

Hair, J.F., Black, W.C., Babin, B.J., & Anderson, R.E. (2010). *Multivariate data analysis* (7th ed.). Upper Saddle River, NJ: Prentice Hall.

Ilin, V., Ivetić, J., & Simić, D. (2017). The determinants of e-business adoption in ERP-enabled firms and non-ERP-enabled firms: A case study of the Western Balkan Peninsula. *Technological Forecasting & Social Change*, 125(2017), 206-223.

Im, I., Kim, Y., & Han, H.J. (2008). The effect of perceived risk and technology type on users' acceptance of technologies. *Information & Management*, 45, 1-9.

Jamaluddin, N. (2013). Adoption of e-commerce practices among the Indian farmers, A survey of Trichy District in state of Tamilnadu, India. *Procedia Economics and Finance*, 7(2013), 140-149.

Kabango, C.M., & Asa, A.R. (2015). Factors influencing e-commerce development: implications for the developing countries. *International Journal of Innovation and Economic Development*, 1(1), 64-72.

Kapurubandara, M., & Lawson, R. (2006). Barriers to adopting ICT and e-commerce with SMEs in developing countries: An exploratory study in Sri Lanka. *Proceedings of the Conference on Collaborative Electronic Commerce Technology and Research*, Adelaide, Australia.

Kyobe, M. (2011). Investigating the key factors influencing ICT adoption in South Africa, *Journal of Systems and Information Technology*. 13(3), 255-267.

Lawrence, J.E., & Tar, U.A. (2010). Barriers to ecommerce in developing countries. *Information, Society & Justice*, 3(1), 23-35.

Looi, H.C. (2005). E-commerce adoption in Brunei Darussalam: A quantitative analysis of factors influencing its adoption. *Communications of the Association for Information Systems*, 15(3), 61–81.

Martín, H.S., & Herrero, A. (2012). Influence of the user's psychological factors on the online purchase intention in rural tourism: Integrating innovativeness to the UTAUT framework. *Tourism Management*, 33, 341-350.

National Statistical Office (2014). *2013 Agricultural census whole Kingdom.* Retrieved from *http://web.nso.go.th/en/census/agricult/cen_agri03.htm*

Office of Agricultural Economics (2019). *Agricultural statistics of Thailand 2018*. Retrieved from http://www.oae.go.th/assets/portals/1/files/jounal/2562/yearbook 2561.pdf

Pett, M., Lackey, N., & Sullivan, J. 2003. *Making sense of factor analysis*. Thousand Oaks, CA: Sage Publications, Inc.

Sahavacharin, N., & Srinon, R. (2016). The influence of price transmission on Thai Hom Mali rice supply chain. *Proceedings of the International MultiConference of Engineers and Computer Scientists 2016*, (Vol. 2).

Saunders, M., Lewis, P., & Thornhill, A. (2009). *Research methods for business students* (5th ed.). Essex: Prentice Hall.

Slade, E.L., Dwivedi, Y.K., Piercy, N.V., & Williams, M.D. (2015). Modeling consumers' adoption intentions of remote mobile payments in the United Kingdom: Extending UTAUT with innovativeness, risk, and trust. *Psychology & Marketing*, 32(8), 860–873.

Straub, E.T. (2009). Understanding technology adoption: Theory and future directions for informal learning. *Review of Educational Research*, 79(2), 625-649.

Tan, K.S., Chong, S.C., & Lin, B. (2013). Intention to use internet marketing: A comprehensive study between Malaysians and South Koreans. *Kybernetes*, 42(6), 888-905.

Tarhini, A., El-Masri, M., Ali, M., & Serrano, A. (2016). Extending the UTAUT model to understand the customers' acceptance and use of internet banking in Lebanon: A structural equation modeling approach. *Information Technology & People*, 29(4), 830-849.

Terzis, V., & Economides, A.A. (2011). The acceptance and use of computer based assessment. *Computer and Education*, 56, 1032-1044.

Titapiwatanakun, B. (2012). *The rice situation in Thailand* (Project Number: TA-REG 7495). Technical Assistance Consultant's Report. Asian Development Bank. Retrieved from https://www.adb.org/sites/default/files/project-document/73082/43430-012-reg-tacr-03.pdf

Venkatesh, V., Morris, M.G., Davis, G.B., & Davis, F.D. (2003). User acceptance of information technology: Toward a unified view. *MIS Quarterly*, 27(3), 425-478.

Vogt, L., Gröger, T., & Zimmermann, R. (2007). Automated compound classification for ambient aerosol sample separations using comprehensive two-dimensional gas chromatography-time-of-flight mass spectrometry. *Journal of Chromatography A*, 1150(1-2), 2-12.

Wang, H.Y., & Wang, S.H. (2010). User acceptance of mobile internet based on the unified theory of acceptance and use of technology: Investigating the determinants and gender differences. *Social Behavior and Personality*, 38(3), 415-426.

Wattanutchariya, W., Tansuchat, R., & Ruennareenard, J. (2016). Supply chain management of Thai parboiled rice for export. *International Conference on Industrial Engineering and Operations Management*, 504-510.

Wu, Y.L., Tao, U.H., & Yang, P.C. (2007). Using UTAUT to explore the behavior of 3G mobile communication users. *IEEE*, 199-203.

Yamane, T. (1973). *Statistics: An introductory analysis* (3rd ed.). New York, NY: Harper and Row.

Yu, C.S. (2012). Factors affecting individuals to adopt mobile banking: Empirical evidence from the UTAUT model. *Journal of Electronic Commerce Research*, 13(2), 104-121.

Zhao, F., & Khan, M.S. (2013). An empirical study of e-government service adoption: Culture and behavioral intention. *International Journal of Public Administration*, 36, 710–722.

Appendix A

Constructs of hypothetic research model scale design for the following questionnaire:

Variables	**Items**		**References (Adapted from)**
Performance Expectancy (PE1 – PE4)	PE1:	Adoption of e-commerce for rice selling will be able to increase trade opportunity.	Venkatesh et al. (2003); Im et al. (2011); Martín & Herrero (2012); Yu (2012); Tan et al. (2013)
	PE2:	Adopting of e-commerce for rice selling can increase profit.	
	PE3:	Adopting of e-commerce for rice selling can avoid middleman in intervening the price.	
	PE4:	Adopting of e-commerce for rice selling can increase a chance to sell rice more quickly.	
Effort Expectancy (EE1-EE4)	EE1:	Adopting of e-commerce for rice selling requires good IT skills.	Venkatesh et al. (2003); Abrahão et al. (2016); Yu (2012); Tan et al. (2013)
	EE2:	Adopting of e-commerce for rice selling is complicate, difficult to understand due to many technical processes.	
	EE3:	Adopting of e-commerce for rice selling requires good languages skills e.g. Thai and English etc.	
	EE4:	Adoption of e-commerce for rice selling requires electronic banking knowledge, such as registration, online payment or money transfer.	
Social Influence (SI1-SI4)	SI1:	As the change of consumer behavior which more using e-commerce, adopting of e-commerce for rice selling seems to be more important.	Venkatesh et al. (2003); Tan et al. (2013)
	SI2:	As promoting and facilitating by Government policies, it can contribute to the more importance of the adoption of e-commerce for rice selling.	
	SI3:	The social influences and new trends of doing business in the digitalization era will influence the rice selling via e-commerce being more important.	
	SI4:	E-commerce successful Farmer is an important role model to e-commerce adoption.	
Perceived Implementation Cost (IC1-IC4)	IC1:	The cost of internet service and IT equipment of using of e-commerce will inhibit the adoption of e-commerce for rice selling.	Yu (2012); Ghobakhloo & Tang (2013); Abrahão et al. (2016)
	IC2:	There are concerns about cost of rice producing and selling directly to consumer.	
	IC3:	The cost of transportation for rice delivery will inhibit the adoption of e-commerce for rice selling due to it affects to the price of rice.	
	IC4:	Cost of the internet and IT equipment for selling rice does not affect the intention to e-commerce adoption.	
Perceived Risk (PR1-PR3)	PR1:	Adoption of e-commerce for rice selling has the risk from Cybercrime e.g. data theft, fake information and/or misuse of information.	Abrahão et al. (2016); Ghobakhloo & Tang, (2013)
	PR2:	Adoption of e-commerce for rice selling has the risk from dishonest or cheating.	
	PR3:	The system of online payment and transaction system may cause risks.	
Insufficient Facilitating Conditions (FC1-FC4)	FC1:	The IT infrastructure of Thailand is still not suitable for the adoption of e-commerce for rice selling.	Venkatesh et al. (2003); Yu (2012); Tan et al. (2013)
	FC2:	Internet signal still not cover in all areas, especially in the suburb and rural area.	

Variables	Items		References (Adapted from)
	FC3:	The online transaction systems still need to be improved in order to be efficient the adoption of e-commerce for rice selling.	
	FC4:	Logistics and facilities especially in the suburb and rural area still need to be improved for supporting the adoption of e-commerce for rice selling.	
Government Support (GOV1-GOV8)	GOV1:	The government support about dissemination of e-commerce knowledge could assist me adopt e-commerce in effective way.	Looi (2005)
	GOV2:	The government support, such as providing e-commerce training and seminar will help me having more knowledge to adopt e-commerce.	
	GOV3:	The government support could influence the adoption e-commerce for rice selling.	
	GOV4:	The government support encourage me to focus and pay more attention on the online market than before.	
	GOV5:	The government support about improving IT infrastructure could encourage me to adopt e-commerce more.	
	GOV6:	The government support such as subsidy about rice transportation cost could encourage me to adoption of e-commerce more.	
	GOV7:	The government support such as subsidy about IT service cost could encourage me to adoption of e-commerce more.	
	GOV8:	The government support could influence me to have more confidence about e-commerce system.	
Sufficient IT Knowledge and Skills (IT1-IT4)	IT1:	Sufficient IT knowledge and skills can improve the efficiency of the adoption of e-commerce for rice selling.	Ghobakhloo & Tang (2013)
	IT2:	Sufficient IT knowledge and skills can help to understand the adoption of e-commerce for rice selling.	
	IT3:	Sufficient IT knowledge and skills can somehow make the adoption of e-commerce market for selling rice being easier and not complicated.	
	IT4:	Sufficient IT knowledge and skills can somehow reduce risks related e-commerce adoption such as payment system, cybercrime, data theft and cheating.	
Behavioral Intention (BI1-BI4)	BI1:	I intend to adopt e-commerce for rice selling.	Venkatesh et al. (2003); Yu (2012); Tan et al. (2013)
	BI2:	I aim to adopt e-commerce for rice selling as much as I can.	
	BI3:	I will adopt e-commerce for rice selling more in the future.	
	BI4:	I do not think to adopt e-commerce for rice selling in the future.	
EC Acceptance and Adoption (AA1-AA4)	AA1:	I accept that "rice" can be placed on e-commerce.	Alshehri et al., (2012)
	AA2:	I accept that e-commerce can be one of alternative rice selling channels.	
	AA3:	I accept that e-commerce can be one of alternative rice selling channels.	
	AA4:	I accept and adopt e-commerce for rice selling.	

Appendix B

Exploratory factor loadings and communalities based on principal component analysis with Varimax rotation for 43 items from study's survey

	PE	EE	SI	IC	PR	FC	GOV	IT	BI	AA
PE1	0.674									
PE2	0.761									
PE3	0.680									
PE4	0.624									
EE1		0.381								
EE2		0.739								
EE3		0.671								
EE4		0.718								
SI1			0.678							
SI2			0.717							
SI3			0.659							
SI4			0.688							
IC1				0.746						
IC2				0.797						
IC3				0.752						
IC4				0.551						
PR1					0.799					
PR2					0.715					
PR3					0.800					
FC1						0.719				
FC2						0.751				
FC3						0.672				
FC4						0.673				
GOV1							0.607			
GOV2							0.688			
GOV3							0.704			
GOV4							0.793			
GOV5							0.761			
GOV6							0.816			
GOV7							0.812			
GOV8							0.820			

	PE	EE	SI	IC	PR	FC	GOV	IT	BI	AA
IT1								0.699		
IT2								0.698		
IT3								0.755		
IT4								0.691		
BI1									0.748	
BI2									0.801	
BI3									0.797	
BI4									0.382	
AA1										0.686
AA2										0.795
AA3										0.810
AA4										0.788

Note: AA = acceptance and adoption of e-commerce; EE = effort expectancy; FC = insufficient facilitating conditions; GOV = government support; IC = perceived implementation cost; BI = behavioral intention; IT = information technology (IT) knowledge and skills; PE = performance expectancy; PR = perceived risk; and SI = social influence