MSc Thesis

Understanding Agricultural Innovation Adoption in Developing Countries: An Indonesian Study

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PETROKIMIA GRESIK

WAGENINGEN UNIVERSITY & RESEARCH

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Abstract

Food security is predicted to face considerable challenges in the upcoming period. This could be more profound in developing countries due to rapid societal change and ecological pressure in these regions. Concerted efforts to deal with these challenges are of great importance, including accelerating the use of improved agricultural input technology (IAIT) such as high yield varieties of seeds and improved fertilizer formulas. This type of innovation is more suitable to being introduced amongst developing countries farmers in order to increase their productivity. However, in reality the adoption rate of this technology is not as high as expected. Thereby, it is important to investigate factors that affect IAIT adoption. This research aims to shed light on farmers' perceptions that can influence the acceptance of IAIT in developing countries. The Technology acceptance model (TAM) and Theory of Planned Behavior (TPB) are used to develop the predictive model in this study. The primary data was obtained through questionnaires that were distributed to smallholder farmers in Indonesia (N =121). Structural Equation Modelling (SEM) was conducted using PLS-SEM software to empirically examine the relationship between subjective norm (SN), perceived usefulness (PU), result demonstrability (RD), perceived cost (PC) and behavioral intention (BI). The results indicated that the BI was positively influenced by PU and negatively affected by PC. They also revealed that SN was only statistically significant on PU, but it did not provide any contribution to BI. Meanwhile, RD showed a significant positive relationship with PU. These findings are expected to provide supplementary insights to assist stakeholders in defining appropriate strategies in order to promote agricultural innovation adoption in developing countries.

Keywords: Innovation adoption, agricultural innovation, technology acceptance model, theory of planned behavior, small-holder farmer, developing country.

Table of Contents

1. Introduction and Problem Statement

Despite substantial effort and investments to enhance agricultural technologies, reconciling the empirical puzzles associated with the low adoption rates of profitable farming technologies remains a challenge. This is particularly important for many developing countries where the aggregate technology adoption trend remains low (Abay et al., 2017). Nevertheless, it plays a pivotal role and is suggested as a substantial component in the development of the agricultural sector (Bowman & Zilberman, 2013).

Low technology adoption is acknowledged as one potential explanation for stagnating growth of agricultural yields in developing countries, which threatens food security (Aker, 2011), especially in the current situationin which the population is rising and agricultural area is shrinking. Indeed, adoption of agricultural innovations has to be promoted to increase agricultural productivity per acre, particularly for farmers in developing countries. Among the various options available, adopting improved agricultural input technology (IAIT) seems to be most feasible solution and most readily adoptable (Shah et al., 2016). IAIT could be high yield varieties (HYV), improved fertilizer formulas, nutrients and other input variables. Although IAIT alone is not a panacea, adopting this technology is likely to play a critical role in fulfilling the need for increasing food production even though profound challenges remain (Delmer, 2005).

Numerous researches concerning IAIT acceptance have raised research attention across the world (Shah et al., 2016; Poolsawas & Napasintuwong, 2013; Asfaw & Admassie, 2002). Farmer characteristics and farm structure are the main factors commonly used in explaining IAIT adoption, but only focusing on these factors provides a limited understanding of adoption motives and processes. This indicates that there is still a need for further research on how farmers in less developed countries can be encouraged to use agricultural technologies. This research used the Technology Acceptance Model (TAM) and Theory of Planned Behaviour (TPB) as theoretical backgrounds to predict the behavioural intention of IAIT among farmers. Perceived cost will be incorporated into the model since smallholder farmers fall under low-income sections of society (Pretty et al., 2003). This factor has to be deliberately evaluated when launching a new technology as it potentially hinders adoption of agricultural innovation (Fujisaka, 1994).

The main objective of this study is to help increase the adoption of IAIT in developing countries by investigating the factors that influence its uptake. The results of this research are expected to provide stakeholders with insights into the key factors that influence the adoption of IAIT. These insights can be used to develop strategies in order to enhance the adoption and use of IAIT in agricultural practices. We analyse empirical data from Indonesian farmers, using a Partial Least Square Structural Equation Modelling (PLS-SEM) analysis approach. The theoretical model developed and tested can serve as a predictive model.

The agricultural sector of Indonesia comprises large plantations (both state-owned and private) and smallholder production models. The large plantations tend to focus on commodities which are important for exports, while the smallholder farmers focus on rice, soybeans, corns, fruits, and vegetables. Agricultural production contributes 14.4 % of total GDP and employs approximately 38.6 % of the labour force (BPS 2014).

The Indonesian government has placed self-sufficiency in certain agricultural products high on the agenda. In particular, this applies to rice which is by far the main staple food for the majority of the population. However, the country is still dependent on imports from Vietnam and Thailand to secure the domestic rice supply. Therefore, considerable effort is still needed to improve the productivity of Indonesian farmers. One approach is through introducing IAIT which can help farmers deal with their structural problems. Unfortunately, the adoption rate of improved agricultural technologies in Indonesia is still low (Musyafak & Tatang, 2005).

A central research question and sub research questions have been determined to guide this research. The central research question to be used in this research is:

What are perceptions influencing IAIT adoption by farmers in developing countires?

The sub research questions that will be answered to solve the central research question are:

1. How does the subjective norm influence the behavioural intention to adopt IAIT?
2. How does the perceived of usefulness influence the behavioural intention to adopt IAIT?
3. How does the result demonstrability influence the behavioural intention to adopt IAIT?
4. How does the perceived cost influence the behavioural intention to adopt IAIT?

2. Literature Review

2.1. Challenge in Food Security

Food security occurs when all people, at all times, have access both physically and economically to obtain adequate, safe and nutritious food that fulfils their dietary needs and preferences for a good quality of life (FAO, 1996). Currently, sufficient food is produced to feed the approximately 7 billion world population. Nonetheless, this is still a challenging issue in developing countries as one in six people in this area still suffers from prolonged famine (Ruane and Sonnino, 2011). This could be down to lack of purchasing power, unavailability of food, unevenly distributed food, and insufficient use of food at household level (FAO, 2019).

This unacceptable situation may deteriorate in the future for two main reasons. The first is the fast changing socio-environment. By 2050 the world population is predicted to climb to close to 9 billion in total, and the majority will reside in developing countries (Andréosso-O'Callaghan % Taylor, 2016). Additionally, the ongoing migration from rural to urban areas is projected to continue, resulting in 70 % of the world population being urban dwellers in 2050 (compared to 50 % today) (United Nations, 2007). Rising incomes predicted in developing countries also lead to dietary changes, where the needs of staple food will decrease, whilst the ratio of vegetables, fruits, edible oil, meat, dairy, and fish will grow (Kearney, 2010). This larger and wealthier population may trigger an increase in global food demand by 2050 that is 70 % higher than current levels (FAO, 2011). The second reason is climate change, which causes changing farming patterns as well as the distribution patterns of pests and diseases that can jeopardize crops and livestock. Climate change has also impacted the frequency of extreme weather events, creating increased probability of unexpected natural disasters in the forthcoming period. These phenomena require an advancement in agricultural technology in order to deal with their impacts. Developing technically feasible, socio-culturally acceptable and economically viable (e.g. Shah et al., 2016) innovation seems to be the main agenda under both societal and ecological pressure to feed the entire global population.

2.2. Agricultural Development and Innovation

The challenges faced in agriculture have led to development and innovation of technological agriculture in which the paradigm has shifted from a technological push into co-developing innovation, adjusting to the increased complexity of issues in agriculture (Klerkx et al, 2012).

Table 1. Shifting in agricultural development and innovation platform

Characteristics	**Transfer of technology (ToT)**	**Agricultural Knowledge and Information System (AKIS)**	**Agricultural Innovation System (AIS)**
Activities	Supply technology	Participatory research	Co-develop innovation
Knowledge and discipline	Single discipline	Interdisciplinary	Transdisciplinary
Scope	Yield increase	Farm-based livelihoods	Value chains
Core elements	Technology packages	Joint production of knowledge and technologies	Shared learning and change, social network
Drivers	Science push innovation	Demand pull innovation	Complex pattern of interaction
Key change sought	Farmer's behaviour change	Empowering farmers	Institutional change, innovation capacity
Desired outcome	Technology adoption	Co-evolved technology	Capacity to innovate, learn and change

Adapted from Klerkx et al. (2012)

The transfer of technology views development and innovation in agriculture as a linear process in which technology is developed based on identified problems and is then subsequently introduced to end users (Sassenrath et al., 2008). This perspective suggests that mere scientific knowledge can be used to design innovation and understand the complexity of agriculture. Thus, the product developers believe in designing well-adopted innovation by farmers. This traditional platform has worked effectively in developing and transferring simple technology such as high yield varieties in relatively ideal production systems during the Green Revolution (Douthwaite et al., 2002). The innovation flows down through the pipeline with each party taking responsibility at different stages. Local knowledge might be taken into account during product testing prior to release (Douthwaite et al., 2002). However, this has evolved as increasing challenges are faced in agriculture. Klerkx et al. (2012) proposed two main reasons why this perspective of agricultural innovation should be shifted. First this linear process is unable to address the complex social processes embedded in the innovation. Second the research push paradigm does not consider some issues such as heterogenity in farming systems and complex natural resource management conflicts that might exist in farming societies. Participatory research emerges as an improved approach that can address these weaknesses. This perspective includes the broader knowledge system in which farmers are actively involved and evolving, which is labelled Agricultural Knowledge and Information Systems (AKIS). Nevertheless, AKIS mostly emphasizes farmers, researchers, and extension officers, but the involvement of a larger network of actors and institutions that influence innovation in agriculture is apparently overlooked (Klerkx et al., 2012). A more recent approach, called Agricultural Innovation Systems (AIS), looks beyond research and technology development as a driver of innovation. It is not only about transferring technology to the farmers, but also balancing the technical process with other related factors that need to be addressed such as markets, land tenure, and distribution of benefits (Brooks & Loevinsohn, 2011; Dormon et al., 2004). The transdisciplinary characteristic of this perspective has the capability to magnify creativity in order to to unravel the complexity of contemporary agricultural issues (Sassenrath, 2008). Although many efforts have been made to implement this co-developed innovation in developing countries, several innovations still seem to reflect the typical transfer of technology paradigm (Schut et al., 2015). Understanding constraints and opportunities, jointly attempting to mobilise resources and building strong complementary visions are recognized to deliver significant contributions to the required transformation (van Paassen et al., 2014). This immense process needs mind-set alignment of various actors, and sometimes requires a political process. Lastly this change will not be realized without structural and broad-based learning as well as capacity development (Schut et al., 2015).

2.3. Agricultural Innovation Adoption Model

Agriculture remains the largest sector of economy in many developing counties (FAO, 2015). This sector is deemed to play an imperative role in creating food security and reducing poverty by potentially raising the incomes of smallholder farmers and reducing the market price of staple foods (de Janvry & Sadoulet, 2002; Ogundari, 2014). The means to achieve these purposes include promoting agricultural innovations and technology in developing countries. They are particularly designed to provide benefits to farmers via improvement of their soil fertility, conservation of soil nutrients, water and other natural resources, increasing productivity, improving pest management, and aiding farm mechanisation. Due to the importance of new agricultural technology in achieving the full potential of agriculture, this has remained a central domain of study for both academics and policymakers over the years (Ogundari & Bolarinwa, 2018).

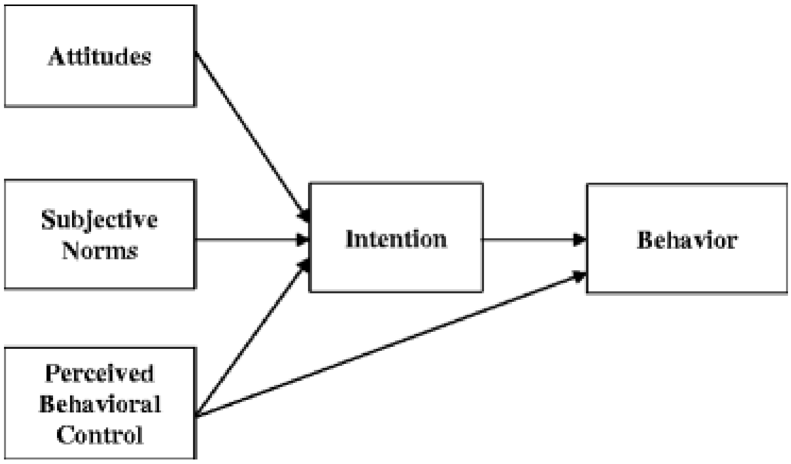
Before a particular agricultural innovation is released to the farmer, it is important to examine variables that influence adoption of its innovation. Adesina & Zinnah (1993) mentioned that there are three common models that are usually used to evaluate adoption of innovation in agriculture: the innovation-diffusion model, the economic constraint model, and the adopter perception model (focus of this research). Each of these three models suggest distinct factors that affect adoption, and stakeholders who are interested in gaining an overarching understanding of agricultural innovation adoption need to evaluate all of these models (Masangano & Miles, 2004). The innovation-diffusion model, based on the work of Rogers, reveals that access to information about an innovation is the key factor determining the success of its adoption. The characteristics of innovation are passively modified, and the issues associated with technology adoption are reduced by communicating information on the technology to the potential adopter (Adesina & Zinnah, 1993). Communication is the central force for dissemination of ideas within peasant communities (Shaw, 1987). Agriculture extension, media, and opinion leaders are usually used as channels of communication. Experiment field visits and on-farm trials are also used to influence the minds of the "sceptic" non-adopters (Adesina & Zinnah, 1993). In this model, the type of adopters are divided into five groups, depicting their propensity to adopt an innovation in a time sequence; innovators, early adopter, early majority, late majority and laggard (Rogers, 2003). The economic constraint model proposes that economic constraints are the main determinants of the adoption decision. Availability of capital, land or labour significantly affects farmer decision to adopt, and numerous past researches have been carried out using this model (Atala, 1984; Chen et al., 1989; Hooks et al., 1983). This approach postulates that technology adoption is influenced by resource constraints and endowments of the end-user (Masangano & Miles, 2004). The last model, called adopter perception model, suggests that subjective evaluations regarding the attributes of the innovation are key factors influencing farmer adoption decisions. Studies using this model involve perception variables relating to either the farmer's perceptions of severity of the problem to be solved or perceptions of technical innovation.

In this research, we primarily emphasize the adopter perception model for two main reasons. First, this allows us to develop a parsimonious model in which perceptions are used as constructs. Second, from a pragmatic perspective, assessing the adopter perception of IAIT is valuable as it can be followed up by management action (Agarwal & Prasad, 1997). Despite the fact that there are several theories relating to how human perception affects behavioural outcome, the majority of researchers tend to use two notable theories in their papers on understanding adoption of innovation based on the perception model: The Theory of Planned Behaviour (TPB) and Theory Acceptance Model (TAM) (Agarwal & Prasad, 1997).

2.3.1. Theory of Planned Behaviour (TPB)

Theory of Planned Behaviour (TPB) is a broadly applied expectancy-value model that has identified the relationship between intention and behaviour (Ajzen, 1991). TPB is a theoretically structured framework that provides parsimonious explanations of human behaviour according to beliefs and attitudes. According to this theory, actual behaviour is determined by personal intention to perform particular actions and perceived behavioural control. Intention is affected by three factors; attitudes, subjective norms, and perceived behavioural control (Ajzen, 1991). Attitudes refer to how favourably or unfavourably a person views a behaviour, subjective norms represent perception of social pressure to perform a behaviour, while perceived behavioural control indicates an individual's perception in relation to control (e.g. skill, resources, and opportunity) over behaviour. This theory has successfully explained causal relationship in a variety of situations (Lee & Kozar, 2008).

Figure 1. Theory of Planned Behaviour (TPB)



Source : Ajzen, 1991

TPB has been widely applied when exploring individual beliefs and evaluations of behavioural intentions in the fields agriculture, consumption, information technology, management, and so forth. With regard to farming innovation adoption, it has been used to assess the factors influencing adoption of Green Fertilizer Technology among Malaysian farmers (Adnan et al., 2018), to investigate factors that affect the adoption of grazing systems by Irish cattle farmers (Hyland, et al., 2018), and applied to understand the variables which influence farmers' intentions to adopt a Nutrient Management Plan (Daxini et al., 2019).

Notwithstanding the fact that this theory has been applied in the various fields of research, this theory is by no means viewed as a flawless theory. TPB is criticized for its general and abstract belief measurements that need to be modified based on behavioural situations (Davis et al., 1989 & Mathieson, 1991). Furthermore, this model tends to measure general behaviours instead of emphasizing technical perception of innovations, which provides restricted implications for the product development team (Mathieson, 1991).

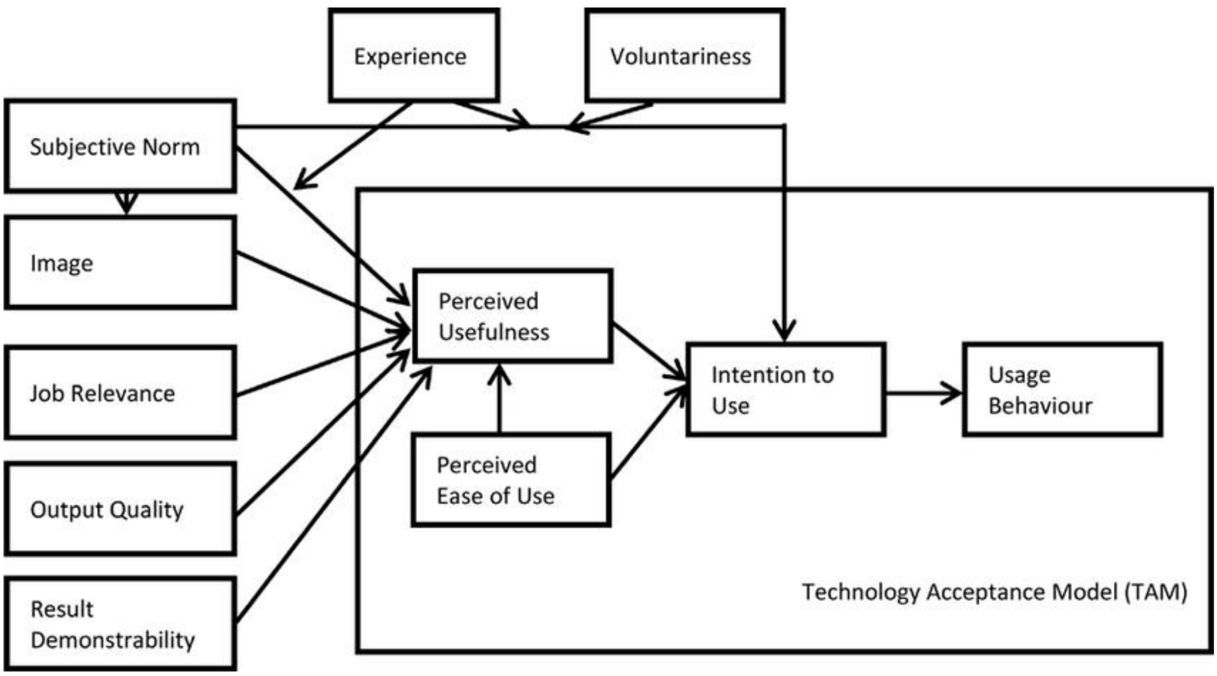
2.3.2. Technology Acceptance Model (TAM)

The Technology acceptance model (TAM), inspired by the Theory of Reasoned Action (Ajzen & Fishbein, 1980), was first introduced by Davis (1989) to predict user acceptance and usage of information technology (IT). TAM theorizes that an individual's behavioural intention to use a system is determined by two beliefs: perceived usefulness, the extent to which a person believes that using the system will enhance his or her job performance, and perceived ease of use, the extent to which a person believes that using the system will be free of effort (Venkatesh and Davis, 2000). According to the TAM, perceived usefulness is also influenced by perceived ease of use, asthe easier the system is to use, the more useful it can be (Davis, 1989). The TAM is regarded as a robust and parsimonious model in predicting and explaining adoption of an innovative technology. Several studies have concluded that TAM consistently exhibits a significant proportion of the variance, typically around 40 %, in usage intention and behaviour (Venkatesh & Davis, 2000).

In spite of the TAM being broadly used in various disciplines, it seems it has been used to a lesser extent in the field of agriculture. Some examples, using mostly the TAM, are: an examination of technology adoption in dairy farming (Flett et al., 2004), investigations into the perception and attitudinal characteristics of farmers who plan to adopt precision agriculture (Adrian et al., 2005), research about the applicability of TAM to extension officers' acceptance of a knowledge management system in agricultural extension services (Folorunso & Ogunseye, 2008), and a description of the difficulties of precision agriculture technology adoption (Aubert et al., 2012).

While TAM has consistently excelled in terms of explaining behaviour across many studies, its narrow nature has created limitations, and certain essential determinants of decisions and action have gone unobserved (Bagozzi, 2007). Additionally, TAM puts greater emphasis on technology features rather than social influences for examining technology adoption intention (Chu & Chen, 2016). TAM 2 is an improved version aimed at lifting these limitations. Venkatesh & Davis (2000) proposed TAM 2 in which they included social influence processes (subjective norm, voluntariness, and image) and cognitive instrumental processes (job relevance, output quality, result demonstrability, and perceived ease of use) as determinants of perceived usefulness and usage intentions. They found that both social influence processes and cognitive instrumental processes significantly influence user acceptance. They also claimed that predictive power increased up to 60 %. However, TAM 2 become more complicated than the original theory (Bagozzi, 2007) and it is suggested that it is now less transferable to other settings (Schaak & Mußhoff, 2018). Therefore, in order to maintain its simplicity and applicability, it needs to be adjusted when it is used for answering research questions in non-IT fields.

Figure 2. Technology Acceptance Model 2 (TAM 2)



Source : Venkatesh and Davis (2000)

Some researchers have modified TAM 2 to adapt with their research context and purpose by including additional variables and excluding irrelevant TAM 2 variables. Schaak & Mußhoff

(2018) omitted image and job relevance as antecedents of perceived usefulness in their study on German farmers' behaviour with respect to the adoption of grazing practices. Chu & Lu (2007) incorporated the perceived cost into their research model to investigate the purchase behaviour of early adopters of online music in Taiwan. Fenner and Renn (2010) excluded perceived ease of use in technology-assisted supplemental work acceptance since perceived usefulness of technology more strongly and consistently affects behavioural intentions to adopt technology (Karahanna et al., 1999).

3. Research Model and Hypothesis Development

Innovation adoption may involve complex social mechanisms in its process. However, factors that affect the propensity of end users to adopt agricultural innovation can be addressed. In this research, we examine factors influencing the adoption of IAIT among developing country farmers by combining TAM and TPB. Thus, three relevant explanatory variables (i.e. perceived usefulness, subjective norm and result demonstrability) are retained to build a predictive model in the current study. Perceived usefulness and result demonstrability are proposed by TAM 2, whilst subjective norm can be found in TPB as well as TAM 2, though its measurement slightly differs. Perceived cost also will be included to predict IAIT adoption since this concept is viewed as an important determinant of agricultural technology adoption in less developed countries. The behavioural intention is used as an outcome variable in this paper.

Perceived usefulness, subjective norm, result demonstrability and perceived cost are theoretically acceptable to provide causal effect on behavioural intention. However, result demonstrability probably needs a mediating variable to make it more understandable in explaining the process of causality. Meanwhile, theory seemingly does not support correlation between subjective norm, result demonstrability, and perceived cost. In addition, perceived cost perhaps correlates with perceived usefulness. In a prior study, Grabor & Granger (1966) confirmed that price can be an indicator of quality, if the usefulness is considered as a proxy of quality, in case other cues are unavailable. Nonetheless, in reality, these two variables do not always emerge chronologically. In reality, the order is somewhat random when farmers examine these variables in adoption decision processes. Consequently, we argue that perceived usefulness and perceived cost do not possess a meaningful relationship with each other. This is supported by de Vaus (2013) who proposed that correlated variables should be not only be theoretically legitimate but also reasonable in time order. The effects from causality can appear immediately or may take a longer time (e.g. months or years). Additionally, farming inputs are not totally novel technologies for smallholder farmers.

3.2. Key Concepts and Hypothesis

Behavioural intention

Behavioural intention (BI), can be described as a farmer's subjective probability of performing a specified behaviour, and is the major determinant of actual usage behaviour (Ajzen & Fishbein, 1980 ; Yi et al., 2006). People tend to perform actual behaviour when their intentions become stronger (Ajzen & Fishbein, 2000). However, the relationship between actual behaviour and behavioural intentions is difficult to measure in reality. Thus, Ajzen & Fishbein (2000) recommend that the measurement of behavioural intention assumes predictive power for the future, with the focus on behavioural intention instead of actual behaviour. Therefore, this research uses behavioural intention as an outcome variable of IAIT adoption affected by perceived usefulness, subjective norm, result demonstrability and perceived cost.

Perceived Usefulness

Perceived usefulness (PU) refers to "the degree to which an individual believes that using a particular system would enhance his or her job performance" (Davis et al., 1992). This research redefined perceived usefulness as the extent to which a farmer believes that using a particular farming input technology will enhance their farming productivity. In numerous studies, it has consistently been a strong predictor of adoption intention (Venkatesh & Davis, 2000). This construct along with perceived ease of use were suggested as the two main beliefs in the original TAM (Davis, 1989). However, we only retain perceived usefulness in the model and excluded the perceived ease of use to adjust for innovation characteristics. Innovation in agricultural input technology is a simple innovation that does not require demanding pre-conditional capacity (i.e. skills) (Zanello, 2016). Experienced farmers will likely not face difficulty when applying IAIT since it is generally developed without creating considerable change of farming practices (Shah, 2016). One example would be improved fertilizer formula offering increases of yield; the application remains almost the same as for common fertilizer. Despite the fact that innovation in farming inputs is often considered as an incremental innovation, it is a significant determinant of farming success in developing countries (Shah et al., 2016). For instance, improved farming input potentially increases farmer income and stabilizes food prices for both urban and rural consumers (Spielman et al.,2012). It also plays a major role in achieving food security (de Janvry & Sadoulet, 2002; Ogundari, 2014). Therefore, it is reasonable to include perceived usefulness in the model as the smallholder farmer may look at the utility of IAIT before they decide to adopt. Previous research by Adrian et al. (2005) clarified that perceived usefulness is one of the significant positive predictors of farmers' intention to adopt precision agriculture technology. Accordingly, this research hypothesizes that :

H1 : Perceived usefulness positively affects the behavioural intention of IAIT

Subjective Norm

Subjective norm (SN) refers to a person's perception that most people who are important to him think he should or should not perform the behaviour in question (Fishbein & Ajzen, 1985). The concept of subjective norm is more restricted than the norms in the sociology discipline that are typically defined as "socially agreed upon ruled, the definition of what is right and proper" (Webster, 1975). Sociologists have viewed norms as the broad range of permissible, but not necessarily required, behaviour (Fishbein & Ajzen, 1985). On the other hand, subjective norms emphasize the perceptions of significant others to engage in a behaviour, for example the leader of a farming community suggesting the use of biofertilizer. Fishbein & Ajzen (1985) mentioned that the greater the perceived importance of an opinion leader in the eyes of a farmer, the the greater the likelihood that the farmer will follow the suggested behaviour. The reason for the inclusion of subjective norm in this research is that a person does not perform particular behaviour independently of culture or the opinion of others, but rather than determined by perceived social influence (Burton, 2004). The important influencers for farmers in developing countries may come from various sources, such as peer farmers, group leaders, family, dealers, agricultural extension officers, and company salespersons (Shah et al., 2016). Those people may influence farmer behaviour as they have relatively better knowledge, thus their opinion will be more valued by small-holder farmers (Rogers, 2003).

In TPB, effects of SN were measured by multiplying normative belief with motivation to comply. However, for the sake of simplicity, SN in this research will be measured only by scoring the perceived pressure by farmers from important influencers to adopt IAIT. The motivation to comply will be defined by evaluating the effects of SN on BI. Kelman (1958) classified three motivational processes on how social influence determines human behaviour. The first mechanism is called compliance, wherein farmers tend to perform prescribed behaviour wihout question in order to obtain a specific reward or avoid sanction. The second process is identification; via this process, farmers are encouraged to adopt a particular behaviour in order to to maintain a satisfying relationship with others. The content of behaviour is evaluated but rather irrelevant. The last mechanism is called internalization. This occurs when farmers adopt a behaviour due to the intrinsic reward it provides. Farmers accept prescribed behaviour as they feel it will provide tangible benefits to resolve their issues.

In this study, we consider that SN, which leads to farmer behaviour formation, could be enlightened through those motivational processes (Kelman, 1959; Warshaw, 1980). SN may influence BI indirectly via PU as a consequence of the internalization mechanism, and SN may also provide a direct effect on BI due to the compliance effect (Davis et al., 1989; Warshaw 1980). Past studies in the agri-food domain have indicated that SN provides a significantly positive effect over BI as well as a positive indirect effect via PU (Heyder et al., 2010; Schaak & Mußhoff, 2018). Based on the discussion above, this study hypothesizes that:

H2 : Subjective norm positively affect the behavioural intention to IAIT.
H3 : Subjective norm positively affect the perceived usefulness of IAIT.

Result Demonstrability

Result demonstrability (RD) can be defined as "the tangibility of the results of using the innovation (More & Benbasat, 1991). Result demonstrability was used in the TAM 2 as an antecedent of perceived usefulness (Venkatesh & Davis, 2000). This concept is developed based on the observability construct that is used in the Diffusion of Innovation Theory. Prior research indicated that the observability construct was rather too complex to be applied (Moore & Benbasat, 1991). Observability had been originally described as the degree to which the results of an innovation are visible and communicable to others (Rogers, 2003). However, the further explanation by Rogers put more emphasis on the object of innovation rather than the result. He argued that less observable innovation usually has slower rates of adoption (he exemplified software and hardware of a computer). If the focus was just on the result, then visibility would be meaningless for the potential adopter. With this argument, Moore and Benbasat (1991) created a new construct, labelled result demonstrability, that combines observability and communicability. This concept is considered to provide better understanding of how the user looks at the advantage of innovation and how they communicate the experience of using it to their community (Hussein et al., 2011). Farmers in developing countries frequently learn such an innovation through horizontal communication or by noticing the crop field of peer farmers (Shah et al., 2016). Thus, we suggest that this factor is probably relevant in explaining farmers' decisions in accepting IAIT.

Demonstrating the result is a classic strategy that can be used to raise awareness of agricultural innovation. The basic idea of this concept is allowing farmers to observe the result of application of farming technology, and become interested in it without having to fully understand the process involved. This strategy is often performed in the form of field experiments aiming to communicate existing knowledge and experience rather than generating new insights (Leeuwis, 2004). A simple example of implementation of this strategy is fertilizer trials, in which farmers can make a direct comparison of the effect of different fertilisation practices on their crops.

Empirical studies with regard to agricultural innovation have shown that higher RD generates significantly higher BI to adopt (Rezaei-Moghaddam & Salehi, 2010; Shah et el., 2016), but it remains unclear on how they correlate. One viable option to illustrate this phenomenon is perhaps by mediating RD via PU that has a positive direct effect over BI (Venkatesh & Davis, 2000). This path seems to be plausible as if the farmers have opportunities to be exposed to the advantages of IAIT during the adoption process, they automatically have a greater possibility to understand the benefits of the innovation, subsequently creating BI (Oh et al., 2003). Based on this, this study hypothesizes the following :

H4 : Result demonstrability positively affects the perceived usefulness to the IAIT..

Perceived Cost

In this study perceived cost (PC) can be defined as perceived quantifiable costs of acquisition and use of technology (Koenig-Lewis, Palmer & Moll, 2010). Within the issues related to the agricultural technology adoption, many researchers have considered cost as an important factor influencing farmers' behavioural intention (Onwude et al., 2016). Huijts et al. (2012) mentioned that perceived cost can be divided into monetary cost (e.g. cost of purchasing and using the innovation) and non-monetary cost (e.g. time, effort, skill). In the current study we focus on monetary cost rather than non-monetary cost because farmers are probably more concerned with this factor when purchasing IAIT. Normally, the farmer incurs a significant costs when adopting indivisible technology rather than divisible technology. Nonetheless, we argue it is still relevant to include the cost factor in this study since the farmers in developing countries have often been associated with lack of financial resources (Elser et al., 2014). Likewise, they probably take into account the perceived cost in their IAIT adoption decision.

The role of perceived cost may emerge when improved farming inputs aimed at raising yields are introduced to the farmer. Indeed, in order to increase the agricultural productivity, it is recommended to farmers to apply good farming input technologies. However, better farming technologies usually are followed by higher selling price. For instance, in Indonesia hybrid rice seeds, which offer sizeable increases in rice productivity, are sold at a much higher price than conventional rice seeds. Manifestly, any farmer with sufficient resources can acquire this input to produce a large amount of food. Nonetheless, most farmers in developing countries are not in such a position, and the poorest generally lack the financial assets to purchase costly inputs and technologies (Pretty et al., 2003). Price intervention along with other policies during the Green

Revolution, which resulted in increased adoption of fertilizer, may indicate that perceived cost is one of several factors affecting farmers' acceptance of a particular technology (Rashid et al., 2013). Numerous past studies have shown that higher perceived cost can prevent adoption of innovation (Fujisaka, 1993; Ho Cheong & Park, 2005). According to this discussion, the following hypothesis is suggested:

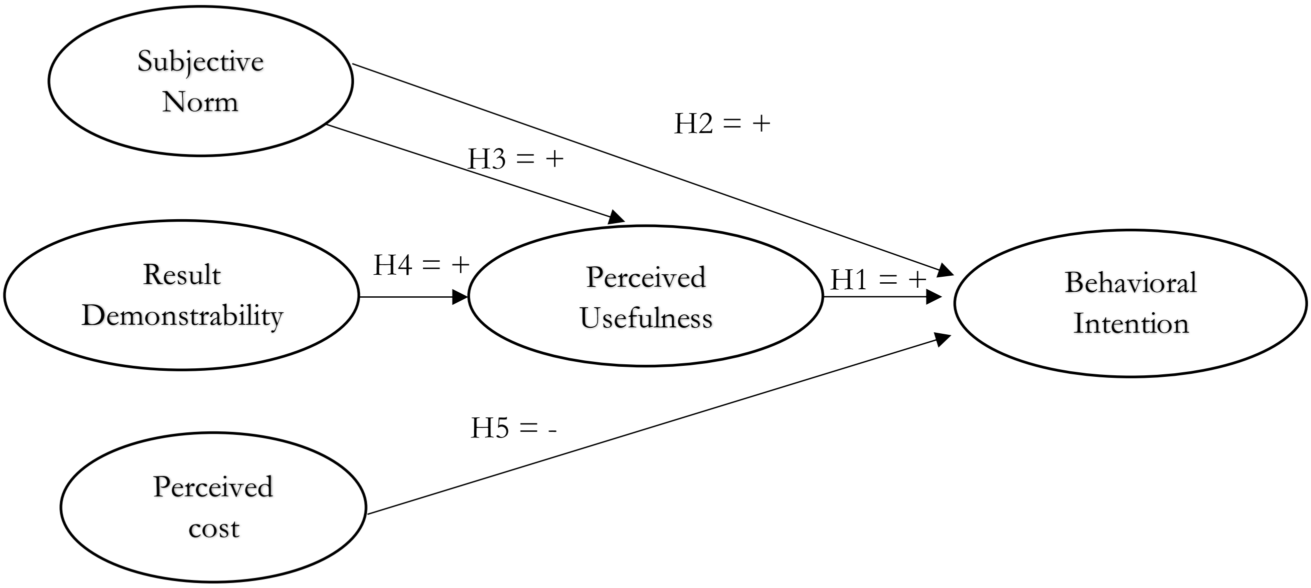
H5 : Perceived cost negatively affects the behavioural intention of IAIT

3.3. Conceptual Framework

Based on literature review, the conceptual framework is designed as presented in figure 3. The conceptual framework shows the hypothesized relationships between perceived usefulness, subjective norm, result demonstrability and perceived cost as the independent variables and behavioural intention to use IAIT as the dependent variable. The causal linkages between these variables, reflected by arrows, are mainly developed based on TAM 2. Subjective norm's effect on behavioural intention is partially mediated via perceived usefulness, whilst result demonstrability is completely mediated via perceived usefulness, which jointly with perceived cost indicates a direct effect on behavioural intention, albeit in a different direction.

H1 : Perceived usefulness positively affects the behavioural intention to the IAIT.
H2 : Subjective norm positively affects the behavioural intention to the IAIT.
H3 : Subjective norm positively affects the perceived usefulness to the IAIT.
H4 : Result demonstrability positively affects the perceived usefulness to the IAIT.
H5 : Perceived cost negatively affects the behavioural intention to the IAIT.

Figure 3. Conceptual framework



4. Research Design and Strategy

This study utilises quantitative research aimed at measuring perceived usefulness, subjective norm, result demonstrability and perceived cost in Indonesian farmers' adoption of IAIT. The data were gathered through cross-sectional survey using a questionnaire developed based on prior highly cited research.

4.1. Data Collection Method

The study areas of this research were in Central Java and Lampung, Indonesia. These provinces individually represent two of the main centres of agriculture in Indonesia, namely the islands of Java and Sumatra. They are also well known as the two main users of agricultural input technology in Indonesia, ranging from fertilizers, pesticides and improved seeds (Sulistiyowati et al., 2018). The farmers living in these areas were the target of the study population. There was no restriction regarding farmer classification based on plant cultivated. Primary data was obtained via cross-sectional survey using a questionnaire developed following the operationalization of key constructs below. The questionnaire was initially constructed in English and then translated into Indonesian and printed on A4 paper. The questionnaire was designed with both open and closed questions, with 6 questions capturing the respondent's sociodemographic information, followed by 11 questions pertaining to the independent variables and ending with 1 dependent variable question (see detailed questionnaire in appendix). In terms of sampling strategy, convenience sampling was applied. Given limited resources, this allowed a sufficient number of respondents to be acquired in a quicker and more affordable manner. The survey was conducted manually from 21 October 2019 until 5 November 2019 as the internet usage among respondents was assumed low. The data was collected via face to face interview by the author, assisted by 3 employees from an Indonesian fertilizer company, and then translated back into the questionnaire. The total number of respondents was 121, comprising of 59 farmers from Lampung and 62 from Central Java.

4.2. Operationalization of Key Concept

The questionnaire was developed consisting of three main sections. The first section contained brief information on IAIT, excluding the product value proposition to avoid personal bias. The IAIT used in the questionnaire was an improved fertilizer formula produced by a state-owned enterprise in Indonesia. This product is relatively new in the market, developed based on an existing subsidized fertilizer, and even given almost a similar brand name. However, the selling price is three times higher than the subsidized fertiliser.

The following section covered the questions capturing the respondents profile, comprising gender, age, education, land tenure, and plant type. Gender was examined by providing a predefined two options answer: male and female. Age and land tenure was individually measured with an open question. The level of education was determined by presenting a question about the highest education that the respondents had attained. Five levels of education were provided as answer choices; less than high school, high school graduate, associate degree graduate, bachelor degree, and higher than bachelor degree. The plant type was examined by providing a question about the main type of crop that farmers were planting in one year. A two options answer was provided for this question: staple food and horticulture.

Finally, the last section contained questions to measure key constructs which were developed based on previous studies to ensure content validity. BI was measured by only one indicator. Meanwhile PU was measured by three indicators, RD by four indicators, SN and PU were individually tested by two indicators. Each indicator had Five-point Likert scales ranging from “strongly disagree” to “strongly agree” and “strongly unlikely” to “strongly likely”. Accordingly, respondents were asked to indicate to what extent they agreed with the proposed statements. Five-point Likert scales have often been used in previous agricultural literature (Bergevoet et al., 2004; Gorton et al., 2008). It allows respondents to distinguish between the proposed options relatively easily (Hansson et al., 2012).. The detailed measurement of key constructs is presented below :

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Table 2. Measurement of key constructs

No.	Constructs		Indicators	Scale	References	Nature of data	Type of variables
1.	Behavioural intention	bi1.	When it is available, I intend to use IAIT	1-5 Likert scale	Davis, 1989	Continuous	Dependant variable
2.	Perceived usefulness	pu1.	Using the IAIT improves my crop performance	1-5 Likert scale	Davis, 1989	Continuous	Independent variable
		pu2.	Using the IAIT increases my crop productivity				
		pu3.	I find the IAIT to be useful to my crop				
3.	Subjective norm	sn1.	People who influence my behaviour think that I should use the IAIT.	1-5 Likert scale	Taylor & Todd(1995); Mathieson (1991)	Continuous	Independent variable
		sn2.	People whose opinion I value think that I should use the IAIT				
4.	Result demonstrability	rd1.	I have no difficulty telling others about the results of using the IAIT	1-5 Likert scale	More & Benbasat, 1991	Continuous	Independent variable
		rd2.	I believe I could communicate to others the consequences of using the IAIT				
		rd3.	The results of using the IAIT are apparent to me				
		rd4.	I would have difficulty explaining why using the IAIT may or may not be beneficial.				
5.	Perceived cost	pc1.	The cost of adopting IAIT is affordable.	1-5 Likert scale	Lee & Kozar, (2008)	Continuous	Independent variable
		pc2.	Adopting IAIT is NOT expensive.				

5. Data Analysis and Results

This research evaluated its model and prediction power with Partial Least Square-Structural Equation Modelling (PLS-SEM) using the statistical program SmartPLS 3.0, which utilizes a principle component-based for estimation (Hair et al., 2011). Generally, PLS-SEM accommodates small sample sizes and complex models and makes practically no assumptions about the underlying data (Marcoulides et al., 2009). PLS-SEM can also simply handle reflective as well as formative measurement models, single-item constructs and different scale types (e.g. ordinal, as Likert scales), with no substantial issues (Hair et al., 2017). Data from the questionnaire was inputted into Microsoft Excel and subsequently imported into SmartPLS software for further statistical analysis.

This research follows a two-step procedure to analyse data. First, the measurement model was employed using reflective measurement. In the next step, structural equation modelling (SEM) was established to investigate the strength and significance of the relationships amongst the theoretical constructs.

5.1. Demographic Characteristics of Sample

The primary data was obtained from 121 respondents with no missing value issues. The characteristics of the respondents illustrates that the respondents were highly dominated by male farmers (99%). The majority of respondents were aged between 45-54 years (39 %) followed by 55-64 years (25%). About 56 % of participants hold less than a high school certificate, slightly higher than those who have graduated from high school (42 %). In terms of land tenure, 44 % of respondents owned 2.500-5.000 m_2 of agricultural land. Most of the respondents (59%) are cultivating grains/cereals in their field annually (table 3).

Table 3. Respondent characteristics

Variables	Description	Frequency	%
Gender	Male	120	99
	Female	1	1
Age	Under 35 years	11	9
	35-44 years	24	20
	45-54 years	47	39
	55-64 years	30	25
	Above 64 years	9	7
Education	Less than high school	68	56
	High school graduate	51	42
	Associate degree	2	2
Land Tenure	Under 2.500 m_2	24	20
	2.500-5.000 m_2	53	44
	5.001-7.500 m_2	8	7
	7.501-10.000 m_2	11	9
	Above 10.000 m_2	25	21
Main plant	Rice, maize etc.	71	59
	Horticulture	50	41

5.2. Pearson Correlation

Pearson correlation analysis was performed to evaluate the strength and direction of linear correlation amongst assigned constructs. The Pearson correlation coefficient (r) ranges from -1 to 1. The value of 0 means no correlation, whilst -1 indicates perfect negative correlation and 1 shows perfect positive correlation. High correlation between variables potentially leads to multicollinearity issues (Lean, et al., 2009). Pearson correlation coefficients were determined by comparing composite scores of each construct, which were obtained by averaging scores across indicators constituting that construct. The results of correlation coefficients amongst constructs in this study range from -0,43 to 0,45 (table 4). Perceived usefulness, result demonstrability, and perceived cost show significant correlation with the independent variable (behavioural intention).

Table 4. Pearson correlations coefficient

Descriptive Statistics	Mean	Std. Deviation	N	1	2	3	4	5
1. Behavioural intention	3.32	1.01	121	1.00				
2. Perceived usefulness	3.84	0.61	121	0.36**	1.00			
3. Subjective norm	3.35	0.88	121	0.07	0.32**	1.00		
4. Result demonstrability	3.80	0.50	121	0.23*	0.45**	0.12	1.00	
5. Perceived cost	3.14	0.96	121	- 0.43**	- 0.25**	- 0.02	0.09	1.00

** Correlation is significant at the 0,01 level (2-tailed)
* Correlation is significant at the 0,05 level (2-tailed)

5.3. Evaluation of Measurement Model

Evaluation of the measurement model was initially done before assessment of SEM. This analysis needs to be completed in order to examine the reliability and validity of the indicators representing each construct. The reflective measurement model and formative measurement model are two common methods in measurement model testing. This research used the reflective measurement model since the given indicators representing one construct are considered highly correlated with each other. Assessment of the reflective measurement model includes internal reliability, convergent validity, and discriminant validity.

Table 5. Validity and reliability of constructs

Constructs	Indicators	Loading	AVE	CR	Cronbach's alpha
Behavioural Intention (BI	bi1	1.000	1.000	1.000	1.000
Perceived Usefulness (PU)	pu1	0.952	0.849	0.944	0.910
	pu2	0.869			

	pu3	0.941			
Subjective Norm (SN)	sn1	0.970	0.954	0.976	0.953
	sn2	0.984			
Result Demonstrability (RD)	rd1	0.904	0.745	0.920	0.883
	rd2	0.955			
	rd3	0.905			
	rd4	0.658			
Perceived cost (PC)	pc1	0.984	0.961	0.980	0.960
	pc2	0.977			

Internal reliability was assessed by testing Cronbach's alpha and composite reliability. Cronbach's alpha value of each construct ranged between 1.000 - 0.883 (table 5), above the recommended threshold value of 0.7 (Hair et al., 2017). This indicates that all the assigned constructs in this research are reliable. The result also demonstrates that all composite reliability scores surpassed the proposed minimal value of 0.7 (Hair et al., 2017).

Convergent validity was established to assess the relationship between each indicator and its connected construct. This was evaluated by looking at factor loading score value (indicator reliability) and average variance extracted. According to the result, all factor loading scores are beyond the threshold of 0.7, apart from item rd4. However, we decided to retain this indicator with the aim of preserving content validity. Hair et al (2017) pointed out that indicators with rather low factor loading (0.4 - 0.7) could be maintained with respect to their contribution to content validity. Meanwhile, average variance extracted scores of all constructs were above the recommended lower bound of 0.5 (Hair et al., 2017).

Discriminant validity was tested using Fornell-Lacker criterion in order to ensure that a latent construct is unique and does not overlap with other constructs in terms of measuring variables in SEM. Based on the analysis, all of the constructs have acceptable discriminant validity as the correlation between constructs is less than the correlation of the same construct (table 6).

According to all parameters of the evaluation measurement model, we concluded that there are no issues with respect to the reliability and validity of indicators and constructs, showing that employing SEM analysis was viable.

Table 6. Discriminant reliability

	Behavioural Intention	Perceived cost	Perceived usefulness	Result demonstrability	Subjective norm
Behavioural intention	**1.000**				
Perceived cost	-0.432	**0.980**			

Perceived usefulness	0.357	-0.245	**0.921**		
Result demonstrability	0.216	0.086	0.463	**0.863**	
Subjective norm	0.083	-0.025	0.323	0.142	**0.977**

5.4. Evaluation of Structural Model

Analysis of SEM was started by assessing collinearity between constructs. Collinearity problems between two or more predictors create difficulties in judging the individual contribution of predictors (Field, 2018). Thereby, this analysis is necessary in order to achieve the aim of generating an interpretable model. Based on the calculations, all VIF values exhibited in table 5 clearly show a value below the threshold of 5 (Hair et al., 2017), meaning collinearity between constructs is not an issue in this research.

Table 7. Collinearity assessment

Construct "Behavioural Intention"		**Construct "Perceived Usefulness"**	
Predictor Constructs	**VIF**	**Predictor Constructs**	**VIF**
Subjective Norm	1.120	Subjective Norm	1.021
Perceived Usefulness	1.191	Result Demonstrability	1.021
Perceived Cost	1.067		

To test the statistical significance, bootstrapping procedures were carried out using 5.000 subsamples to examine the relationship between specified constructs in SEM analysis. It was shown that PU positively and significantly affected BI ($\beta = 0.272$; $p = 0.001$), implying that IAIT offering any benefit in agricultural practice based on farmers perceptions was more likely to be adopted by farmers (H1 supported). Meanwhile, SN demonstrated positive correlation with PU ($\beta = 0.262$; $p = 0.003$), therefore H3 is supported. Interestingly, SN was not found to provide a substantial direct effect on PU, thus H2 is rejected. Accordingly, we conclude that social influence from significant others leads to BI of IAIT only if PU is present as an antecedent of BI. In addition, RD had a positive direct effect on PU ($\beta = 0.425$; $p = 0.000$), indicating that H4 is confirmed. Not surprisingly, PC provided a negative direct effect over BI ($\beta = -0.366$; $p = 0.000$). That means that high price perception may hinder adoption of IAIT in the samples tested. In conclusion, 4 out of 5 hypothesises proposed in this paper were accepted (table 8).

Table 8. Hypothesis testing

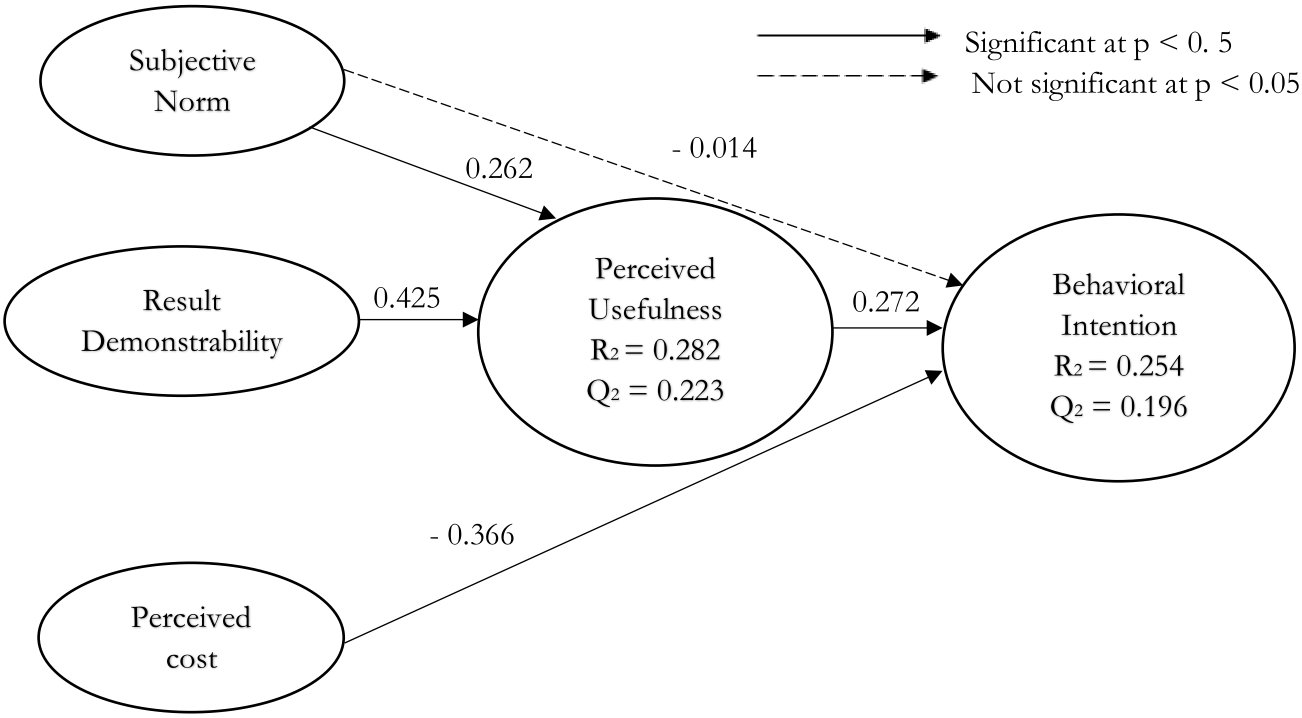
Hypothesises	**Path**	**β**	**t values**	**p values**	**Decisions**	**f square**
H1	PU -- > BI	0.272	3.199	0.001	Supported	0.083
H2	SN -- > BI	-0.014	0.189	0.850	Not supported	0.000
H3	SN -- > PU	0.262	2.928	0.003	Supported	0.094

H4	RD -- > PU	0.425	6.365	0.000	Supported	0.247
H5	PC -- > BI	-0.366	4.725	0.000	Supported	0.168

Significant at $p < 0.05$.

Hypothesis testing involves establishing p-values to examine whether a significant effect exists or not in the correlation between two variables, but this does not show the magnitude of the effect itself. Consequently, we considered to assess not only p-value but also f-square in this research. We used Cohen's (1992) guideline to interpret the f-square value attained, which are 0.02 for small effects, 0.15 for medium effects, and 0.35 for large effects. According to the calculations, size of effect from PU on BI and SN on PU were relatively small, whilst a medium effect could be found with RD on PU and PC on BI (table 8).

Figure 4. Structural equation modelling



Following the evaluation of the structural model, the coefficient determination (R_2) and the predictive relevance of the model (Q_2) were obtained. Overall, the model only explains 28 % and 27 % of the variance for PU and BI respectively (figure 4). Whilst, Q_2 illustrates positive value, proving that the model has predictive relevance for both endogenous variables; PU and SN.

6. Discussion and Conclusion

The main goal of this research is to predict farmer behaviour to adopt IAIT by combining TAM and perceived cost as a representative of perceived behaviour control in TPB. This study was conducted by cross-sectional survey amongst small-holder farmers living in Indonesia. Adopting this simple, but important, innovation in developing countries is becoming important in dealing with potential future challenges in achieving food security in these regions. Based on empirical results, adoption of agricultural input innovation was positively influenced by PU and negatively affected by PC. Meanwhile SN and RD provided positive indirect effects over BI via PU.

PU, as expected, showed statistically positive influence over BI. This result is similar with previous TAM based studies in agriculture (Adrian et al., 2005; Verma & Sinha, 2018). PU represents the farmers perceptions on the extent to which IAIT can improve both productivity and performance of their crop. Formation of this perception arises from either observing results or through interaction in their farming community. Stakeholders in Indonesia consciously leverage these two ways to propose new agricultural inputs. As farmers realize the benefits of farming inputs, they have propensity to adopt prescribed inputs as long as the others barriers, like cost or availability, can be successfully surpassed. In fact, the term of usefulness can be narrowed down to its application in agriculture. Diverse interpretations probably emerge in translating the term of usefulness. This research used fertilizer as the targeting technology. However, the term of usefulness may refer to specific technical aspects when it is used to assess others. For instance, farmers consider drought tolerance and pest resistance when assessing new cultivars. Some farmers may also connect this term with the effectiveness of new inputs as value promised, the others can look at the rate of its effects after application or perhaps both of them. Nevertheless, relying on one aspect of production in agriculture is not a guarantee of a surge in food production. This also needs collective action amongst various stakeholders to take care of ecosystems, meaning adoption of promising inputs can yield the desirable outputs.

In terms of the relationship between SN and its endogenous constructs, surprisingly this study could not find any statistically significant effect between SN and BI. A significant effect was only exhibited for the relationship between SN and PU. This indicates that farmers in developing countries tend to conduct preceded evaluation of the tangible benefits of IAIT as an internalization effect when they receive pressure from significant others. Although the compliance effect can be found in mandatory settings and some voluntary settings (Schepers & Wetzels, 2007), Indonesian farmers possibly need more than influences from important persons to change their behaviour. The rationale behind this is probably that new products involve uncertainty with respect to both performance and risks. Finite resources may push the farmer to carry out a rigorous evaluation before deciding to adopt new technology. Additionally, agricultural yield is not determined merely by agricultural inputs. Uncontrollable variables (e.g. weather) also take a role in influencing farming success. Perhaps the potential unpredictable result from application of IAIT, such as the imbalance of benefits compared with expense incurred, is more profoundly perceived by Indonesian farmers as this risk will be borne by the farmers themselves. Moreover, farmers still have product alternatives which offer more affordable prices (e.g. subsidized fertilizers). However, regardless of the absent effect of SN over BI, spreading innovation through influencers might still gain benefit in terms of enhancing PU of IAIT, but it is less relevant in the case that it is intended to directly stimulate BI. These results contradict the typical research on TAM conducted by Cheung (2002). In his study, he tested TAM using students as respondents. Sears (1986) concluded that students have high similarity with non-students and high obedience with the authority, thus the compliance effect tends to occur. As a proponent of this notion, Schepers & Wetzels (2007) pointed out that the relationship of SN and BI was stronger for students than non-student participants.

RD had a significant relationship with PU. This confirms that farmers can obtain a better understanding of the benefits of using IAIT when the results of its application are more observable. In fact, tangibility of the results from using new technology provides a contribution to determining adoption decisions in developing countries. It assists in inflating positive farmer perceptions toward prescribed innovation. RD can be actively designed in agricultural innovation to create recognizable visibility and spread this among a number of potential farmers. In reality, classic strategies like a demonstration plot are often used in Indonesia to draw attention when introducing IAIT. This "show-off event" located in the fields of influential farmers aims to strengthen the subsequent effect of RD. As a consequence, this approach can be effectively used to aggregate farmers. Thereby, it provides an opportunity for them to get familiar with the new inputs proposed, allowing them to conduct thorough assessments and ultimately recognize its usefulness and implications. However, this traditional approach is somewhat costly and the effects difficult to reach dispersed geographical area (Aker, 2011).

Perceived cost seemed to be a major impediment of IAIT adoption. This may be caused by the fact that farmers tend to compare the IAIT with subsidized versions that have a significantly lower price. The Indonesian government has been allocating relatively large expenses to subsidize inputs since more than three decades ago. The government had appointed state-own enterprises to produce those subsidized inputs and then capped the ceiling price, which is lower than the actual price. Later, it covered the gap between ceiling price and actual selling price. Consequently, farmers enjoy much lower input prices. However, these subsidies are finite and not all farmers are eligible to obtain these benefits. Thus, recognizing farming habits thoroughly, positioning the IAIT astutely, and segmenting farmers appropriately is possibly helpful in alleviating the perception of IAIT as unaffordable.

7. Limitations and Further Research

We acknowledge that convenience sampling used in this study may create potential bias. Accordingly, it would be desirable to obtain a larger sample and use random sampling to alleviate this issue. Meanwhile, the results obviously showed possibility of modified TAM to predict the acceptance of IAIT in developing countries. However, in reality the process of IAIT acceptance is not really straightforward and possibly involves complex social mechanisms. Thereby, future research can employ additional approaches and also include more variables. We recommend conducting qualitative studies to supplement the shortcomings of the nature of quantitative data. For example, interviews with diverse actors to delve deeper into innovation processes. Moreover, the cross-sectional survey in data collection is also considered as a limitation of this research. This does not allow the researcher to capture changes in farmer behaviour over time since the human behaviour is dynamic rather than static. To resolve this issue, we propose panel data for future studies in order to be able to more comprehensively explore the innovation adoption process within small-holder farmers.

This paper only focused on incremental innovation that does not change current farming practices. Thus, it would be more interesting for future research to explore adoption processes of advanced technology in developing country agriculture (e.g. smart farming). Lastly, the paradigm of agricultural development and innovation has evolved over time from a technological push into coinnovation involving multiple actors, processes, and partnerships. As the result, investigating the challenges of this shift from a developing country standpoint would also be valuable.

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Appendices

9.1. Questionnaire

The IAIT in the questionnaire refers to the non-subsidies fertilizer, namely Phonska Plus, that produced by fertilizer company in Indonesia. This product are relatively new introduced to the market. Moreover, fertilizer product is chosen as a representative of IAIT since it is predominantly used by any farmer (with different dosage application) with no restriction regarding the plant type he/she cultivate.

Questionnaire

Introduction

Dear Sir/Madam,

We would like to invite you take part in out short survey for an academic purpose by students of the Wageningen University & Research. The purpose of this research is to determine the intention to use relatively new fertilizer namely Phonska Plus. This is non-subsidy fertilizer that is sold at a price approximately three times than subsidized fertilizer.

It will take you approximately 3-5 minutes to answer all the questions. Your involvement in this study is confidential and your answers will be fully anonymous. There are no correct answers. It is your opinion that we are interested in.

Thank you for your cooperation on this study !

Sociodemographic

Q1. Where do you live (regency/district)?

Q2. How old are you?

Q3. What is your gender?

□ Male

□ Female

Q4. What is the highest level of education that you have?

□ Less than high school

□ High school graduate

□ Associate degree graduate

□ Bachelor's degree

□ Higher than bachelor's degree

Q5. How much land farming do you have (m3)?

Q6. What are most type of plant do you most planting in one year?

□ Staple food

□ Horticulture

Perceived usefulness

Q7. I think using the Phonska plus improves my crop/plant performance.

 Strongly disagree

 Disagree

 Neither agree or disagree

 Agree

 Strongly agree

Q8. I think using the Phonska plus increases my crop/plant productivity.

 Strongly disagree

 Disagree

 Neither agree or disagree

 Agree

 Strongly agree

Q9. I think Phonska Plus to be useful to my crop/plant.

 Strongly disagree

 Disagree

 Neither agree or disagree

 Agree

 Strongly agree

Subjective norms

Q10. People who influence my behavior (e.g. peer farmers, group leaders, family, dealer, agricultural extension, and company salesperson) think that I should use Phonska Plus ?

☐ Strongly disagree

☐ Disagree

☐ Neither agree or disagree

☐ Agree

☐ Strongly agree

Q11. People whose opinion I value (e.g. peer farmers, group leaders, family, dealer, agricultural extension, and company salesperson) think that I should use Phonska Plus ?

☐ Strongly disagree

☐ Disagree

☐ Neither agree or disagree

☐ Agree

☐ Strongly agree

Result demonstrability

Q12. I think I have no difficulty telling others about the results of using Phonska Plus

☐ Strongly disagree

☐ Disagree

☐ Neither agree or disagree

☐ Agree

☐ Strongly agree

Q13 I believed I could communicate to others the consequences of using Phonska Plus

□ Strongly disagree

□ Disagree

□ Neither agree or disagree

□ Agree

□ Strongly agree

Q14. I think the results of using Phonska Plus are apparent to me

□ Strongly disagree

□ Disagree

□ Neither agree or disagree

□ Agree

□ Strongly agree

Q15. I think I would have difficulty explaining why using the Phonska Plus may or may not be beneficial.

□ Strongly disagree

□ Disagree

□ Neither agree or disagree

□ Agree

□ Strongly agree

Perceived cost

Q16. I think the cost of adopting Phonska Plus is affordable

□ Strongly disagree

□ Disagree

□ Neither agree or disagree

□ Agree

□ Strongly agree

Q17. I think adopting Phonska Plus is NOT expensive.

□ Strongly disagree

□ Disagree

□ Neither agree or disagree

□ Agree

□ Strongly agree

Intention to use Phonska Plus

Q18. When it is available in the fertilizer dealer, how likely are you to use Phonska Plus?

□ Very unlikely

□ Unlikely

□ Neither likely or unlikely

□ Likely

□ Strongly likely

End of Questionnaire

Thank You