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FULL PAPER

The role of trust in adoption of internet of things among farmers in Selangor, Malaysia

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Abstract

This research is conducted to understand the adoption of the Internet of Things (IoT) among farmers in Selangor. Farmers' perspective of IoT utilization in their agricultural practices is analyzed to fully comprehend the elements involved in their decision to use IoT. This research explores the relationship between perceived value and perceived risk towards trust and the link between trust and IoT adoption among farmers. Perceived value and perceived risk are two common factors that influence trust among farmers, consequently affecting their decision to adopt IoT in their agricultural practices. A total of 100 farmers in Selangor who utilise IoT in their agricultural practices were selected to answer the survey. Multiple regression analysis is conducted to test the hypothesis. The result indicates that perceived value significantly influences trust but not perceived risk. Perceived risk is not significant but shows a negative relationship towards trust. Trust also showed a significant relationship towards IoT adoption among farmers. This study can help policymakers and responsible bodies to enhance the awareness of farmers to take full advantage of IoT to improve their business.

1. Introduction

In this day and age, technology plays an integral part that has transformed every economic sector. The utilisation of technology is not only limited to industrial sectors; other sectors, such as agriculture, also employ technology in their core practices. The Internet of Things (IoT) has revolutionised how technology has been used to revamp each economic sector to achieve new milestones (Muangphrathrub *et al*., 2019). With the rapid increase in human population and limited resources, food security is one of the main issues that need to be addressed. Food production needs to be improved to feed the growing population. By relying only on conventional methods, crop production will not suffice to overcome the problem. Conventional agricultural practices also sparked many debates among scholars about the long-term impact it has on the environment, such as excessive use of pesticides, fertiliser, land degradation, water contamination, biodiversity loss and greenhouse gas emission (Gomiero *et al*., 2011; Kanianska, 2016; Pandey and Diwan, 2018; The World Bank, 2019; Tudi *et al*., 2021). The utilization of IoT in agriculture is currently seen as one of the solutions to problems originating from traditional farming practices. IoT enables farmers to evaluate field variables to improve crop yields and crop quality and reduce the cost of production. The increase in productivity will, in turn, ramp up food production to ensure food security. This is why the agriculture industry must leverage IoT for farming to improve productivity.

Smart farming by utilising IoT is becoming more famous due to its applicability and usability in improving traditional agriculture practices. Among the critical technologies in IoT are sensors, information transmission technology, information processing technology, radio-frequency identification and 3S technology (Xu *et al*., 2022). The sensors are mainly used to detect and measure physical phenomena such as humidity, soil pH, heat and pressure. These data are then collected and transmitted via a wireless sensor network (WSN). The 3S technology includes remote sensing (RS), global navigation satellite system (GNSS), and geographic information system (GIS). These technologies enabled a comprehensive data collection system that makes IoT powerful technology in helping the industry grow.

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IoT brings about new ways to modernise conventional agricultural practices. IoT technology, such as drones equipped with multispectral cameras helps in crop monitoring and identification of specific areas for pesticide spraying (Rao Mogili and Deepak, 2018). Meanwhile, field-level weather forecasting can help farmers monitor the weather and integrate their water management system (Divyapriya *et al*., 2020) to ensure that they can manage the soil moisture level accurately. Automation capabilities help reduce dependency on the human workforce in agricultural practices such as irrigation and soil management helping farmers spend less time on the farm (Puranik *et al*., 2019) and allowing remote control of the irrigation system (Saraf and Gawali, 2017). Automation in water management helps farmers save water and maximize productivity by applying accurate amounts of water determined by the threshold set by farmers. Thus, productivity will increase and translate into higher income for farmers. Besides weather forecasting and IoT automation, variable rate application is used to monitor in-field conditions to help farmers increase their crop production level by gauging their input usage (Fastellini and Schillaci, 2020). The technology helps farmers to monitor the needs of the plants and make better decisions regarding input usage. Excessive usage of agricultural input will increase the production cost and pollute the environment. The application of these sensors helps farmers increase their profitability and, at the same time, practice sustainable farming.

Despite the positive outcome of the utilization of IoT in agriculture, there are also several risks that have been highlighted especially in the usage of technology. The most common perceived risk associated with technology is security and privacy risk (Brewster *et al*., 2017). Being on the internet makes it easier for any party to steal and manipulate the data. A large number of users on the net and a large volume of data shared on the networks make it less safe as there is a higher chance someone can hack into the systems and retrieve the data illegally without being traced. Farmers that use IoT raises concern about the safety of their data collected using the IoT tools. They worried that the data collected would reveal their farms' condition and performance (Ferrag *et al*., 2020; Pillai and Sivathanu, 2020). The data can be manipulated by the IoT provider company or their competitors. These perceived risks often influence the trust the users have in IoT. Users feel more uncertain about IoT adoption since their trust in the technology is affected by the risk the technology imposes. (AlHogail, 2018). The role of trust has been studied closely regarding the adoption of technology. It is an element that plays a pivotal role in online or technology-related tools in business compared to the brick-and-mortar store. Much research conducted on the adoption of online platforms to conduct business has shown that trust significantly impacts the behaviour of consumers (Farivar *et al*., 2017; Akman and Mishra, 2017). The main factor that can influence human behaviour is trust. Ji *et al*. (2020) found that farmers can conduct their business online by building trust with the consumers.

IoT's advantages have been widely applied in agriculture to improve crop yield and quality. IoT technology has become more mature and improving day by day, making it more accepted by farmers although it also comes with certain risks that might threaten the trust farmers have in the technology itself. Thus, the study is conducted to investigate the influence of perceived value and perceived risk towards trust in IoT and how trust then translated into IoT adoption among farmers.

2. Materials and methods

This study focuses on farmers that have adopted IoT in their farms. Since the accurate population of farmers that utilized IoT in their farm in Selangor is unknown and the short time frame in conducting the survey, a total of 100 respondents have been selected to participate in the survey. A convenience sampling technique is used in this study. The questionnaire is divided into six parts. Part A covers the demographic of the respondents, such as age, gender, education background and land size. The second part identifies the type of IoT technologies the farmers currently use on their farms. There are 25 questions in Part C until Part F covering all the variables studied in this research. Part C explores the element of trust in the adoption of IoT among farmers. Parts D and E focus on the perceived risk and perceived value. Lastly, Part F identifies the respondents' views on the advantages of IoT on their farms. The five-point Likert scale is used for all 25 items in the questionnaire.

In this study, Statistical Package for the Social Sciences (SPSS) is used to analyse the data collected. First, descriptive analysis is conducted to explore, summarise, and describe the data collected in Part A and Part B. The analysis provided general observations about the data collected, such as the number of males and females, the age group of respondents, their educational background, and the types of IoT technologies they adopted. A reliability test is then conducted for all five-point Likert scale items used in the questionnaire. Cronbach's alpha is used to test the internal consistency of all scale items. Next, multiple linear regression is conducted to identify the relationship between the variables studied in this research.

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3. Results and discussion

3.1 Reliability test

A reliability test using Cronbach's alpha is conducted to measure the internal consistency and stability of the measure used in the questionnaire. Based on Table 1, the reliability test was conducted on all 25 items, and all items showed a high alpha value with a minimum of 0.936. Therefore, all items show high internal consistency and are suitable for this research.

Table 1. Reliability statistics

Variables	No of items	Cronbach's Alpha value
Perceived value	6	0.971
Perceived risk	4	0.973
Trust	7	0.937
IoT adoption	8	0.936

3.2 Descriptive analysis

Based on Table 2, a total of 63% of the respondents are male, while 37% are female. The majority of the respondents are less than 35 years old, with 32% coming from the less than 25 years old age group, while 35% are in the 25 to 35 years old age group. Only 4% of the respondents were more than 55 years old. More than half of the respondents involved in this research are highly educated, with 35% of the respondents having a diploma qualification, followed by degree holder (16%), and 8% earned a master's qualification. The most popular IoT technologies adopted by the farmers are drones (81%), followed by GPS-based field mapping (51%), yield data analysis (24%), field-level weather forecast (13%), variable rate technologies (8%) and lastly autosteer for planting (5%).

Table 2. Socio-demographic data of farmers (n = 100).

Socio-demographic profile	Frequency	Percentage (%)
Gender		
Male	63	63
Female	37	37
Age		
Less than 25	32	32
25 - 35	35	35
36 - 45	15	15
46 - 55	14	14
More than 55	4	4
Level of education		
SPM	41	41
Diploma	35	35
Degree	16	16
Master	8	8
Size of farm (acre)		
Less than 1	9	9
1 – 5	35	35
5 – 10	35	35
10 – 25	14	14
25 – 40	6	6
More than 40	1	1
IoT technology adopted		
Yield data analysis	24	24
GPS-based field mapping	51	51
Variable rate technologies	8	8
Field-level weather forecast	13	13
Autosteer for planting	5	5
Drone	82	82

Based on the table above, the majority of the respondents are male with more than half of them young farmers aged less than 36 years old. Most of the respondents are highly educated with more than half receiving tertiary education. These are in line with results from other studies that found that most of the farmers who adopt technologies in their farms are male (Jayashankar *et al*., 2018; Pillai and Sivathanu, 2020), young adults (Pillai and Sivathanu, 2020) with higher education and had a farm of 5 to 10 acres (Shi *et al*., 2022)

3.3 Multiple linear regression

Multiple linear regression is conducted to identify the relationship between the variables. In this study, the regression is conducted to identify the relationship between perceived risk, perceived value, trust, and adoption of IoT. Table 3 shows the regression result between perceived risk, value, and trust.

Table 3. Results of coefficients for perceived risk, perceived value, and trust

Model	Standardised Coefficients Beta	t	Sig.
(Constant)		3.454	0.001
Perceived risk	-0.023	-0.255	0.799
Perceived value	0.585	6.578	0

a. Dependent variable: trust

Based on the Table 3, perceived risk is insignificant in this model. The t-value for perceived risk is negative. The result shows the opposite relationship between perceived risk and trust. The higher the perceived risk, the lower the trust, albeit insignificant in this study. The perceived value shows a solid significant level of 0.000 ($p<0.05$). The beta coefficient of 0.585 means that the trust will increase by 0.585 units for every 1 unit increase in perceived value. The increase in the perceived value will significantly increase the trust of respondents.

The results show that the respondents' trust plays a significant role in determining IoT adoption in their agricultural practices. The roles of perceived risk and perceived value in influencing trust are also explored in this research. Between perceived value and perceived risk, perceived value plays a vital role in affecting trust

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despite being one of the factors that can influence trust (Abror *et al*., 2021; Ali *et al*., 2021; Zhai *et al*., 2021) while perceived risk is not significant in this research. Although perceived risk is not significantly related to trust, the negative beta coefficient shows the negative effect of perceived risk on trust. Perceived risk is found not to be significant towards trust. This result is supported by other studies that show the same negative but insignificant results in their studies. Psychoula *et al*. (2018) found that although the users were aware of many risks of adopting IoT, they still wanted to use the IoT services if they were beneficial. The result proves that perceived value is more important to the user when it comes to IoT adoption, and it compensates for the risk they face.

Based on the result in Table 4, trust is found to significantly influence IoT adoption among farmers at a significant level of 0.000 ($p<0.05$). The beta coefficient of 0.551 shows that with an increase of 1 unit of trust, there will be an increase of 0.551 unit of IoT adoption.

Table 4. Results of coefficients for trust and IoT adoption.

Model	Standardised Coefficients Beta	t	Sig.
(Constant)		8.447	0.000
Trust	0.551	6.529	0.000

a. Dependent variable: trust

Perceived value significantly influences trust. This result is supported by other studies that found similar findings. In terms of understanding consumers' behaviour in the context of intelligent technology, it is observed that perceived value is one of the elements that shape consumers' trust in smart technology. Besides, in their study, Roh *et al*. (2022) found that perceived value plays a vital role in building trust. Trust can play an essential role in influencing users' behaviour. Another study by Sharma and Kline (2020) also found that perceived value significantly influences perceived trust. Perceived trust will, in turn, influence the behaviour. The expectation of the influence of IoT on performance increases the probability of farmers using IoT equipment and facilities (Ronaghi and Forouharfar, 2020). IoT adoption in the agriculture sector brings many advantages as it increases productivity and reduces the time spent on farms compared to conventional agriculture practices (Pillai and Sivathanu, 2020). Thus, perceived value will influence the farmers to adopt IoT. Trust is a critical element in influencing the adoption of IoT. Leroux and Pupion (2022) that found trust plays a crucial role in the local authority's adoption of IoT in France. Koohang *et al*. (2022) stated that IoT users are more inclined to continue using IoT when they trust it. Other studies also dictate similar findings that support the relationship between trust and the behaviour of users (Chuang *et al*., 2020; Roh *et al*., 2022; Sharma and Kline, 2020). Trust is proven to be a foundation in adopting technology since it comes with uncertainty and risk. Alaeddin and Altounjy (2018) found that trust positively influences attitudes toward technology adoption. Building trust in IoT will help users to adopt the technology. The more trust one has in the technology; the more one will likely adopt it.

4. Conclusion

Perceived value has been identified as the main factor that significantly influences trust among farmers who adopt IoT in their farms. Many benefits come with the adoption of IoT in the agriculture sector. IoT helps increase productivity and, at the same time, lowers the production cost, which helps increase the farmers' profitability. Besides, IoT can also provide answers to the sustainability issues in the sector. By utilising IoT, conventional agricultural practices that are widely known as harming nature can be replaced by intelligent farming that utilises the advantage that technology offers to minimise the impact of these practices. Whilst all of these advantages seem beneficial to farmers, there are still barriers that hinder IoT adoption. Perceived risk is identified as one of the factors that hinder IoT adoption among farmers. Although, in this study, perceived risk is not found significant, the negative beta coefficient shows the connection between perceived risk and trust. The higher the perceived risk, the lower the trust farmers have towards IoT adoption. Since trust is one of the factors that can influence the adoption of IoT, understanding every element that can affect trust is crucial. The results can be used to help the government and policymakers find ways to attract more farmers to adopt IoT in their farms to replace conventional agricultural practices.

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