A Framework on Intention to Adopt Internet of Things Among MSMEs in Farming

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Abstract. The agrofood sector is essential in many countries worldwide for food security, food safety and nutrition but facing challenges and issues of productivity, lack of involvement from youth, climate change, and scarcity of resources. Many countries have promoted the Internet of Things (IoT) as part of the policy intervention to curb these challenges. Malaysia is not excluded. The IoT adoption in farming is being focused by the government in order to increase productivity in the industry. Currently, the IoT implementation in the agrofood sector in Malaysia is still in the early stages of development. IoT adoption by farmers, especially from micro, small and medium enterprises (MSMEs), is still far from expected. Many MSMEs may not be aware of the benefits of IoT for real-time information and reducing uncertainties in farming. Therefore, there is a huge gap in terms of reliable and timely information for decision-making processes. However, related studies on factors influencing IoT adoption among agrofood's MSMEs are minimal. Previous study on IoT in farming mainly focuses on the technical implementation of IoT. Furthermore, very few studies focus on the organization level and attitude of the owner-manager. Hence, based on the Technological-Organizational-Environmental (TOE) framework, this study will propose a conceptual framework that links the factors influencing the intention adoption of IoT in farming among MSMEs and mediating effect of attitude of the owner-manager on IoT adoption intention. This paper contributes to the existing body of knowledge and guides related stakeholders to develop suitable strategies for encouraging IoT adoption among agrofood's MSMEs.

Keywords: Internet of things (IoT) · IoT system adoption · Micro small and medium enterprises (MSMEs) · Agrofood industry

1 Introduction

The agrofood sector is important for food security, food safety, and nutrition for the Malaysian population. This sector also provides employment to rural areas and contributes 3.45 per cent of Malaysia's Gross Domestic Product (GDP) in 2020. In order to increase productivity and stable contribution to GDP, there is a need to adopt and use technology intensively. According to [1] Ministry of Agriculture and Agrofood Industries (MAFI) adopting innovative technology is critical to increasing productivity and

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reducing the agrofood sector challenges. National Agrofood Policy (NAP) 2.0 has pioneered this agenda by advocating smart farming and modernization as one of thrust in NAP policy. Malaysia Digital Economy (MyDIGITAL) Blueprint, National Fourth Industrial Revolution (4IR) policy, 12th Malaysian Plan (RMK-12), and Shared Prosperity Vision (SPV) 2030 also focus on technology innovation and smart farming with IoT technology to progress this sector.

The Malaysian government has emphasized on technology adoption, particularly IoT technology in farming, to boost productivity in agrofood among micro, small and medium enterprises (MSMEs). Many government agencies in Malaysia are seeking for more in-depth research into the challenges and drivers of IoT adoption [2]. IoT technology in agrofood sector is still in nascent stage in Malaysia, with some past research stating that IoT adoption is still in its infancy [3]. There is also lack of study on the deployment of IoT technology in Malaysia among MSMEs [4] includes MSMEs in agrofood sector.

The Malaysian agrofood's MSMEs continue to use the traditional method in their production process. The adoption rate of modern technologies in the agriculture sectors remains at low levels [5]. This is contributed by various factors such as lack of holistic efforts, dependency on low and semi-skilled labors, ageing farmer, lacks of private sectors investments, lacks of technical knowledge, fragmentation of information, higher deployment cost and poor network connectivity to support smart technologies [6].

Many agrofood's MSMEs are still unable to effectively adopt IoT technology due to a lack of awareness of the technology [7] and a lack of usage of high-tech machinery [8, 9]. IoT is important as it can help to reduce challenges in agrofood sector by providing live information for immediate decision making [10, 11]. It is imperative to understand the factors influencing the intention to adopt IoT technology empirically from the perspective of MSMEs in order to encourage them to adopt the technology in their farms.

2 Literature Review

2.1 Internet of Things

The term Internet of Things (IoT) was introduced by Kevin Ashton from Massachusetts Institute of Technology (MIT) in a presentation about the benefits of radio-frequency identification made for Procter and Gamble in supply chains in 1999 [10, 12, 13]. There is no universally agreed upon definition of IoT. In 2014, the International Organization for Standardization (ISO) organized an expert panel to define IoT. According to them, IoT is "an architecture of networked things that can interpret data from the physical and virtual worlds and react accordingly" [14].

IoT refers to system of interrelated devices, network, and application that connected through the internet, can communicate with one another to generate enormous data for further decision-making process [15–18]. In simple term, IoT is the technology that connects any device to the internet. It describes networks of objects or "things" that are not themselves computers but have embedded components that connect to the internet [19, 20].

Table 1. Definition of MSMEs in Malaysia based on size

Size	Manufacturing	Services and other sectors
Medium	Sales turnover between RM15 million and RM50 million OR Between 75 and 200 employees	Sales turnover between RM3 million and RM20 million OR Between 30 and 75 employees
Small	Sales turnover between RM300,000 and RM15 million OR Between 5 and 75 employees	Sales turnover between RM300,000 and RM3 million OR Between 5 and 30 employees
Micro	Sales turnover between RM300,000 OR less than 5 employees	Sales Turnover below RM300,000 OR less than 5 employees

Source: SME Corp (2020)

2.2 Agrofood's MSMEs in Malaysia

The Malaysian government has consistently invested a significant amount of money and time in the development of MSMEs, primarily through the national-level strategy. Previously, the Malaysian government announced the National IoT Strategic Roadmap in 2014 as a means of sustaining economic growth, with the SME Corporation Malaysia (SME Corp) spearheading the initiative and as one of the key players. However, MSMEs continue to confront numerous obstacles when it comes to accepting and utilizing IoT [4].

According to the SME Corp. Malaysia's Guideline for New SME Definition [21], MSMEs in Malaysia are grouped into three which are micro, small and medium. The grouping is according to their industry, sales turnover, and the number of employees [22]. Table 1 shows the definition of MSMEs in Malaysia. Agrofood sector fall under group of other services and other sector.

Based on a study by SME Corp in 2018, MSMEs in Malaysia have been slow to adopt new technologies such as ICT technology, the internet and the most recent innovation of IoT [9, 23]. The study further revealed that 35 percent of MSMEs used IoT but only limited in certain activities of building security and surveillance and fleet tracking solutions only. Furthermore, report published by Malaysia Productivity Corporation (MPC), (2020) [5] showed that there are slow and low adoption of modern innovation technology and technique in agrofood sector by MSMEs.

The IoT in agrofood sector in Malaysia is still in the early stages of development [24] and far from ideal due to various reasons such as remote locations, limited access to the latest knowledge and technology, insufficient institutional support, vulnerability to wide range of uncertainties, including pest and disease attacks and outbreaks, global climate change, and fluctuations in the agricultural markets [25].

Many agrofood's MSMEs have not adhered with the current standards of good practice, related to efficiency and sustainability [25, 26]. For example, fertilizer is used at the farms not according to farms' needs but based on standard practice. Many agrofood's MSMEs lack the understanding of pest life cycles. Hence, they are vulnerable to crop failure due to infestations and environment changes [27].

Most of the farm level decision and information are subjective and interpretation are by individual and most of the time vary between them [28]. In the past, result of trial and error of become the basis for an intelligent guess during critical situation [29]. MSMEs always face fundamental questions all the time about their farm includes when, how and what to plant, the cost of input resources, the adequate level of input application, pest and diseases monitoring, animal monitoring and channel of marketing and distribution of their produce and so on.

Therefore, there is huge gap for farming in term of reliable and timely information for decision making processes [25, 30, 31]. And IoT can easily fill this gap by providing data and information on demand and live data for immediate decision making. Based on literature, brief description of the construct incorporated in the proposed conceptual framework and how they are related to the intention to adopt IoT is discussed.

2.3 Perceived Usefulness

AlHogail [32] found that perceived usefulness is a significant variable for a better adoption rate. Correspondingly, some past studies have illustrated perceived usefulness to be a significant predictor of technology adoption or IoT adoption-related studies [33–37]. For these reasons, perceived usefulness is included as one of the important determinants of IoT technology adoption in farming among MSMEs in Malaysia. Hence, it is proposed that:

Proposition 1: Perceived usefulness is positively related to IoT technology adoption intention in farming.

2.4 Perceived Ease of Use

Perceived ease of use relates to a person's perception of how easy it will be to utilize a certain system [38]. It is predicted that perceived ease of use predicts intention [39]. Extensive research conducted over the last decade demonstrates that perceived ease of use has a considerable effect on usage intention, either directly [37, 40, 41] or indirectly [42] via its effect on perceived usefulness. Hence, it is proposed that:

Proposition 2: Perceived ease of use is positively related to IoT technology adoption intention in farming.

2.5 Perceived Compatibility

Previous studies considered perceived compatibility as a significant factor in technology adoption because technology innovation will cause impacts on the firms' structure, task practices, daily routines, form process flow, human capital and cost [43, 44]. In the case of the current study, if IoT technologies are compatible with a farm's current work, the agricultural MSMEs will be more likely to adopt them [45]. On this basis, it is proposed that:

Proposition 3: Perceived compatibility positively related to IoT technology adoption intention in farming.

2.6 Perceived Trustworthiness

Past studies have also found that trustworthiness is linked to MSMEs managers' behaviour in the e-commerce world. For example, Ma, Shazad et al. and Tu [46] found that trustworthiness had a big impact on managers' behaviour when they used e-commerce services. Unless business owners have a strong sense of trust in the e-vendors, they are unlikely to accept the risk of implementing e-commerce services in their SMEs. Thus, this study proposes the following:

Proposition 4: Perceived trustworthiness positively related to IoT technology adoption intention in farming.

2.7 Financial Cost

Financial costs can be a big factor for MSMEs businesses, like farming organizations, where the introduction of IoT based technology in farms will be a huge investment. [45]. Hence, the following is proposed:

Proposition 5: Financial cost is negatively related to IoT technology adoption intention in farming.

2.8 Lack of Skills

People who do not have the skills to use new technology or are not ready to use new technology are called "lack of skills" [47]. If a company has a lot of technology and employees who are up to date on IT knowledge and skills, it is more likely to use ICT and vice-versa [48]. Thus, it proposed that:

Proposition 6: Lack of skills is negatively related to IoT technology adoption intention in farming.

2.9 Human Resource Vulnerability

Human resource vulnerability is the extent to which an organization doesn't have enough people to do new things or use new technology [49–51]. The size of a company's human resources corresponds to how many people it has. Thus, it is proposed that:

Proposition 7: Human resource vulnerability negatively related to IoT technology adoption intention in farming.

2.10 Normative Pressure

Normative pressure refers to the pressure that trade organizations and other IT professional groups put on people to do things the right way [52]. Normative pressure is about how a company is connected to other people, like suppliers and customers. If a lot of businesses already use new technology, they'll be more likely to see it as a good thing to do. Thus, the following is proposed that:

Proposition 8: Normative pressure is positively related to IoT technology adoption intention in farming.

2.11 Mimetic Pressure

Mimetic pressure is a way of life that causes businesses to copy the behaviour and activities of other businesses, usually their competitors [52]. Mimetic pressure is caused by a company's perception of how well its competitors are doing. It comes from the company's belief that its competitors are doing well [52]. Thus, the following is proposed that:

Proposition 9: Mimetic pressure is positively related to IoT technology adoption intention in farming.

2.12 Coercive Pressure

Coercive pressures come from important customers or suppliers who keep asking for things [52]. It is also group of formal or informal forces that come from politics and rules [52]. It can be hard for businesses to deal with this kind of pressure because they depend on other businesses, like their main suppliers or customers. Firms may feel this kind of pressure when they think that powerful suppliers or customers want them to adopt innovation. Thus, the following is proposed that:

Proposition 10: Coercive pressure is positively related to IoT technology adoption intention in farming.

2.13 Government Support

Studies by Bakar et al. [53] indicates that government support is positively related to the MSMEs' adoption of sustainable technology. Furthermore, a previous study confirmed that external support from the government is a fundamental process of Internet technology adoption by firms [54]. Previous studies say that governments have a big impact on how micro, small and medium-sized businesses use certain types of information technology [55]. Thus, the following is predicted that:

Proposition 11: Government support is positively related to IoT technology adoption intention in farming.

2.14 Organization's Management Attitude Towards Technology

It is very important for the management of an organization to have a positive attitude about technology in order for them to adopt new technology. A study by [56] found that leaders' attitudes play a role in whether or not people use new technology. In this study, leaders' attitudes about technology act as a full mediating factor in the impact of technological factors on technology adoption, and a partial mediating factor in the impact of cooperatives and environmental factors on technology adoption. This study found that in order to get more people to use new technology, we need to try to change the way leaders think about it. Thus, the following were proposed as:

Proposition 12: Organization's management attitude towards technology mediates the positive relationship between perceived usefulness and IoT technology adoption intention in farming.

Proposition 13: Organization's management attitude towards technology mediates the positive relationship between perceived ease of use and IoT technology adoption intention in farming.

Proposition14: Organization's management attitude towards technology mediates the positive relationship between perceived compatibility and IoT technology adoption intention in farming.

Proposition 15: Organization's management attitude towards technology mediates the positive relationship between perceived trustworthiness and IoT technology adoption intention in farming.

Proposition 16: Organization's management attitude towards technology mediates the negative relationship between financial cost and IoT technology adoption intention in farming.

Proposition 17: Organization's management attitude towards technology mediates the negative relationship between lack of skills and IoT technology adoption intention in farming.

Proposition 18: Organization's management attitude towards technology mediates the negative relationship between human resource vulnerabilities and IoT technology adoption intention in farming.

Proposition 19: Organization's management attitude towards technology mediates the positive relationship between normative pressure and IoT technology adoption intention in farming.

Proposition 20: Organization's management attitude towards technology mediates the positive relationship between mimetic pressure and IoT technology adoption intention in farming.

Proposition 21: Organization's management attitude towards technology mediates the positive relationship between coercive pressure and IoT technology adoption intention in farming.

Proposition 22: Organization's management attitude towards technology mediates the positive relationship between government support and IoT technology adoption intention in farming.

3 Conceptual Framework

IoT are essential to ensure productivity and reducing all challenges in the agrofood industries. Agrofood's MSMEs can improve their daily operations by using the IoT technology [57]. The factors influencing and how they related to adoption intention of IoT technology in farming by MSMEs are illustrated in Fig. 1.

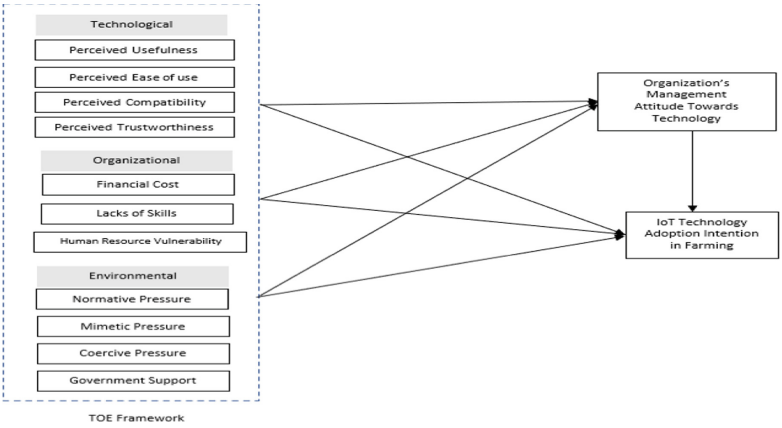

Fig. 1. Conceptual Framework

4 Implication

The current study contributes to a better understanding and explanation of MSMEs' intentions to adopt IoT technology in agrofood sector. The conceptual framework shows the relationship between the factors identified in three distinct contexts of technological, organizational, and environmental influences on IoT technology adoption intention, as well as the mediating effect of an organization's management attitude toward technology. It contributes to the existing body of knowledge by addressing the gaps in literature and guiding policy makers, MSMEs, IoT business players and training providers to develop suitable strategies to improve policies or existing plans and for encouraging the adoption of IoT among MSMEs.

5 Conclusion

The IoT is inevitably and going to be a major and critical role in all sector in a near future. Many developing countries like Malaysia are still slow in adopting the IoT especially in agrofood sector. This study attempts to proposed a conceptual framework of IoT intention adoption among MSMEs in farming by describing the relationship of factors influencing, mediating role of organization's management's attitude and adoption intention of IoT in farming. Based on literature review on IoT adoption, this study contributes to body of knowledge in IoT adoption area and stakeholder involved in agrofood sector in Malaysia.

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