# Exploring Technology Readiness and Acceptance of Small-scale Farmers in Sabah towards the Adoption of Internet of Things Technology

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**Abstract**
This study aims to explore and propose a conceptual framework to study the determinants of Internet of Things (IoT) adoption intention of small-scale farmers in Sabah for their farming practices. Report from Twelfth Malaysia Plan presented a tremendous decrease of workforce in agriculture sector over the years. In addition, in this contemporary era marked by technological advancements, all industry players in the agriculture sector are compelled to integrate new technologies relevant to agrobusiness. Hence, there is an urgent need of intervention to solve this issue as it will affect food production in Malaysia in the near future. The objective of this study is to formulate a conceptual framework based on semi-structured literature reviews on agricultural technology, incorporating theoretical frameworks from case studies, government reports and statistics. The paper discusses on which framework and its mode of integration that could be adopted in order to study the intention of IoT adoption among small scale farmers in Sabah. This initial conceptual framework provides insights into the needs and concerns of small-scale farmers regarding IoT adoption, serving as a guide for IoT service providers and policymakers in shaping initiatives for agricultural transformation in Sabah.
**Keyword:** Technology readiness; Technology acceptance; Internet of Things; Agrotechnology; Small-scale farmers

## 1. Introduction

Agricultural sector is important for economic growth and food security that its development could produce food to cater for 9.7 billion people projected by 2050 (World Bank, 2023). The global agriculture production needs to increase 60% more output to cater for food demand for the global population by the year 2050 (FAO, 2022). Governments worldwide have recognized the immense potential of IoT technologies in revolutionizing the agriculture sector. By integrating IoT devices and systems into farming practices, governments aim to enhance productivity, sustainability, and profitability while addressing challenges faced by farmers. Despite of the many benefits of IoT, the implementation of Agriculture 4.0 and IoT technologies in the agricultural sector remains uneven worldwide. There are significant gaps that need to be addressed to understand why some countries have been successful in utilizing these technologies while others are left behind.

Sabah, one of the Bornean states, played a crucial role in the formation of the Federation of Malaysia in 1963. Agriculture, particularly the oil palm industry, is a significant contributor to Sabah's economy, accounting for 12.6% of Malaysia's national GDP and 15.2% of Sabah's GDP in 2022 (DOSM, 2023a). The state government has emphasized the development of agriculture, as outlined in the Sabah Maju Jaya plan (Sabah State Government, 2021). However, there is an urgent need to prioritize the agrifood sector, given the growing population of 3.39 million, which results in substantial food imports, creating a dependence on external sources (DOSM, 2022b). Other than fulfilling food demand, Sabah government is using the industry to boost the state's income as it has been performing comparatively low (bottom two in Malaysia) throughout the years (EPU, 2021).

Despite Sabah's abundant land and biodiversity, the state faces multiple challenges in agriculture, including low productivity, limited technology adoption, manpower shortages, inadequate infrastructure, inefficient collaboration between state and federal agencies, and shrinking agricultural land. These challenges have persisted since the 1990s when the first agricultural policy was formulated. Small-scale farmers, who have relied on traditional practices for decades, struggle with economic stagnation and limited income, highlighting the need for modernization in agricultural practices to improve productivity and income for these farmers (Johari, 1991; Yusof & Anuar, 2023). Another challenge facing Sabah is its heavy reliance on oil palm outputs. The state government's 2021-2025 development strategy aims to modernize traditional farmers, fishermen, and livestock farmers, with a focus on collaborative industry development, economic activities, labor issues, and regional inclusivity. The plan includes a substantial investment of RM560.39 million and involves various state agencies as key drivers and implementors, aiming to enhance the livelihoods of targeted groups, increase Sabah's food self-sufficiency, and diversify the state's potential as a food producer (Sabah State Government, 2021).

In Malaysia's 12th Economic Plan (EPU, 2021), it acknowledges that the agricultural sector still lags behind in adopting new technology. The SSR food production sector in agriculture was reported to be at 53.3% which was under 60% target (EPU, 2021). Towards achieving more production output, economy of scale and to generate higher income for farmers, Malaysia has chosen to implement smart agriculture through the IoT (MAFI, 2021). As part of technologies associated with Industrial Revolution 4.0 (IR4.0), IoT is an innovative solution that helps rural farmers boost their operations in many ways. It provides real-time data that could reduce the risk of crop failure, increase crop yields, reduce fertilizer use and water consumption, therefore decreasing production costs and increasing profitability and sustainable practices (Kondoyanni et al., 2022; Xu et al., 2022). Agricultural transformation depends on these technologies to boost productivity. These technologies indeed require huge investment, but incremental revenue and profits, as well as the social and environmental impact, justifies it. To this date, the Malaysian government initiated eLadang pilot projects which increased yields up to 12%, supported development of big data system (the Agriculture Flagship), distributed grants worth RM76 millions for automation and invested in development and commercialization of 57 new agricultural technologies (EPU, 2021).

Despite the acknowledged benefits of IoT, the global implementation of Agriculture 4.0 and IoT technologies in agriculture remains uneven. Understanding why some countries succeed in adopting these technologies while others face challenges is a critical research gap. Amidst the hype surrounding IoT, it is crucial to note that technological readiness and acceptance pose challenges, especially among small-scale farmers (Harun et al., 2015; Mat Lazim et al., 2020). The driving factors behind this challenge must be more specific and generalized, needing a precise examination of the root cause (Mat Lazim et al., 2020; Aris, 2021; Sinha & Dhanalakshmi, 2022). Recognizing this issue and striving to improve the readiness level and acceptance of IoT technologies in the agriculture industry, particularly in Sabah, is imperative. Sabah faces the dual challenge of boosting food production outputs and addressing various resource issues (Sabah State Government, 2021; EPU, 2021). This research is proposed in response to these challenges, with the technological acceptance (Davis, 1989) and readiness model (Parasuraman, 2000; 2015) serving as the framework and foundation for systematically investigating these issues.

## 2. Literature Review

IoT adoption remains a complex and unfamiliar concept for small-scale farmers in Malaysia, particularly in Sabah, despite its presence for some time. Many perceive it as too intricate and costly, often associating it with larger agricultural enterprises. Small-scale farmers, who are generally resistant to change, often see IoT as beyond their reach due to these perceived complexities and high installation and maintenance expenses. While previous researches have concentrated on the technical and legal aspects of IoT adoption, there has been limited exploration of the attitudes and readiness of potential adopters, which are pivotal for successful implementation.

Positive attitudes toward IoT adoption involve a willingness to embrace new technologies and a belief in the potential benefits it offers. Conversely, negative attitudes or resistance could hinder the process. Educating and creating awareness about the advantages of IoT could help foster positive attitudes. IoT adoption often necessitates changes in processes and workflows, and the readiness to manage these changes is crucial. Effective change management practices, including clear communication and training, could alleviate resistance and enhance readiness for IoT implementation. Readiness encompasses technical, organizational, and individual aspects. Technical readiness entails having the necessary infrastructure and expertise to support IoT deployment. Organizational readiness relates to having a supportive culture and leadership commitment. Individual readiness involves the knowledge, skills, and training required for personnel to effectively engage with IoT systems. Demonstrating the benefits of IoT, addressing concerns, and learning from past experiences are all vital elements in maximizing the chances of successful IoT adoption in the agricultural sector.

In the literature of technology acceptance predictor, common theories that would be mentioned include Theory of Reasoned Action (TRA), Theory of Planned Behaviour (TPB), Technology Acceptance Model (TAM), Social Cognitive Theory (SCG), Diffusion of Innovation (DOI), Unified Theory of Acceptance and Use of Technology (UTAUT) and many others (Venkatesh et al., 2003; Taherdoost, 2018). The selection of which theory to use as the base technology acceptance framework will depend on the users – do they belong to a group or collectively tested or are they being analysed individually; or is the research a time-based analysis (Venkatesh, 2006). There would be various justifications and combinations of framework that had been presented from previous researchers. However, for the case of Sabah small-scale farmers, the internal and external characteristics of the adoptee must be considered such as the level of exposure and experience towards the technology, awareness, the capacity and curiosity to learn – all of this could potentially affect their attitude towards acceptance in adopting an IoT technology (El Bilali et al., 2021). Understanding the configurations of Sabah small-scale farmers could likely help in determining which technology acceptance theoretical framework to use as the foundation of this research.

## 3. Methodology

The basis of this conceptual review of the research is carried out after undergoing semi-structured article reviews based on the contextual topics of interests that revolve around agrotechnology adoption studies within Malaysia as well as internationally, technology adoption cases and reviews from related industries first, and also relevant industries or adoption that involve an individual-level decision-making or awareness level; mostly focused on new adoption where picked technology was treated as novelty to the respondents or user. This method is adapted from Shaffril et al. (2021). These articles were screened, compared, and information extracted based on its theoretical foundation, similarity or differences in adoption issues, information or data consistency and the country of origin of where the research was conducted. A total of 179 documents were preliminarily identified and gathered for analysis, which include peer-reviewed articles and journals, press articles, statistics and government policy reports were referred and reviewed.

The following section will discuss further on the parameters of applied methods consisting of the research question and strategies on how to answer the question.

### 3.1 Research Question

The purpose of this research is to explore on conceptualising the theoretical framework for acceptance of IoT implementation among small-scale farmers in Sabah, Malaysia. Based on the objective, the paper seeks to investigate previous researches or documents that could answer this question:

*What are the trends or theoretically underpinned researches and empirical case studies on new technology acceptance and implementation in agriculture industry globally?*

The question later is used as guide when determining contexts and keywords for further strategies in selecting articles and documents for further analysis.

### 3.2 Articles Systematic Searching Strategies

According to Shaffril (2021), the steps for articles collection for systematic literature review (SLR) could be broken down into *identification, screening, eligibility* and data analysis from *articles that are ready to be reviewed;* which could be illustrated in Figure 1. The details on how articles for review are collected is discussed further in upcoming Section 3.2.1-3.2.4.


**Figure 1.** Strategy for systematic literature review by Shaffril et al. (2021)

#### 3.2.1 Identification

In this stage, articles search was carried out from Google Scholar, Emerald Insights, Elsevier, and Springer databases. Keywords that were used to get a pool of related articles to analyse for answering research question include multiple combinations of “technology acceptance”, “small-scale farmers”, “agriculture industry”, “new technology adoption” and “IoT”. The results were then filtered to retrieve articles from year 2015 to 2023.

As for Malaysian cases, keywords used to identify articles were combinations of words such as “technology adoption AND/OR Malaysia AND/OR agriculture” or combinations from keywords such as “new technology adoption”, “adoption in Malaysia”, “Malaysia agriculture”, "farmers", "Malaysia" and "IoT" from previously used database group with similar timeframe from 2019 to 2023. In addition to scholarly databases, the research was using database from Malaysian agriculture authority sub-organisation, which is Malaysian Agricultural Research and Development Institute (MARDI), for its vast publications and case studies on innovation and technologies for Malaysian agriculture. Finally, the overall findings from this information gathering and articles analyses were used to provide answers for the research question.

### 3.2.2 Screening

Articles that were compatible with criteria for consideration for this research were screened from the total number of articles that were collected from the Identification stage. At this stage, a total of 79 articles were screened from identification stage in Section 3.2.1. Criteria for inclusion for further processing include methodology where the research focuses on finding more empirical data and whether the research was carried out based on an established theoretical framework. Additionally, this research intends to gather information from case studies that are conducted around the world that have more or less similar demography, level of technological diffusion and technological capacity as in Malaysia.

### 3.2.3 Eligibility

At this stage, the methods and parameters of empirical studies carried out were examined from the 79 articles that were filtered from screening stage. As to match the adoptee criteria of this research, the area of focus was to select the similarity of respondents with intended adoptee criteria. Attention was given more towards studies that were directed towards farmers on individual level. However, given that limited research was carried out for the same focus, this research also considered on studies that were carried out towards farmers as a collective social group or an organisation.

### 3.2.4 Articles Ready for Review

15 final articles were selected for review to answer the research question, with 9 articles from the final list were selected to support for Malaysian context. Findings were then compared and analysed from the final remaining articles that were reviewed according to the research question that was formulated as guidance.

## 3.3 Demography Statistics and Current Condition Information Gathering

Malaysian federal government's agenda and policies reports were scrutinized to get an overview of the development of agriculture industry in Malaysia at present, and the government's aspiration for the future in according to the plan. The main findings of these information were extracted from Malaysian government official economic plan, the Twelfth Malaysian National Economic Plan (EPU, 2021) and National Agrofood Policy 2.0 or known as *Dasar Agromakanan Negara 2.0* (DAN 2.0), which was released by the authority in agriculture industry, formerly known as the Ministry of Agriculture and Food Industry Malaysia (MAFI, 2021). Onwards on investigating state level economic landscape, Sabah state information was extracted from the state's recent economic agenda documented as *Sabah Maju Jaya Roadmap 1.0* (Sabah State Government, 2021). In addition to that, statistical information from Department of Statistics Malaysia was used to supply the research findings.

## 4. Research Findings

### 4.1 Findings from Articles and Government Reports

#### 4.1.1 Semi-structured Literature Reviews

As to highlight the theoretical framework and empirical evidence of applicable researches in agriculture case studies worldwide towards adoption of new technology in agriculture, significant articles are compiled, analysed and compared upon. The comparisons for theoretical applications across countries in agriculture could be illustrated as tabled in Table 1.

**Table 1**. Application of adoption models towards behavioural intention case studies

| Article | Theoretical Model | Country of Research | Significance |
|---|---|---|---|
| Caffaro et al. (2020) | TAM and information source | Italy | Formal information source mediates adoption |
| Wang et al. (2019) | TAM with external variables TOE (cooperatives/organisation, environment, and technology factors) | China | Leader attitude mediates positively towards adoption; organisation and environment factor positively affect adoption |
| Li et al. (2020) | AUTAUT and PNTC | China | Farmers perception of benefits and facilitating condition to adopt are important determinant to adopt |
| Ataei et al. (2020) | TPB, Health belief model and Behavioural Intention | Iran | Moral-norms, attitude and self-identity of farmers are determinants to adopt new technology |
| Nguyen & Drakou (2021) | TPB with climate change as external variable | Vietnam | Social norms and climate change communications as significant factor towards adoption. |
| Saengavut & Jirasatthumb (2021) | TAM with external variables; age, cost, experience, and environment | Thailand | Socio-economic and psychological factors affect intention to adopt; Perception of ease of use and perception of usefulness relates positively to adoption. |
| Adnan et al. (2019) | TPB, DOI and TAM; external variables – communication channels and environmental concerns | Malaysia | Significant factors to adoption include mass media usage for communication, social-norms and technology complexity. |

From the case studies listed in the Table 1, it is evident that using more than one theory or using extended variables to extend a theory is favourable and more inclusive in finding significant factors towards behavioural intention to adopt a technology in agriculture industry across countries. It is, too, observed that external or latent variables could be significant and these variables mostly touched on human perceptions and factor that affects farmers' attitude towards adoption of new technology.

**Table 2**. Articles analysed for Malaysian case studies

| **Article** | **Method/Theoretical Model** | **Case** | **Significance** |
|---|---|---|---|
| Rahim et al. (2017) | No underpinning theory used. Qualitative and quantitative method | Evaluation on technology adoption in tomato cultivation. | Technology adoption in tomato cultivation is at moderate level. Sabahan farmers have lower technology adoption level than farmers in Cameron Highlands. Socioeconomic profile is not significant towards adoption. Significant factors include capital, market, technical ability, institutional support, infrastructure and incentives. |
| Adnan et al. (2019) | TPB, DOI and TAM; external variables – communication channels and environmental concerns | Factors of adopting green fertilizing technology towards paddy farmers | Factors contributing direct effect towards intention include perceived awareness, attitude, group norm, perceived behavioral control, environmental concern, agro-environmental regulations, relative advantage, compatibility, trialability, and observability |
| Mat Lazim et al. (2020) | No underpinning theory used. | Reviews on IR4.0 adoption in Malaysian agricultural industry | Current available IR4.0 technologies for agriculture in Malaysia and its application.<br>Challenges towards adoption include farmers attitude, lack of awareness and interests, high costs to invest, facilities and infrastructure. |
| Ahmad Tarmizi et al. (2020) | DOI, TRA and TAM; variables include knowledge and firm profile | Empirical study on IoT adoption level among Malaysian halal agro-food SMEs | Lack of IoT adoption among respondents to manage business and lack of technical knowledge. Perceived ease of use and perceived usefulness are significant towards intention. Knowledge and firm |

| | | | |
|---|---|---|---|
| | | | profile are insignificant. Challenges include, complex implementation, lack of technical knowledge and high costs of implementation. |
| Aris et al. (2021) | Literature reviews | Technology adoption among agrofood supply chain in Malaysia | Proposed push and pull factors analysis in Malaysia based on work by Wolfert et al. (2017) |
| Harun et al. (2015) | Benchmarking using Fuzzy Logic and fuzzy set theory. Secondary & primary data used. | Technological practice in paddy cultivation comparison in Malaysia (West Malaysia) and Vietnam | Technology practice/use in Malaysia lower than in Vietnam. Overall adoption level is moderate. Majority Malaysians (65%) have average knowledge, 8% adequate or suitable knowledge, 27% low in knowledge. Recommend training and technology transfer to improve adoption. |
| Bujang & Bakar (2019) | Report and research findings presentation by MARDI | Agriculture 4.0 conceptualisation by MARDI | MARDI role in implementing Agriculture 4.0 in Malaysia. Challenges and opportunities in Malaysia. Technological availability and competency towards Agriculture 4.0. |
| Abu Dardak et al. (2022) | Report and research findings presentation by MARDI | Smart farming technology transfer case study by MARDI | Details on case study of technology transfer project. Revealed that of all technology transferred, only 8% fully adopted. Challenges include technology application, investment and profitability. |
| Rusli et al. (2023) | TRI – statistical anylisis from primary data using SPSS software | TRI level amongst paddy farmers in MADA (Kedah), KADA (Kelantan) and IADA BLS (Selangor) | Farmers at these areas are excited to use new technology; however mixed findings on relationships of level of drivers index (innovativeness and optimisim) with level of inhibitors (discomfort and insecurity). Other factors may affect such as maintenance and financial risks. |

Table 2 provides information on technology adoption cases in agriculture industry in Malaysia that have been documented thus far in articles. Synced together with government agenda reports and statistics, the research findings could be referred and summarised in the next Section 4.1.2.

**4.1.2 Malaysian Agricultural Landscape and Attitude Towards New Technology**

The Malaysian Government's Twelfth National Economic Plan outlined eight main strategic thrusts which include to decrease poverty and income inequality gap, to increase development efforts for less developed states – focusing on Sabah and Sarawak, to increase technological acceptance and adoption towards digitalization efforts and to increase investment for high technology activities (EPU, 2021). Agriculture industry is one the prioritized industries as strategy for economic growth in Malaysia. In alignment with the call, DAN 2.0 outlined strategies to involve smart-farming technologies to improve operational efficiencies and increase food production in agriculture by focusing on improving acceptance and awareness of available technologies towards farmers and the agricultural industry supply chain stakeholders (MAFI, 2021).

As reported by government documents (MAFI, 2021; EPU, 2021) and reviewed articles (Harun et al., 2015; Rahim et al., 2017; Bujang & Bakar, 2019; Ahmad Tarmizi et al., 2020; Mat Lazim et al., 2020; Abu Dardak et al., 2022;), the adoption level of farmers towards Agriculture 4.0 technology ranges from low to moderate. The Sabah state government already urged and created awareness on importance of adopting IoT in agriculture since 2015 through various incentives, training and promotional efforts; though, adoption of these technology remains relatively low compared to other states in Malaysia (UMS, 2015; Rahim et al., 2017; Daily Express, 2022).

Most articles reviewed were discussing about significant factors towards adoption that include social collective norms and environmental factors which are external drivers of the adoptee. Acceptance models that were used mainly involved combination of TAM, TPB and UTAUT with other extended variables. In selecting which theoretical combination that would be useful and suitable for this research, the cognitive characteristics, social norms or demography of adoptee that is uniquely representing Malaysia and Sabahan farmers are considered. Based on information from Malaysian landscape analysis, it indicated that Malaysia has the capacity with the appropriate technology and local technology provider to help supply, install and train the farmers to adopt Agriculture 4.0 – particularly IoT technology for their farming practice (Bujang & Bakar, 2019; Abu Dardak et al., 2022). Given that the government has already ramping up its campaigns with providing trainings, increasing awareness and whipping up budgets to incentivise IoT adoption, one possible question pertaining issues in adoption is – are the farmers, as the decision maker and adoptee, actually ready to adopt or use this new technology? From undergone analysis, the lack in empirical data that portrays the actual awareness level amongst Sabahan over initiatives by the Malaysian government, too, triggers a clue to investigate their technological readiness towards using IoT technology for their farming operations.

## 4.2 Theoretical Framework Exploration

### 4.2.1 Technology Readiness and Acceptance Model (TRAM)

The Technology Readiness Index (TRI), originally developed by Parasuraman in 2000 and later updated to version 2.0 in 2015, serves as a valuable measurement tool for assessing individuals' preparedness to embrace and utilize new technologies (Parasuraman, 2000; 2015). This index has been widely applied in various fields, including agriculture and technology research, to investigate technology adoption patterns and assess the readiness of individuals, especially farmers, to adopt technological innovations. The TRI is grounded in four key dimensions: optimism, innovativeness, discomfort, and insecurity, making it particularly relevant for evaluating farmers' readiness to incorporate new technologies into their agricultural practices (Parasuraman, 2000). Through the TRI, researchers could examine factors influencing farmers' technology adoption, including perceived usefulness, ease of use, attitudes, self-confidence, and resistance to technological change.

When integrated with other models like the Technology Acceptance Model (TAM), the TRI enhances the comprehension of farmers' technology adoption behavior. By adding the TRI to the TAM framework, researchers obtain a more comprehensive understanding of the psychological readiness and propensity of farmers to embrace new technologies. This combination provides a holistic view of the factors impacting technology acceptance and adoption within the agricultural context, making it a valuable tool for advancing technology research in this field.

### 4.2.2 Proposed Theoretical Framework

A lot of researches for assessing the antecedents of small-scale farmers’ intention to use or adopt an IoT technology for their operations would be either too simplistic or too complex; depending of the countries and targeted group of where the research was carried out. In the case of Sabah, observing that small-scale farmers are often the single decision-maker for their operations, and more often than not, rely on traditional farming methods; it is proposed that their readiness level be identified to observe where they are at and how likely are they going to accept and use IoT technology for their farming operations. The integration of TAM and TRI to form TRAM is not something new; however, its application is yet to be explored across various industries, agricultural industry included (Lin et al., 2007, Compernolle et al., 2018; Chiu & Cho, 2020; Damerji & Salimi, 2021).

The proposed application of this concept toward agriculture industry in Sabah would be a two-level analysis where optimism, innovativeness, discomfort and insecurity would be accumulated, calculated and aggregated to get the technology readiness index; as the antecedent for perception of usefulness and perception of ease of use towards the small-scale farmers intention to use an IoT technology. The framework that is adopted from the work of Lin et al. (2007) is shown as in Figure 2. More discussions on the potential application of the framework would be explained in the next section (Section 5).

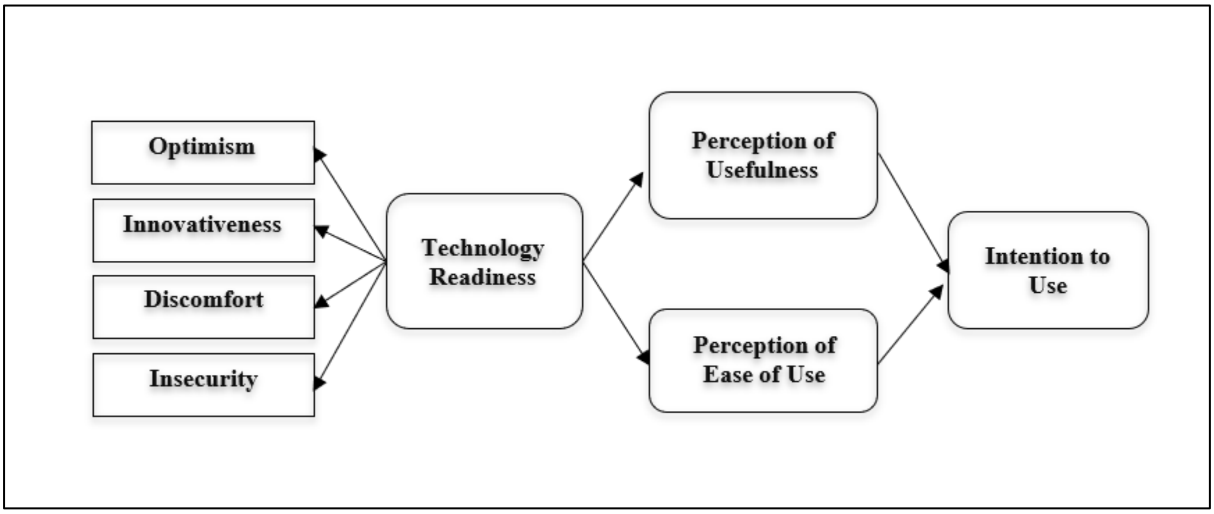


**Figure 2.** Conceptual Framework of TRAM by Lin et al. (2007)

## 5. Discussion and Conclusion

The IoT technology implementation in agriculture industry has been carried out in Malaysia and the initiatives were led by the government agencies as well as from private sectors through joint collaborations to help the farmers in Malaysia. In technological readiness theory (Parasuraman, 2015), the feelings of innovativeness and optimism relate as the driving factors towards readiness in using a new technology; whereas the feelings of discomfort and insecurity relate to the inhibitors from being ready to use a new technology. When introducing a new technology, promoting technological and technical features for its usefulness and ease of use might not translate to a successful technological adoption (Bujang & Bakar, 2019, Abu Dardak et al. 2022). General practice of IoT technology transfers and awareness, government agencies and providers often give out talks and short trainings on technical know-hows on how to use a solution with little considerations on the technological awareness or readiness of their audience – the farmers (Abdullah & Samah, 2013, Abu Dardak et al. 2022). Through understanding the drivers and inhibitors of IoT application and adoption amongst small-scale farmers in Sabah, the related stakeholders, be it government agencies as well as technology and service providers, could devise a more direct and strategic IoT adoption plan that could amplify driving factors and/or help decrease the inhibiting factors towards the technology (Rusli et al., 2023).

By having the readiness level information of Sabahan farmers as a potential user group, technology and service providers could use the level of innovativeness and optimism of the farmers towards engineering solutions that could increase the sense of achievement, positive learning experience and sense of progress of a farmer after experiencing or testing on an IoT system. This could be done by observing the farmers learning style, understanding their needs and, therefore, structure modular solutions that could progressively build into a total holistic package for their agricultural needs. Similarly, the information on readiness level could be used to reduce impacts of inhibiting factors towards adopting IoT technology. High level of discomfort and insecurity could be addressed by reducing uncertainty or ambiguity with actively providing adequate information and demonstration on the solution's navigation and usability, as well as on data privacy and online data transaction security for the farmers, in order to gain their trusts and confidence in using the IoT technology. Likewise, the government could improve technological readiness level by not only offering subsidised IoT solutions, but also continuous hand-holding towards successful technological transfers; and finally, not to undermine the importance of providing adequate facilities such as secure and stable network for the farmers in Sabah, especially in the rural areas, to enable them to seamlessly use IoT technology at its full potential (Abu Dardak et al. 2022, Rusli et al., 2023). Studies have shown that technological readiness index could influence an individual's acceptance of a new technology which leads towards the intention to adopt the new technology (Lin et al., 2007, Compernolle et al., 2018; Chiu & Cho, 2020, Damerji & Salimi, 2021). This proposed TRAM framework could be useful to capture the Sabahan farmers technological readiness level and its relation with technological acceptance towards adoption IoT technology for their farming operations.

This paper outlines the agricultural industry scenario in Malaysia, where inequality exists across states within the nation and on potential small move to reduce the gap by understanding new technology readiness and acceptance, particularly in IoT technology towards agricultural practices amongst small-scale farmers in Sabah. The proposed application of using TRAM as the base of conceptual framework for this research potentially could be the first and foundational step in order to understand the barriers of IoT adoption in agriculture industry in Sabah. Arguably, there could be other non-technological factors that could be cognitive – such as intrinsic drive or motivation of the farmers or resource-wise issues that could be hindering a small-scale farmers in Sabah from adoption IoT technology. Additionally, this research is an initial conceptualised idea based on existing findings and it aims to explore other potential factor that could moderate or mediate the TRAM relationship with the intention to use IoT technology in agricultural industry amongst small-scale farmers in Sabah.

This paper has explored and confirmed that a technology acceptance theory must be extended or integrated with other framework or variables for it to be more robust in findings. Framework integration suitability varies when applied in different countries depending on national policies and agenda direction and execution; and social profiles of a geographical area. Understanding which adoption level a society is at, as according to theory Diffusion of Innovation by Rogers (1995), might help determine which framework to apply when studying the determinants of actual intention to adopt new technology towards an individual decision maker.

This paper too poses some limitations in its findings. Firstly, the characteristics of Malaysian technological landscape and Sabah farmers characteristics might not be as accurate as in reality due to limited information or data available for analysis. Secondly, the semi-structured literature review could be further enhanced with more comprehensive analytical system such as the utilisation of PRISM (Moher et al., 2009) or ROSES (Haddaway et al., 2018) protocols for literature reviews; as well as conducting theory-grounded qualitative research method to determine potential extension of currently used technology acceptance theoretical framework.

New IoT-based technologies are propagating at a faster and more advanced rate and the applications varied in different sectors of industries. As the need for food is growing more urgent these days, lacking in awareness or ignorance about how IoT technologies could be adopted should not be the excuses on why less developed or less aware nations are left behind. The dire need for more efficient food production value chain and more volume on food outputs as laid out by FAO (2022) only signals that the time to change and transform is now.

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