A Systematic Review of Behavioural Intentions Influencing Data Analytics Adoption among Malaysian Crop Farmers

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DOI: https://dx.doi.org/10.47772/IJRISS.2024.8110105

Received: 28 October 2024; Accepted: 03 November 2024; Published: 07 December 2024

ABSTRACT

Technology adoption situation has changed tremendously in the agriculture industry. Farmers prefer on using the traditional way of farming as they have the opportunity of adoption technology, these changes acquire in terms of the farming system, innovation, usage of technology and many more. The systematic literature review paper aims to discover the adoption of technology strategy that contributes to the latest technology system strategy. This study attempts to pair and match with the theory of Ventakesh (2003) technology adoption strategy. There are 142 eligible articles on the subject sourced from Research Gate and Scopus databases over the past five to ten years. The PRISM protocol needs to identify new technology adoption strategy and that is performance expectancy, effort expectancy, social influence, personal computer utilization and behavioural intention. Practically these new strategy serves as a guideline for crop farmers to upgrade their farming lifestyle and innovation by using their technology adoption system to be incorporated in the agriculture industry in Malaysia.

Keywords: technology adoption, agriculture, farming system, farmers

INTRODUCTION

The fourth industrial revolution, Industry 4.0, driven by digitalization and automation, has transformed industries worldwide, including manufacturing and agriculture. Malaysia has embraced this digital transformation, with its digital economy making significant contributions to the GDP, particularly through sectors like e-commerce and information technology (Zaman et al., 2023). However, the agriculture sector, despite being a cornerstone of Malaysia's economy and a major source of employment, has been slower in adopting digital technologies. This is crucial as agriculture plays a vital role in ensuring food security and economic stability, especially for smallholder farmers (Dai & Cheng, 2022).

The adoption of technology in agriculture, often termed as digital farming or Agriculture 4.0, can address key challenges faced by the sector. By leveraging information and communication technologies, farmers can enhance farm management, boost productivity, increase profitability, and promote natural resource conservation. Despite these benefits, the widespread adoption of smart farming technologies has been hindered by various factors, including the reluctance of farmers to embrace new technologies, structural challenges within the agricultural ecosystem, and economic conditions (Mat Lazim et al., 2020).

Understanding the dynamics of technology adoption and diffusion in agriculture is crucial for the successful implementation of digital farming practices. This requires not only focusing on individual adoption but also considering the broader agricultural system, including farm and operator characteristics, as well as political, structural, and economic conditions (Han et al., 2021). By addressing these challenges and promoting advancements in the agriculture sector, Malaysia can improve its agricultural productivity, ensure food security, and contribute to economic growth.

Leading firms often aim to influence the development of technological applications to benefit their own interest (Lai, 2017). The rate at which consumers adopt these technologies is influenced by various factors, including availability, convenience, consumer needs and security. Numerous studies have explored consumer’s adoption of new technologies (Ahsan & Ayub, n.d.; Dwivedi et al., 2019). A key strategy in the

agricultural industry is to improve and efficiency is known as smart farming or precision agriculture. This method involves optimizing inputs such as water, fertilizers, pesticides, and tools to enhance crop yield, quality, and overall productivity. Smart farming relies on location-specific crop management and satellite farming technologies to observe, assess, and respond to crop variability (Carrer et al., 2015). Additionally, the concept of the Fourth Industrial Revolution, known as Industry 4.0, holds great promise for the agriculture sector, indicating significant changes and advancements.

Malaysia's agriculture industry has also embraced the Fourth Industrial Revolution, Industry 4.0, which is currently underway in several states across the country. This revolution aims to merge disruptive technologies to reshape not only the agricultural sector but also people's lifestyles and work practices. Key technologies driving Industry 4.0 include the Internet of Things (IoT), robotics, and virtual reality, among others. While agriculture may seem traditional, it is not immune to these disruptive technologies, which bring both challenges and opportunities (Wiliam et al., 2021).

This study focuses on exploring innovative approaches within Malaysia's agriculture ministry, emphasizing the increasing need for agricultural extension services and improved access to rural financing for farmers. These measures are intended to enhance crop output and contribute to the advancement of Malaysia's agriculture sector in the era of Industry 4.0. Furthermore, the research addresses technology adoption in Malaysia's agriculture industry, with approximately 95.7% of farmers utilizing technology to a moderate extent, according to the FFTC Agricultural Policy Platform (Eweoya et al., 2021).

A systematic literature review (SLR) is appropriate for topics of special interest since the coverage is more comprehensive. (Robinson & Lowe, 2015) emphasised that past studies need to be reviewed systematically rather than through a normal review which may be constrained by issues on comprehensiveness, bias and quality. In addition, s systematic literature review provides information on the review process, such as the keywords used, article collection, reproduction, and confirmation of the findings. SLR is more organized because the process is clear and transparent and it also can be said as a procedure and research method for locating and evaluating pertinent studies, as well as for gathering and examining data from other studies (Okoli & Schabram, 2010). The study also must reveal all the processes involved in writing the article and the use of SLR in this particular study should contribute to the body of knowledge regarding dimensions of technology adoption.

This SLR is based on the following 4 fundamental research questions: (1) How does Performance Expectancy, Effort Expectancy, Social Influence, PC Utilization influence Technology Adoption among Agriculture industry in Malaysia? (2) How does Performance Expectancy, Effort Expectancy, Social Influence and PC Utilization influence Behavioural Intention as the mediator among Agriculture industry in Malaysia? (3) How does behavioural Intention as the mediator influence technology adoption among Agriculture industry in Malaysia? (4) How does Behavioural Intention affect the relationship between Performance Expectancy, Effort Expectancy, Social Influence, PC Utilization and Technology Adoption among Agriculture industry in Malaysia? The aim of this study this study is threefold. First, to identify and analyse the key factors influencing the behavioural intention of Malaysian crop farmers to adopt data analytics in agriculture, focusing on performance expectancy, effort expectancy, social influence, and PC utilization. Second, to examine the direct impact of behavioural intention on the adoption of data analytics technologies among Malaysian crop farmers, determining how these intentions translate into actual technology uptake. Third, to assess the overall effectiveness of data analytics adoption in improving agricultural practices and outcomes among Malaysian crop farmers, providing insights into the benefits and challenges faced during the adoption process. The mapping of this study is crucial in order to identify the similarities and differences between the traditional and modern way of farming so if there is a new dimension strategy in technology adoption is can be suggested to the crop farmers and could be verified as compatible and parallel with modern farming strategy.

The next section will discuss the methodology of study which comprises the PRISMA protocol, searching strategy, quality extraction, data extraction and analysis. Results and findings of the reviewed selected articles are presented following this section. Next is the discussion on the findings together with the academic and practical implications of the study. In the final section is the conclusion and recommendations for future research.

METHODOLOGY

This section discusses the five significant sub-sections that were used in the current study, namely PRISMA, resources, inclusion and exclusion criteria, the systematic literature review process, and data extraction and analysis.

PRISMA

PRISMA is a collection of evidence-based reporting elements for systematic reviews and meta-analyses. This reporting framework is centred on studies that examine randomised trials and provide information on systematic evaluations of particular testing kinds, especially intervention evaluations. PRISMA is suitable for the following user types: (1) Authors: PRISMA is meant to help authors create reports on meta-analyses and programme evaluations. (2) Editors and peer reviewers of journals: PRISMA can be useful for the critical evaluation of published systematics reviews, even though it is not a suitable method for assessing the quality of a systematic literature review. PRISMA updates the extensive collection of scientific literature every time, making it possible to search for specific words.

SYSTEMATIC SEARCHING STRATEGIES

The three principal processes in the SLR are identification, screening and eligibility.

Identification

The approach in searching for synonyms, comparable terms, or variants or major keywords in the study, which are technology, agriculture, digital technology, industry revolution 4.0, Internet of Things is known as identification. The goal is to increase the possibilities to identify more related more related papers to the study is a selected database. Keywords can be developed based on previous research or recommended by database such as Scopus, or Web of Science (Selcuk, 2019).

Two databases, Research Gate and Scopus, were used to conduct evaluation in the study. The purpose of using both databases is to focus on and narrow down the search scope. Research Gate and Scopus are two of the most well-known databases for academic literature and thus the publications selected are rigorously screened. According to (MacFarlane et al., 2022) prior to conducting any research, it is advised that the protocol be accepted by peer review, that is, that the procedure to find pertinent literature that is appropriate and rigorous and the search tactics are organised and created. The goal is to use search terms to put into practice your research questions and find all available published and unpublished work that addresses them and searching carefully through at least two different electronic databases is the best way to locate a great deal of published articles that discusses your study (Siddaway et al., 2019).

Screening

The objectives of screening are to eliminate redundancy and identify papers that do not meet the study's criteria. In the first stage, the study conducted a database redundancy check, which led to the deletion of 23 articles. In the second stage, 217 articles were screened using the study's inclusion and exclusion criteria. The first criterion is the type of literature which focused on journal papers (research article) that contain empirical data and provides useful analytical evidence and other data. It should be noted that the review only selected articles are written in English. The study period spans 10 -15 years (2010-2022) that sufficiently captures the latest technological advancement. Enter digital farming, also known as smart farming or Agriculture 4.0, which aims to tackle these challenges by collecting and analysing data through information and communication technologies, thereby supporting effective farming processes (Doss, 2006). It is also reasonable to consider the maturity period on the topic of the study (Siddaway et al., 2019). Stated by (Okoli, 2015) reducing the number of studies to be analysed to manageable amount for the reviewers is the aim of the practical screen. Consequently, the dimension of agriculture technology as a topic has matured in their technological advancement during the selected study period. In addition, this research examined publications globally for optimal comprehensiveness. Finally, to ensure retrieval of related article this study is confined to publications in business, agriculture, and technology.

Eligibility

At this stage, a total of 200 articles were selected. It is crucial that all their titles, abstracts, and key contents were rigorously examined and reviewed to ensure that they met the criteria. As a result, 79 articles were excluded since they were not relevant and difficult to locate despite using the Google Scholar search engine. The remaining 121 papers were selected for evaluation.

QUALITY APPRAISAL

The 139 articles were then examined for high quality and these were measured using the mixed method appraisal tool (MMAT). The articles were then graded on a scale of high, moderate, and low – quality ranking and only those at the two higher quality levels were selected for review (Okoli, 2015). All 121 articles thus vetted were considered suitable for the current research.

Table 1. The inclusion and exclusion criteria

Criteria	Inclusion	Exclusion
Literature Type	Journal research article), article review, meta-analysis, systematic review and conference proceedings	Book chapter
Language	English	Non – English
Timeline	2010-2022	< 2010
Territory	Worldwide	Non
Subject Area	Business, Agriculture, Technology, Management	Other than Business, Agriculture, Technology, Management

DATA EXTRACTION AND ANALYSIS

An integrative analysis was used in this study by analysing and synthesizing diverse research designs such as qualitative, quantitative and mixed method which including transformed ones. The techniques for determining important themes were based on the thematic analysis, which involves grouping the new dimensions discovered through reviewing the selected articles. The data collection stage was initial step in the theme creation process. The final group of 121 articles was exhaustively analysed at this initial step to extract statements or data that can resolve the research questions. In the second step, influential groups were created using coding technique. Depending on the type of data. Raw data were converted into usable data aby describing trends, concepts, or ideas.

This filtration process included six new dimensions that can be divided into three categories; (1) traditional farming, (2) resistance to change, (3) Ageing farmers. The dimensions however changes from time to time. The current trend in adopting technology in the agriculture industry is getting more advance and there are a lot of opportunity for the farmers to use and it is more on the digitalization aspect. As this study has discovered few articles that focused in smart farming such as big data, industry revolution and data analytics. Another factor is the presence of young individuals in the agriculture industry. Because young people are tech savvy, we can use their expertise in the agriculture industry, which would be an excellent profession for the future. Having younger individuals assist or help farmers whose have been in the agricultural sector for a long time could be a good duo to create better digitalization in the agricultural sector. During the data analysis process, a record of all analyses, viewpoints, puzzles or other ideas that could be related to data interpretation were kept. The authors compared and discussed the findings for inconsistencies in the subjects and address any anomalies in the theme-building process. Finally. Established themes were able to be altered to preserved their continuity.

RESULTS

There were 139 articles from 2010-2022 that were considered suitable and thus selected for this SLR paper. It was discovered that within the last twelve years, a distinct number of articles were published and included in

the Research Gate and Scopus databases. Scopus has published 46 articles and Research Gate 93. With all papers sourced from 139 different journals.

EXTRACTED THEME AND NEW DIMENSION

Extraction of the theme began with a thorough examination of 139 articles on technology adoption. Any dimension or adopting technology strategies mentioned in these were extracted and appropriately organized. The next step was to identify and distinguish the new dimension from existing and similar strategies. The new dimensions were defined based on comparison with similarly identified or common dimensions in different years of publication. These were then grouped according to the themes based on the suitable criteria as per Ventakesh (2002).

Technology adoption

Farmers are more likely to adopt new technologies and methods if they can increase their profitability. Furthermore, pioneering measures to adopt new technologies can provide farmers with a competitive advantage over those who do not (non-adopters) or who only adopt them later. (Pivoto et al., 2019). To comprehend the factors that contribute to this disparity between entrants and non-adopters, it is essential to examine the variables that affect the process of adoption of technology. Stated by (Carrer et al., 2015) Some factors may influence farmers' willingness to adopt new technologies. The socioeconomic variables in the personal background of the farm's main decision maker are the most studied dimension in the literature. The application of technology in agriculture offers numerous benefits. It enables the efficient utilization of hardware, software, and extensive data resources in both urban and rural settings. Real time data can be used for decision making, reducing costs and minimizing input waste in food production logistics and quality control processes. Technology also facilitates the creation of profitable enterprises in agriculture, allowing for direct interaction with consumers (Nakpong et al., 2019). Moreover, it enables the monitoring of crops to prevent machinery loss and reduce operational cost. Automatic irrigation systems, driven by sensor-measured values for temperature, humidity, and soil moisture, improve water management efficiency (Gómez-Chabla et al., 2019). Additionally, technology allows for the automatic collection of environmental data using sensor networks, which can be processed and analysed later (Zaman et al., 2023). Overall, technology supports decision-making by processing vast amounts of data, enhancing productivity, and improving operational effectiveness in agriculture.

Behavioural Intention

This factor could be defined as the expectation of the user’s intention to perform plans and decisions regarding the use of technology. This refers to the intention of effective use by the consumer of a future product or service (Venkatesh et al., 2003). The majority of TAM and TRA research have been using attitude as a key factor in determining how people would behave when it comes to accepting and using technology (Davis, 1989). Later, it was revealed that attitude was not included in the TAM series' current iteration (López-Bonilla, 2017). A person's adverse attitude toward accepting new technology can often be overcome by the informational source and performance expectations. Stated by (Wu Liang, 2012) The user's behaviour is influenced by the elements, which also include information technology, environmental factors, and user perception. Users can only create specific actions in this manner and estimate of the intensity of one's intention to undertake a given behaviour” is how the concept is defined (Chang, 2012).

In Malaysia, economic barriers are significantly having a big effect towards technology adoption, particularly in rural areas. High initial costs and limited financing options make advanced technology inaccessible for many smallholder farmers and SMEs, income disparities between urban and rural regions exacerbate this gap (MacFarlane et al., 2022). Furthermore, the high cost of internet in rural areas and a lack of affordable training limit the use of digital tools, while a general perception of low returns of investment discourages adoption. Together, these factors create a difficult environment for widespread technology integration in Malaysia(Singh et al., 2023). According to research, a person's behavioural intention directly affects how they use a particular technology (Abrahão et al., 2016). Moreover, this can be characterised as a conscious and deliberate choice that individuals make to engage in a behaviour. As experience and exposure increase, so do the opportunities

for habit reinforcement for the individual because they have more opportunities to experience the cues and carry out the associated behaviour (Williams et al., 2015). As experience grows, Behavioural intention's impact on technology utilisation will diminish.

Social Influence

The extent to which a user believes that important people consider using technology to be important is known as social influence (Diaz & Loraas, 2010). It is comparable to the concept of "subjective norm" as described in the second edition of the Technology of Acceptance Model (TAM). Social Influence is a typical element that explains every person's intention. A person's perception of how much their friends, peers, agricultural consulting officers, and consumers, for example, encourage them to use a new procedure (Taylor & Todd, 1995). However, this component becomes effective when the use of technology must be accomplished, stated by (Afonso et al., n.d.) the social influence measures indicate the impact of influencing factors on user behaviour such as friends or hierarchical superiors' opinions.

Most commercial farmers in China are motivated by those around them to adopt a new technology using Internet of Things-based smart objects irrigation management methods (Ayaz et al., 2019). When a farmer hears an indirect or direct recommendation to use a modern farming technique from other farmers, professionals, colleagues, or others they look up to, they will be motivated to do so. In other words, social influence also can be defined as an individual's perception of the ease of technology usage.

DISCUSSION

The thematic analysis in this study has emerged with few themes that were matched and combined with the existing of technology adoption strategy. In relation to the adoption of technology in the agriculture sector, entering digital farming, also known as smart farming or Agriculture 4.0, which aims to tackle these challenges by collecting and analysing data through information and communication technologies, thereby supporting effective farming processes (Doss, 2006). Understanding the mechanisms of technology adoption and diffusion in digital farming is crucial, not only at the individual farm level but also within the broader agricultural system. Considering these dynamics, it is imperative to comprehend not only individual adoption but also the interplay within the system during the adoption and diffusion process. This context sets the stage for the emergence of smart farming, enabling farmers to remotely monitor their crop fields using sensors and implement automatic irrigation.

The farmers have the behaviour on resistance to change as they are comfortable with their traditional way of farming. Other than that, Malaysia's unique socioeconomic conditions have an important effect on technology adoption, particularly in the rural and agricultural sectors (Heiman et al., 2020). Income disparities between urban and rural areas result in unequal access to technology, as rural regions have limited financial resources and digital infrastructure. Lower educational attainment and digital literacy in these areas further impede technology adoption, as may lack the necessary skills to use new tools effectively (Vuori et al., 2019). Adoption rates are also influenced by cultural factors such as risk aversion and traditional practices, as many farmers are hesitant to make new investments that do not provide immediate benefits (Wee & Lim, 2022). However, Malaysian farmers have displayed hesitation in embracing these innovations. Therefore, this study places its focus squarely on Malaysia's agriculture sector, which has persisted with outdated farming practices, including agropreneurship. The primary objective is to identify and promote advancements within this sector (Wu, 2012). Another dimension in behavioural intention which could be said one of the important strategies in technology adoption which as we can see there are a lot of farmers in the agriculture sector which has been in the industry for more than ten years for that industry.

CONCLUSION

The primary objective of this systematic literature review is to examine the technology adoption usage on crop farmers in the agriculture industry in Malaysia. In particular, we focus on these concepts by systematically reviewing the previous studies on the subject itself. We thus summarise the significant findings in the technology adoption in the agriculture industry in Malaysia and present throughout the SLR process, and the

future research directions. In the findings related to technology adoption, there are many classifications that need to be specific in order to find the right article for the research that is digitalization, industry revolution 4.0. smart farming, and big data. Although we observed and received mixed result, most of the studies indicate that technology has a big impact in the agriculture industry. Practically, the current study provides a reference for agriculture industry which mainly from the government side which remain updated with the current technology adoption trend that can be incorporated in the industry. It should be reminded that, the old-school dimension is still relevant but need to be updated in light of the current development. The current study acknowledges two limitations. Firstly, the focus is on technology adoption alone. Second, the study is limited to two main databases, namely Research Gate and Scopus. Future research needs to comprehend the assessment of the technology, behavioural intention, and the social influence strategy to fully explore and compare the technology adoption dimension in the agriculture industry. Additional databases such as Science Direct, Springer and Sage, should also be included in future studies in order to obtain more comprehensive results.

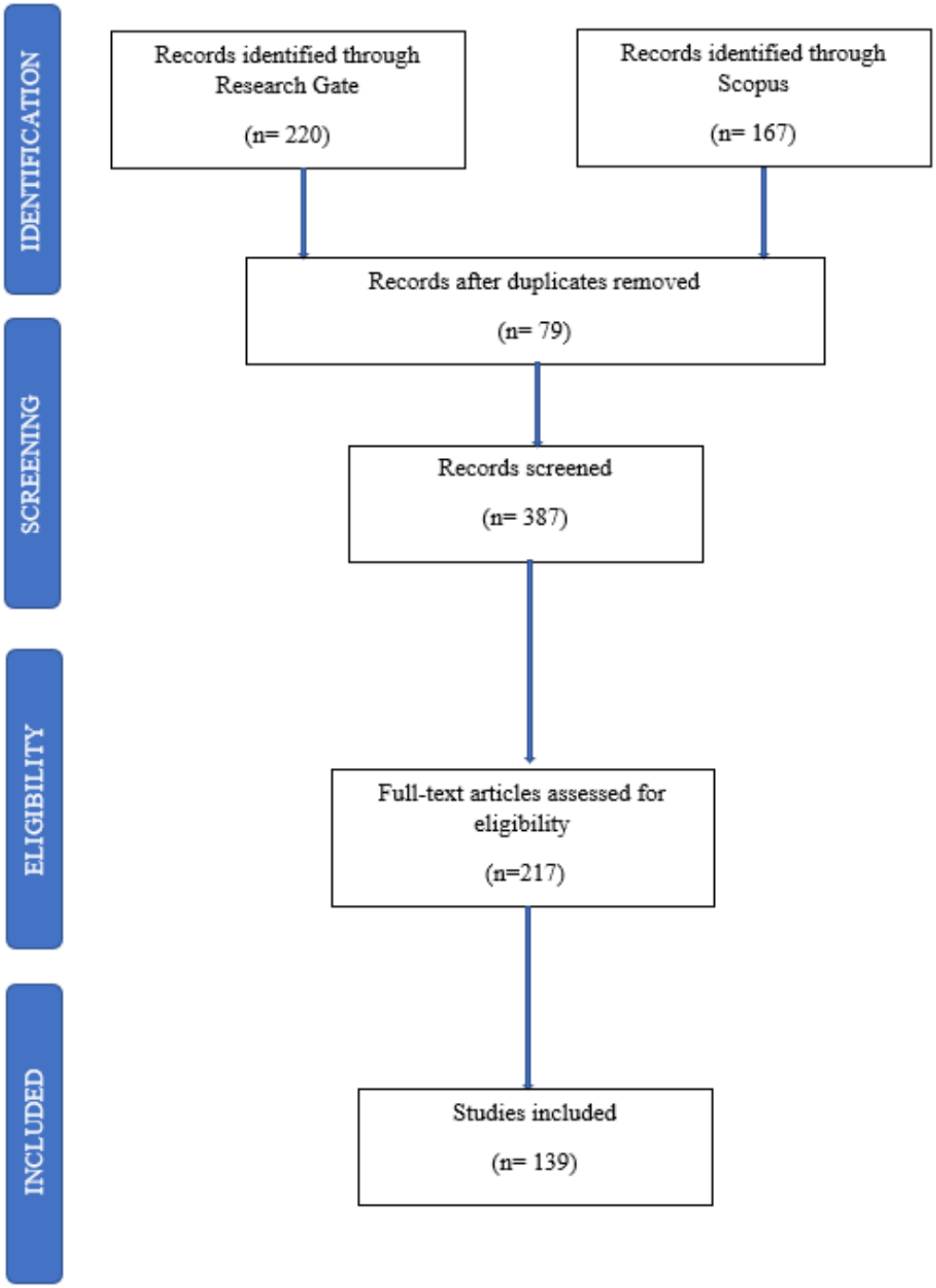

Figure 1: Flow diagram of the study (adapted from Moher et al, 2009)

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