Internet of Things Adoption Among Micropreneurs in Regional Coast of Sabah

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Abstract

This study aimed to determine the awareness and usage of the internet of things (IoT) technologies in aquafarming within the coastal community of Sabah. The UTAUT approach was applied in identifying the acceptance and usage level among these farmers. In conducting the research, both quantitative and qualitative data were collected during the fieldwork from 4 different coastal locations, which specialize in 4 different aqua-farming products. For this preliminary study, the expected outcome of the research project is a UTAUT framework for Aquafarming for the community. The main objective of the study is to determine the awareness (hearing and seeing) and usage (use, time and purpose) of IoT technologies (smartphones, computers and tablets) in aqua-farming communities in Sabah and the moderating effects of age and experience linked between predictors and behavioral intention based on the multi-group analysis. The result of this research is expected to benefit the community in devising new IoT-based policies, which may assist aqua-farmers in their business.

Keywords— Aquafarming, Internet of Things, Micropreneurs, Unified Theory of Acceptance and Use of Technology (UTAUT)

1 Introduction

Aquafarming is an essential industry in Sabah, mainly for its vast diversity of available seafood, but as it is becoming the region's biggest supplier of fresh seafood producer. MESEJ or Mini Estet Sejahtera is a project initiated by the Sabah government, in which it aimed at restructuring the community to uplift poor households, thus enhancing the quality of life of the marginalized through infrastructure access and economic programs. Production from aqua-farming or commercially known as aquaculture is one of the state's biggest contributor for economic sector, and it is imperative to ensure the chain of supply can be maximized through a more systematic approach in managing these aqua-farmers. This initiative hampered by the lack of systematic monitoring and reporting is the main concern, which requires on-site data collection and decision-making process takes longer because of this. If an IoT-based system is introduced to these farmers, it may improve their products as well as their economic returns. Having said that, most of these aqua-farming businesses rely heavily on manual labour to monitor and make a decision based on estimation and experience-related verification which in turn limits the production of seafood produce. The use of UTAUT framework is to identify the farmer's resistance level (if any) or their acceptance, and to what extent do these farmers need to be convinced to adopt technology into their businesses. This was the driving motivation for the researchers to investigate the readiness of these communities for any IoT-based technology adoption for their aqua-farming businesses based on the UTAUT framework model. Various technologies can be applied in achieving the objectives of this project, using various sensors like pH value, temperature, and level sensors to determine the suitability of water conditions, to enable faster decision making by farmers.

2 Research Questions

The use of UTAUT framework is to identify the farmer's resistance level (if any) or their acceptance, and to what extent do these farmers need to be convinced to adopt technology into their businesses. This was the driving motivation for the researchers to investigate the readiness of these communities for any IoT-based technology adoption for their aqua-farming businesses based on the UTAUT framework model. Various technologies can be applied in achieving the objectives of this project, using various sensors like pH value, temperature, and level sensors to determine the suitability of water conditions, to enable faster decision making by farmers. The focus on the research was to address three main questions.

RQ1. Does the UTAUT (Unified Theory of Acceptance and Use of Technology) influence the farmers' acceptance of IoT technology integration?

RQ2. Does age and experience as aqua farmers influence the effect of the four direct determinants in the UTAUT constructs?

RQ3. How much can UTAUT affect these farmers in terms of adopting IoT-based technologies in their businesses?

3 Review of literature

The IR4.0 revolution reflects on the integration of the internet of things (IoT) technologies in the business operations for all industries both physically and virtually, which has become part of the everyday operations of any businesses.

The simplified process and secured transactions have intrigued many businesses into the whole industry revolution bandwagon. However, very few Small and Medium Enterprises (SMEs) in the region have adopted E-Commerce, even though it is an important part of the economy which has made the competition and market penetration tougher for SMEs [21] and especially community-based rural businesses. This was concurred by Ibrahim, Hassan, & Yusuf [9] which emphasises that agro-based small and medium-scale enterprises often deal in commodities that have shorter shelf life hence, agro preneurs must harness technology for maximum profit and food security.

Cause of this reluctance towards technology acceptance have identified significant barriers to technology adoption were finance and economy, industrial policy and research, complexity, knowledge, government, and technical skills, which have further been interlinked with the technology acceptance model [12]. Entrepreneur's perception on information technology innovation adoption reveals that precipitating events can capture the influence of external factors on the behavioural intention to act, improve the model, and fill the intention–behaviour gap [16]. The adoption of digital media was to engage with marketplace stakeholders whilst, technological innovation was seen only as a medium to communicate [2]. Cataldo, Farías, & González [3] wrote that users build mental representations of a system, and these representations change while they progress in the adoption process, which was later triggered by changes informed by other users and the influence they exerted on each other.

Affordability and availability of technology were also identified as a deterrent factor in technological adoption, even though it is essential, it is often too expensive [5]. Given the expensive nature of a specialised farming machine, researchers proposed for a sensor device which will be embedded within any existing farming facility using LoRa (Long Range wireless data protocol with low power modulation) based LPWAN to provide real-time access to the telemetry data, which provides LoRa radio support to underwater acoustic receivers [8]. Cu, Lamacchia, & Nguyen [4] suggested in their study that "smart agriculture" adapts farming techniques to specific conditions via enabling technologies that are often based on an Internet of Things (IoT). IoT technologies have revolutionised farm production in the region using sensors that will be automated and can be easily monitored from other location [11]. Sreelekshmi, & Madhusoodanan [24] suggested for an automated aquaponics system, which is a system with the design and implementation within the framework of the Internet of Things, which integrates recirculating aquaculture with hydroponics.

4 Methodology

This paper collects data during 12-month research undertaken in Beluran district, East Coast of Sabah, Malaysia. Research participants were community members as well as fresh seafood farmers within the district.

A. Statements of Objectives and hypothesis

The following research objectives were addressed.

a) *To investigate the Unified Theory of Acceptance and Use of Technology (UTAUT) in the prediction of behavioural intention to use IoT technologies within the selected community. (RQ1)*

b) *To identify the moderating effects of age and experience linked between predictors and behavioural intention based on the multi-group analysis. (RQ2)*

c) *To determine the level adoption readiness of IoT-based technologies (RQ3)*

We include the following hypothesis

H1: There is a significant relationship between facilitating condition (FC) and aqua-farmers' behavioural intention of technology use

H2: There is a significant relationship between performance expectancy (PE) and aqua-farmers' behavioural intention of technology use

H3: There is a significant relationship between social influences (SI) and aqua-farmers' behavioural intention of technology use

H4: There is a significant relationship between effort expectancy (EE) and aqua-farmers' behavioural intention of technology use

B. The methodology of the research

This research is analytical, aimed at analysing the relationship between one variable with another variable, or how a variable affects another variable. The sample was taken using purposive sampling technique, at the selected location of MESEJ around Sabah, sampling around 150 respondents and focus groups of 50 from selected locations in Kg. Beluran – Freshwater Shrimps (Beluran) Kg. Nala – Freshwater Fish (Lahad Datu) dan Kg. Ligit-Ligitan – Seaweed (Semporna). These aqua-farmers have not been utilising any IoT-based technologies for their farming businesses, and it is through the survey and interviews conducted that it will determine their usage of IoT.

200 respondents participated in the program, ranging from local communities that had previously participated in some form of Internet-based technology devices via multiple platforms. Quantitative data was collected using fixed-response items in a questionnaire, whereas qualitative data were collected using open-ended items in the questionnaire. After filtering those questionnaires with incomplete and redundant responses, a total of 186 responses were quantitatively evaluated using structural equation modelling. The instrument consisted of 28 positively worded statements measuring the degree of technology adoption of the respondents. The first division consists of six items on demographic characteristics of the respondents. The second division consists of statements of technology adoption indicators, and the third division consists of ten items measuring the degree of agreement of the respondents on activities in which technology is taught or infused. The items in the second and third divisions were given responses based on a five-point Likert scale.

In this study, all items in the three divisions were reviewed and modified to increase the breadth and the depth of the variables measured. An additional section was also appended to the instrument to capture qualitative data for the last research question and to triangulate findings from the quantitative data.

RQ1. Does the UTAUT (Unified Theory of Acceptance and Use of Technology) influence the farmers' acceptance of IoT technology integration?

RQ2. Does age and experience as aqua farmers influence the effect of the four direct determinants in the UTAUT constructs?

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5 Analysis & discussion

We verified our model using the confirmatory factor analysis by testing the validity and reliability of our measurement items, followed by the hypothesis test analysis.

A total of 109 (58.6%) female and 77 (41.39%) male respondents participated in the survey, with the majority of these respondents (80.5%) were local farmers aged between 24 and 39 years. Around 73.2% of these respondents were micro business owners. Facebook was the most popular social media platforms used by these respondents to interact with their targeted customers and contact suppliers, and only one respondent did have a Facebook account for his business. Much of the respondents (78%) invest less than an hour to promote their goods via social media platforms. Whereas most of the respondents indicated that social media such as Facebook and Twitter are mainly for socializing and not business-related. As a result, these respondents were believed not to be familiar with the use of social media as an online delivery tool for managing their business.

Based on the confirmatory factor study, the measurement model demonstrated an appropriate to equal fitness to the data obtained.

($\chi 2$ = 78.822, df = 25, $\chi 2$/df = 3.153, GFI = 0.947, AGFI = 0.893, NFI = 0.974, CFI = 0.982, and RMSEA = 0.078).

We then checked the validity and durability of our measuring items. Both constructions are true with composite reliability of more than 0.80 and mean-variance of more than 0.50.

The findings were also found to have supported hypotheses H1, H2, H3 and H4. Specifically, facilitating condition (FC) and performance expectancy (PE) of IoT-technology has a significant effect on the behavioural intention, social influences (SI) have a lesser effect on the aqua-farmers' behavioural intention, and facilitating conditions (FC) have significant effects use behaviour (UB) on the net benefits of IoT-technology. Overall, IoT-technologies have a significant effect on behavioural intention (0.175***) and use behaviour (0.198***).

Social influences are an integral base for e-commerce. We test IoT-technology readiness by using social support and partnership support systems as indicated in previous studies. Overall, the study shows a significant relationship with facilitating condition and performance expectancy when preparing for IoT-technologies. These results are compatible with previous research and underscore the role of the social element in cultivating connections and improving partnerships amongst community members while they share knowledge easily and conveniently. Like any technology, the community's governing infrastructure plays an important role in any technology adoption. Based on the interviews conducted, most of the respondents were positive that they would be more prepared to invest in any IoT-based technologies in managing their aqua-farming activities if it was supported by local governing agencies.

Although the result demonstrated important positive correlations, both promoting state and success expectations, with the implementation of IoT-technology, we have obtained different outcomes for the human construct. Surprisingly, only facilitating conditions showed a positive relationship with use behaviour even though there are contributing factors adversely influencing these results such as experience. Our results demonstrate the important positive association between support for behavioural intentions and use of behaviour, thus showing that social factors are core elements of IoT-based technology acceptance, including consumer confidence, trust and affordability of the system itself. This result is consistent with studies that indicate that, following IoT-based technology adoption, business owners trust an online group member that can comfortably participate in IoT-based technology farming, hence begin to understand its utility and thus increase their satisfaction with this method of aqua-farming monitoring.

Relationships with local community members are enhanced along with dedication and customer satisfaction, which in turn will lead to an increasing inefficiency. The negligible relationship of social factors to user behaviour and behavioural intentions with IoT-based technology adoption does not imply that social influences are unrelated to IoT-based technology adoption. Instead, social factors complement facilitating conditions as they serve as a key foundation for social interaction, given that they play a key role in building relationships between online community members.

6 Future work

This work serves as a foundation towards establishing a proper policy for the Ministry of Rural Development.

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Authors' contributions

The first three authors contributed equally in the original idea, proposed technique, and writing of the paper. The fourth and fifth author helped with the overall quality of the paper, formulating some of the research questions, and preparing the paper for final submission. All authors read and approved the final manuscript.

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Availability of data and materials
The details of the models and codes are already included in this paper.

Declarations

Competing interests
The authors declare that they have no competing interests.

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