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Adoption Intentions of Aquaculture Farmers of the BioDOF-Map System

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In Malaysia, aquaculture utilizes GIS technology to optimize the selection of sites, monitor the quality of water, manage resources, and improve production, hence assuring the implementation of sustainable and efficient aquaculture techniques. The Malaysian Department of Fisheries (DOF) has created a Web-GIS system, namely BioDOF-Map to facilitate comprehension of the fishery. Nevertheless, the use of this technology presents difficulties for farmers who are not acquainted with the execution of the system. The study examines Malaysian aquaculture farmers' adoption of GIS technology, revealing high intentions influenced by attitude, subjective norms, and perceived behavioural control, suggesting policy support for technology uptake. The study highlights the crucial role of GIS technology in optimizing Malaysian aquaculture, demonstrating strong correlations between attitudes, subjective norms, perceived control, and the intention to adopt the BioDOF-Map system using the Theory of Planned conduct (TPB). A total of 278 people were surveyed in this quantitative investigation, utilising a questionnaire. 65.8% of MAFs function as landlords. Out of the total 242 individuals engaged in production, 29.2% possess land spanning an area of 3.1 to 4 hectares, whereas 69.1% reside at a distance of 2 to 3 kilometres from their agricultural plots. Significantly, 49.6% of individuals own property that has been passed down via their family, and an additional 9.7% are involved in non-agricultural activities such as growing crops. Participants engage in either the cultivation of aquatic creatures or the commercial breeding of fish in cages. Perak has the biggest proportion, accounting for 11.15% of the total, while Pahang and Selangor have proportions of 10.07% each. Sarawak represents 9.7% of the total, while Kedah accounts for 8.27%. Both Johor and Negeri Sembilan contribute 7.91% apiece. The study shows that 50.72% of MAFs are 6-10 km from the nearest town and farm, 22.30% are less than 5 km away, 18.71% are 11-15 km away, and 8.27% are over 16 km away. The average intention to implement the BioDOF-Map system was high, with a mean of 4.55 and a standard deviation of 0.296. The correlation analysis revealed a highly significant correlation between attitude and intention to adopt ($r = 0.980$, $p = 0.000$), providing evidence for a robust link between attitude and desire to adopt. Furthermore, there was a strong positive correlation between subjective norms and intention to adopt ($r = 0.325$, $p = 0.000$). Additionally, perceived behavioural control was also strongly connected with intention to adopt ($r = 0.966$, $p = 0.000$). The Ministry of Agriculture and Food Security (KPKM) and other stakeholders have a responsibility to establish policies and programmes that promote knowledge of the system and encourage better behavioural management within it. These practical implications are aimed at enhancing the adoption and utilization of GIS technology like BioDOF-Map among Malaysian aquaculture farmers, ultimately contributing to the sustainability and productivity of the aquaculture sector in Malaysia.

Keywords: WebGIS system, BioDOFMap, spatial analysis, Theory of Planned Behaviour.

INTRODUCTION

Increasingly, aquaculture in Malaysia is making use of web-based and spatial technologies to enhance sector management, monitoring, and decision-making. The use of technology is critical in the commercial and agricultural sectors. Agricultural robots, automation, precision farming, and management information systems are all part of smart farming, according to (KC, 2005). The Third Green Revolution began with the utilization of information and communication technologies in smart farming. The DOF and MYSA collaborated to create the BioDOF-Map GIS web-

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based system for managing biosecurity regulations in the fishing industry. Satellite images taken by the MYSA Earth Station in Temerloh, Pahang, are used in this system. Utilizing geographically scattered data, online GIS solutions necessitate an internet-connected computer, tablet, or smartphone. Interconnections exist between HTTP and URLs generated by machines. A web-based Geographic Information System (GIS) application is being developed, created, implemented, evaluated, and distributed as part of this research endeavor. To enhance the use of GIS and remote sensing for the management and monitoring of biosecurity in fisheries, the application includes features such as User Acceptance Testing (UAT), correct attestation, a user manual, and training. View, search, edit, basic, and aquaculture farm information make up the five components. It all comes down to printer widgets. The system is accessible from mobile devices that run Windows, iOS, and Android. Based on internet monitoring done by fishery officials, the device notifies a dashboard of any illness transmissions. Add a module that can analyze other modules in the system. However, the system is still new to the farmers. To explore this issue, the Theory of Planned Behaviour (TPB) is employed to assess how BioDOF-Map aligns with the beliefs, subjective standards, and perceived behavioral control of MAFs. This study used the Theory of Planned Behaviour to look at how ornamental fish producers in Malaysian aquaculture feel about using BioDOF-Map, as well as their subjective standards and how much control they think they have over their behavior. The use of information technology is one of several human behaviors included in the TPB paradigm (Ajzen, 1991; Ajzen, 2011). Attitude and subjective norms are the driving forces behind behavior, according to the TPB (Zhang *et al*., 2019). Intentional behavior measures how eager someone is to act. A person's attitude is a reflection of how much they enjoy or despise a particular action. The impact of outside forces on a person can be measured using Subjective Norms (SN). Family, friends, coworkers, and others are all considered members. According to SN, important people have particular behavior needs. Perceived behavioral control is a measure of task ease.

MAFs benefit significantly from adopting BioDOF-Map, enhancing biosecurity management by integrating GIS for disease monitoring, which safeguards aquatic health and sustains aquaculture practices. Real-time data improves decision-making, boosting operational efficiency and profitability. The system ensures compliance with regulations, bolstering credibility and market access. Capacity building through training and user support addresses technological gaps, promoting sustainable development. This study fills a literature gap by exploring MAFs' behavioral intentions using TPB, uncovering attitudes and norms influencing system adoption. It informs policy and interventions to facilitate BioDOF-Map adoption, advancing aquaculture management in Malaysia. With the use of the TPB, this study intends to do the following: to clarify the respondents' sociodemographic profiles and spatial characteristics; to determine the respondents' level of intention to adopt the BioDOF-Map system; to identify the level of attitude and subjective norm, and perceived behavioral control towards the intention to adopt the system; examine the relationship between the level of intention to adopt the system and the level of attitude, subjective norm, and perceived behavioral control; and finally, to examine the most influential factors that influence the respondents' intention to adopt the system.

MATERIALS AND METHODS

The present research was conducted to aims at examining the aquaculture farmers' intention level to adopt the BioDOF-Map system reference to the TPB including to clarify the respondents' sociodemographic profiles and spatial characteristics. This experiment was carried out in 14 states of Malaysia.

***Data Collection*:** This study utilized quantitative analysis by conducting questionnaire surveys among ornamental aquaculture growers in Malaysia. The questionnaire employed simple random selection methods and consisted of structured dichotomous choice and multiple-choice items, arranged into five discrete sections. Questionnaires were distributed to respondents from June 1st, 2023, to December 1st, 2023. The distribution was facilitated through the Biosecurity Units in each state of Malaysia, which passed the questionnaires to respondents registered with the Department of Fisheries (DOF). The DOF State Officer will return the completed survey forms to the researcher. The initial phase of the study centered on demographic variables, encompassing a total of 14 questions. Subsequently, the researchers evaluated the participants' inclination to embrace the BioDOF-Map system. This assessment included a contingency question and a level of measurement question, comprising a total of 12 questions. Afterward, the respondents' inclination towards using the BioDOF-Map system was assessed using 12 questions. In addition, the study assessed personal attitudes about adoption using a set of 9 questions and examined the assessment of one's ability to handle behavioral issues related to adoption using a set of 7 questions. TPB was selected as the theoretical framework for this study because of its predictive power, comprehensive nature, empirical validity, and applicability to understanding the complex behaviors associated with technology adoption in agricultural settings such as aquaculture. The researcher employed a wide array of library and online sources to collect secondary data. The statistical data was acquired through interactions with other government bodies, including the DOF. There has been an increase in accessibility to papers, studies, seminars, and research related to off-farm work and rural poverty. Data was collected from several governmental organizations, and the

internet was used to obtain substantial geographic information system (GIS) data. The purpose of these components was to create sampling frames, verify the study's findings using data from other regions or representative samples, and offer a contextual framework for the study locations. JUPEM, the authorized entity, supplied maps that encompass a range of elements including highways, rivers, streams, towns, paddy fields, land usage, the Malaysian boundary, geographic names, and administrative boundaries. These maps facilitate comprehension of vital subjects such as land preservation and strategic advancement. The study will utilize periodicals, books, online resources, and government bodies to collect geographical data, hence enhancing comprehension of the subject matter.

***Data Integration*:** To understand the geographical impact on agricultural system development, socioeconomic and spatial data integration was conducted. Ali *et al*. (2024) linked spatial data with concepts of space and shape. GIS focuses on spatial data accuracy, while non-spatial data includes attribute data with spatial information. Combining agricultural systems methodology with geographical data (KC, 2005) identified the relationship between farming populations and spatial characteristics, analyzing how geographical factors influence agricultural system development.

***Data Analysis Techniques*:** The survey findings were analyzed using the statistical software SPSS 25.0 for Windows in this study. Upon completion of the questionnaire, the responses were converted into numerical values and analyzed using descriptive statistics, notably focusing on the mean and standard deviation. Additionally, spatial analysis was conducted for Research Objective 1. Descriptive statistics were employed for Objective 2. Correlation analysis was conducted for Objective 3. The hypotheses were tested with a significant threshold of 0.01. The geographic analysis involved the integration of field survey data and spatial data, which were then shown in an integrated centralized database. The data that was acquired was analyzed using the subsequent statistical methodologies.

RESULTS

***Respondents' Profile*:** Since most participants are working, the oldest age group is 56 and older. The study also found that many respondents between the ages of 46 and 55 are currently engaged in farming. This means that most MAFs start farming at a young age and few after 56. This is supported by Shephard, (1987) found that aging causes several issues and impairments that limit a person's ability to participate in many activities.

***Years of Respondents Farming Experience*:** The years of farming experience for the respondents of this study ranges between 1 to 26 years and above. The highest categories are those with 16-20 years of farming experience who are about n=121 (43.5%). Youth account for 44 percent of Malaysia's overall population, yet just 15.0% are employed in the agricultural industry (Han *et al*., 2022).

***Income Level of the Respondents*:** The income level of the respondent ranges between RM1,000 to RM15,000 with a mean value of 2.41 and SD of 0.54. The highest categories were RM1.000 to RM5,000 income earners of about n=169 (60.8%), This finding is related to the findings of Constanza *et al*. (2021) who find out that aquaculture interventions increase the recipients' production value, income, and total expenditures, and food consumption.

***Spatial Analysis on Distance from House, The Nearest Town, and Farm Location*:** The relationship between distribution of distance from house, the nearest town, and farm location. It can be seen that the majority of 50.72% of MAFs are involved in aquaculture production (n=123) cage culture fisheries (n=18) stay 6-10 kilometers from the nearest town and farm location. 22.30% of MAFs involve in aquaculture production (n=54) cage culture fisheries (n=8) stay less than 5 kilometers from the nearest town and farm location, and 18.71% of MAFs involve in aquaculture production (n=45) cage culture fisheries (n=7) stay 11 to 15 kilometers from the nearest town and town and farm location. 8.27% of MAFs involve in aquaculture production (n=20) cage culture fisheries (n=3) stay more than 16 kilometers from the nearest town and farm location (Figures 1,2 and 3).

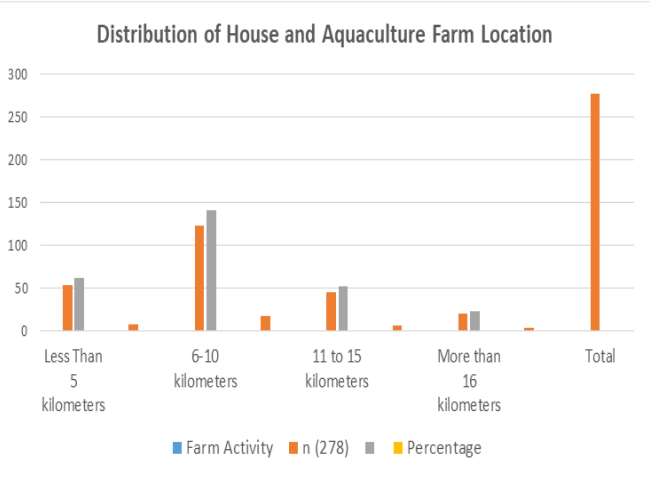

Figure 1. Distribution of House and Aquaculture Farm Location.

***Level of Respondents' Intention to Adopt*:** The respondents' level of intention to adopt the BioDOF-Map system is shown Table 2. This finding suggests that 100.0% (n=278) of the participants achieved a high level. In general, the respondents' intention to implement the BioDOF-Map system is rated as high, with a mean score of 4.55 and a standard deviation of 0.296. Knickel *et al*. (2017) which has found that Smart Farming Technologies (SFTs) can produce more sustainably and increase agricultural productivity through a more accurate and resource-efficient method.

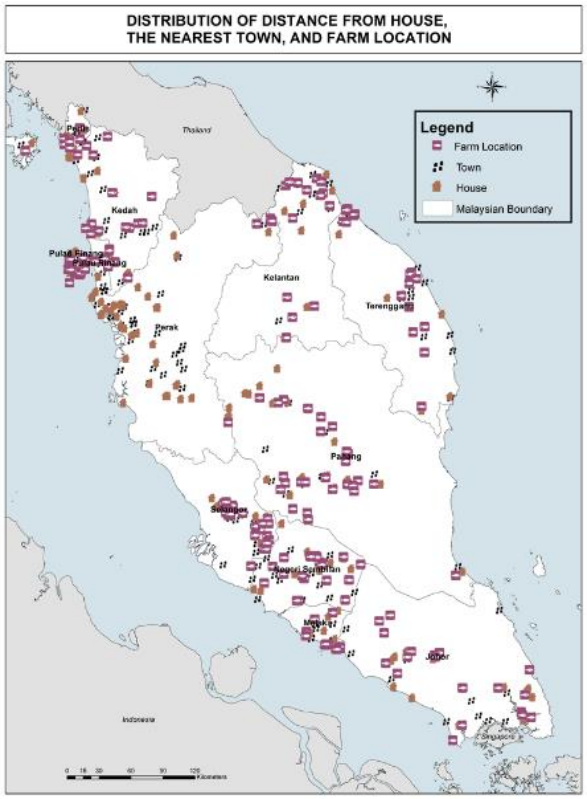

Figure 2. Distribution of Distance from House, The Nearest Town, and Farm Location (Peninsular Malaysia).

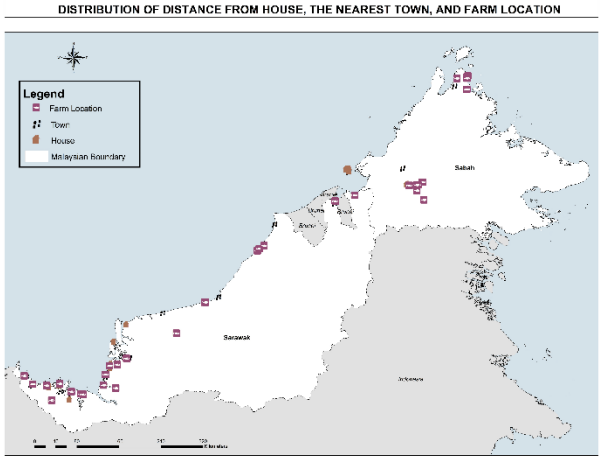

Figure 3. Distribution of Distance from House, The Nearest Town, and Farm Location (Sabah and Sarawak).

Correlation Analysis on Respondents' Average Mean of Attitude, Subjective Norms and Perceive Behavioral Control Level towards Intention to Adopt the BioDOF-Map System: The level of respondents' attitude towards intention to adopt the BioDOF-Map system is shown Table 3. This result indicates that 100.0% (n=278) at the high level. Overall, the score of the respondents' attitude towards intention to adopt the BioDOF-Map system (M=4.56, SD=0.263) is at the high level. People's perspective, norms, beliefs, and attitudes play a significant part in the adoption procedure (Al-Momani *et. al*., 2019).

The respondent's level of subjective norms towards intention to adopt the BioDOF-Map system is shown Table 4. This result indicates that 100.0% (n=278) at the high level. Overall, the score of the respondents' subjective norms towards intention to adopt the BioDOF-Map system (M=4.87, SD=0.174) is at the high level. Previous research on online green advertising have primarily focused on one-on-one interactions between users and the green advertising, as opposed to online interactions amongst users who have viewed the same green advertisement (Ghose and Todri-Adamopoulos, 2016).

The respondent's level of perceive behaviour control towards intention to adopt the BioDOF-Map system is shown Table 5. This result indicates that 100.0% (n=278) at the high level. Overall, the score of the respondents perceives behaviour control towards intention to adopt the BioDOF-Map system (M=4.58, SD=0.329) is at the high level. In contrast, Shalannanda and Hakimi (2016) discovered the importance of PBC on behavioural interactions to accept and utilise ICT in health care systems.

Relationship between the Respondents' Level of Attitude, Subjective Norms and Perceived Behavioral Control and Respondents' Intention Level to Adopt the BioDOF-Map System: The findings indicated a statistically significant association between attitude and intention to adopt, with a significance level of 0.01 (r=0.980, p=.000) is shown Table 6. This implies that a correlation exists between the mindset of MAFs and their intention to adopt the BioDOF-Map system. Furthermore, the r-value of 0.980 suggests a strong positive association between respondents' attitude towards the intention to implement the BioDOF-Map system. The attitude of the MAFs positively correlates with the intention to use the system. The findings from this study are in support with other studies which found a significant positive correlation between attitude and participation at 1% level (Al-Subaiee *et al*., 2005). The findings suggest that there is a statistically significant linear association between subjective norms and intention to adopt, with a significance threshold of 0.01 (r=0.325, p=.000). This finding suggests that there is a clear association between the subjective norms of MAFs and their intention to use the BioDOF-Map system. Furthermore, the data reveals a moderate positive association (r=0.325) between subjective norms and the intention to implement the BioDOF-Map system. There is a positive correlation between the increase in subjective norms and the inclination to use the system. A study found that consumer behaviour is susceptible to being impacted by the norms of the social group (Ackerman and Tellis, 2001), this study hypothesized that Subjective

Table 2. Level of Respondents' Intention to Adopt.

Variables	n	%	Mean	SD	Min.	Max.
Level of the intention to adopt			4.55	0.296	4.08	5.00
Low (1.00 - 2.33)	0	0.0				
Moderate (2.34 - 3.67)	0	0.0				
High (3.68 - 5.00)	278	100.0				

Table 3. Level of Respondents' Attitude towards Intention to Adopt.

Variables	n	%	Mean	SD	Min.	Max.
Level of respondents' attitude towards intention to adopt			4.56	0.263	4.17	5.00
Low (1.00 - 2.33)	0	0.0				
Moderate (2.34 - 3.67)	0	0.0				
High (3.68 - 5.00)	278	100.0				

Table 4. Respondents' Level of Subjective Norms towards Intention to Adopt.

Variables	n	%	Mean	SD	Min.	Max.
Respondents' level of subjective norms towards intention to adopt			4.87	.174	4.44	5.00
Low (1.00 - 2.33)	0	0.0				
Moderate (2.34 - 3.67)	0	0.0				
High (3.68 - 5.00)	278	100.0				

Table 5. Respondents' Level of Perceive Behaviour Control towards Intention to Adopt.

Variables	n	%	Mean	SD	Min.	Max.
Respondents' level of perceived behaviour control towards intention to adopt			4.58	.329	4.00	5.00
Low (1.00 - 2.33)	0	0.0				
Moderate (2.34 - 3.67)	0	0.0				
High (3.68 - 5.00)	278	100.0				

norms might influence consumption behaviour and could be a determinant of customers' adoption behaviour of mobile data services**.** The findings suggest that there is a statistically significant association between perceived behavioural control and intention to adopt, with a significance level of 0.01 (r=0.966, p=.000). There is a correlation between the perception of behavioural control and the intention to adopt the BioDOF-Map system. Furthermore, it is worth noting that the correlation value (r=0.9669) suggests a strong positive association between perceived behavioural control and intention to adopt the BioDOF-Map system. As the perceived behavioural control of the MAFs increases, there is a corresponding increase in the intention to adopt the system. According to research done by Saga and Zmud (1993), personal inventiveness influences acceptance of information technology.

Table 6. Correlation between Independent and Dependent Variable (Intention).

Independent variables	Pearson coefficient	P-value
Attitude	0.980**	0.000
Subjective norms	0.325**	0.000
Perceived behavioral control	0.966**	0.000

**. Correlation is significant at the 0.01 level (2-tailed)

DISCUSSION

The research confirms the theories and literature on technology adoption and acceptability, with a specific focus on the use of GIS systems. In earlier study, there have been associations found between attitude, subjective norms, and perceived behavioural control in different domains and in Western societies, with implications in theory. This study in Malaysia demonstrated the correlation between the factors for the first time. This study further contributed to the existing body of knowledge on the desire to adopt ICT technology, specifically a web-based GIS system, as a model for agricultural extension. This model can be utilised to comprehend the purpose of MAFs (Malaysian Aquaculture Farmers) to implement the BioDOF-Map system with the aim of enhancing production and alleviating poverty. The study's explicit objective to utilise ICT technology theory could be further developed. Although there is existing research on agricultural and associated activities in Malaysia, there is limited information regarding their strategy for using online web-based GIS systems. There has been no research conducted to determine the most accurate predictor of Malaysia's MAF by examining the connection between attitude, subjective norms, and perceived behavioural control.

Therefore, this study's distinctiveness in the field of agricultural extension has set a new benchmark for future research on the adoption of GIS web-based systems, specifically focusing on attitude, subjective norms, and perceived behavioural control.

Prior research conducted in Western settings, specifically by (Davis *et al*., 1989; Venkatesh *et al*., 2003), has established the Technology Acceptance Model (TAM) and Unified Theory of Acceptance and Use of Technology (UTAUT). These models emphasise the significance of attitude, subjective norms, and perceived behavioural control in the process of adopting technology. Our research supports these theories, showing that these criteria are also crucial in the Malaysian context for the use of GIS systems by MAFs. Our research takes a further step by applying these theories to a particular agricultural extension programme in a non-Western culture, thereby offering fresh perspectives. The exclusive emphasis on MAFs and the utilisation of the BioDOF-Map system fills a void in the existing body of literature, as indicated by studies conducted by (Rogers, 2003; Ajzen 1991), which underscore the necessity for research that is tailored to specific contexts in the uptake of technology. In terms of practical application, the empirical findings of this study can assist policymakers in formulating policies regarding MAF intention, potentially leading to positive outcomes. The literature was deficient in theoretical and empirical inquiries into the components of interest, resulting in policy-makers being uncertain about the appropriate course of action. In previous research on this matter, a government has employed policy instruments to incentivize farmers to engage in fish production. This study employs the theory of planned behavior constructs, namely attitude, subjective norms, and perceived behavioral control, to assess the intention of MAFS individuals to utilize a Geographic Information System (GIS) web-based system. The outcomes of this study can be utilized by the MAFS, DOF, and extension organization to establish specific criteria for aquaculture farmers. The findings of this study indicate that Malaysian MAFs possess a high level of proficiency and a modest level of interest in utilizing the BioDOF-Map. Backed by favorable reception of system implementation. This informs stakeholders such as the Ministry of Agriculture and Food Security, extension unit, policy makers, and aquaculture farmers about strategies to enhance MAF's farmer information distribution and DOFs' farmer encouragement. MAF attitudes must also be restricted. This study also aids Malaysian MAFs, especially the Ministry of Agriculture and Food Security (KPKM) and DOF in comprehending the current level of the variable. This would focus on increasing attitude from a moderate level to a high level, improving subjective standards, and enhancing perceived behavioral control from a low level to a high one. The findings additionally indicated that the attitudes of MAFs are more accurate in predicting their inclination to embrace a GIS web-based solution. This demonstrated the necessity for policymakers to broaden their approaches to enhance the perspectives of MAFs and regularly assess for necessary modifications and rectifications. The findings elucidated the correlation between attitude, subjective norms, and perceived behavioral control. Additionally, they developed a plan for including aquaculture farmers in management approaches through the use of extensions. The study provided recommendations to many important stakeholders, such as the Ministry of Agriculture and Food Security, DOF Malaysia, extension unit, aquaculture farmers, and policymakers. The proposals aim to assist stakeholders in developing extension programs and policies that facilitate the active and profitable involvement of aquaculture farmers in agricultural practices that alleviate poverty and enhance aquaculture output. This will be achieved through the implementation of farm monitoring and the utilization of information and communication technology (ICT).

This study provides substantial evidence to support and broaden the application of current technology adoption models such as TAM and UTAUT in a non-Western setting. The study demonstrates that attitude, subjective norms, and perceived behavioral control have a significant impact on the adoption of GIS systems among Malaysian Aquaculture Farmers (MAFs), thereby confirming the broad application of these models. The research addresses a gap in the literature on the adoption of information and communication technology (ICT) in agricultural contexts by applying the Theory of Planned Behaviour (TPB) to the Malaysian aquaculture industry. The results indicate that regardless of cultural and economic differences, the fundamental principles of technology acceptance remain valid. This highlights the importance of implementing context-specific strategies to promote the adoption of technology.

The study provides practical and implementable insights for policymakers, the Ministry of Agriculture and Food Security (KPKM), the Department of Fisheries (DOF), and other stakeholders involved in aquaculture. The strong inclination among MAFs to embrace the BioDOF-Map system, fueled by favorable attitudes, encouraging subjective norms, and a sense of high perceived behavioral control, demonstrates a preparedness for technology adoption. Policymakers can utilize these data to develop focused interventions, such as training initiatives, awareness drives, and support networks, aimed at enhancing the rates of adoption of GIS technology. Regular evaluation and adjustment of policies are crucial to guarantee their efficacy and tackle changing requirements, resulting in improved resource management and enhanced productivity in aquaculture.

The study's constraints encompass a sample size of 278 Malaysian aquaculture farmers (MAFs), which may not adequately encompass the entirety of the population, thereby restricting the ability to make generalizations. The emphasis on particular regions may not accurately represent diverse

socio-economic and cultural circumstances. Relying on data that is self-reported can present potential biases. The use of a cross-sectional design limits the ability to make causal inferences, so it is recommended to conduct longitudinal research in order to gain more comprehensive knowledge. The impact of variances in technological literacy among MAFs on the efficiency of GIS adoption was not taken into account. Although the cultural environment was taken into account, the specific cultural elements that influence the adoption of GIS were not thoroughly investigated, indicating the need for additional research.

Several recommendations for future study should be taken into account, such as doing further testing to see if attitude, subjective norms, and perceived behavioral control remain the most influential factors in predicting the intention to utilize the BioDOF-MAP system. It is uncertain whether this discovery is exclusive to the specific circumstances of this study or if it is a phenomenon that occurs when the theory is applied to decisions regarding any necessary modifications to the system as a whole, or a consistent trend across various forms of technology adoption. Additional research is required to examine and assess the geographical linkages between farms, which could be a significant factor in determining the effects of restrictions on aquaculture producers and off-farm jobs.

***Conclusion*:**This study enhances comprehension of technology adoption in agricultural extension, specifically focusing on GIS systems, in Malaysia. The text emphasizes the importance of attitude, subjective norms, and perceived behavioural control in forecasting the intention to embrace GIS web-based solutions. The findings provide policymakers with valuable insights for developing successful strategies to improve the distribution of information among farmers and promote the adoption of agricultural systems. Recommendations centre on enhancing attitudes, subjective norms, and perceived behavioural control among stakeholders. Subsequent investigations should examine the extent to which these findings may be applied to other situations and evaluate the connections between farms in different locations to gain a full picture of the adoption of technology in aquaculture.

The study has verified that attitude, subjective norms, and perceived behavioural control have a substantial impact on the adoption of GIS systems among Malaysian Aquaculture Farmers (MAFs). The research showcased the wide applicability of the Technology Acceptance Model (TAM) and Unified Theory of Acceptance and Use of Technology (UTAUT) by testing and extending them in a non-Western setting. The results highlight the significance of implementing strategies tailored to the specific context of technology adoption. This provides significant knowledge for policymakers and stakeholders involved in the aquaculture industry. Although there are limitations, such as the small size of the sample and the concentration on a specific region, the study offers a strong basis for future research and practical measures to improve the adoption of technology and increase productivity in aquaculture.

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Ethical statement: This article does not contain any studies regarding human or Animal.

***Availability of data and material*:** We declare that the submitted manuscript is our work,

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***Code availability*:** Not applicable.

***Consent to participate*:** All authors participated in this research study.

***Consent for publication*:** All authors submitted consent to publish this research. article in JGIAS

***Note*:** Highlight the additions and corrections directly in the document. Additionally, create a separate table for easy reference and verification, specifically dedicated to checking and confirming the implemented change.

***SDG's addressed*:** Zero Hunger, Responsible Consumption and Production, Life Below Water, Partnerships for the Goals.

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