Aquaculture Farmers' Spatial Distribution and Intention to Adopt the Sistem Pengurusan Kawalan Biosekuriti Perikanan (BioDOF-Map)

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ABSTRACT

Aquaculture is crucial to food supply and economic growth supported by Industry Revolution 4.0 to boost output. Malaysian Department of Fisheries (DOF) developed a Web-GIS system, a spatial system focusing on aquaculture. However, farmers are unfamiliar with the system. The Theory of Planned Behaviour (TPB) is employed to examine the attitudes, subjective norms, and perceived behavioural control of Malaysian Aquaculture Farmers (MAFs) throughout Malaysia in relation to BioDOF-Map. Questionnaire was used in the present quantitative research, with 278 respondents. Data was analysed using descriptive, spatial, correlation, and regression analysis techniques. 65.8% of respondents are farm landlords. 29.2% respondents own 3.1 to 4 hectares, and 69.1% reside 2 to 3 km from their farm. Notably, 49.6% own family land and 9.7% grow crops or vegetables off-farm. Cage culture or aquaculture were respondents' activities. Perak (11.15%), Pahang and Selangor (10.07%) have the most residents. Spatially, aquaculture farming decisions are influenced by housing and town location. With a mean of 4.55 and SD of 0.296, MAFs intend to use BioDOF-Map. Correlation showed a significant association between attitude and intention at 0.01 level of significance (r=0.980, p=.000), supporting the hypothesis. At 0.01 significance level, subjective norms, and intention are linear (r = 0.325, p =.000), fails to reject the null hypothesis. At 0.01 level of significance (r=0.966, p=.000), perceived behavioural control and intention fails to reject the null hypothesis. Regression shows a significant association between attitude and intention (β = 0.635, t = 20.704, p<0.05). Attitude has the highest beta value of 0.635, predictors variable showed a significant and unique variance total R2 97.4% (0.974). This study contributed to the literature on intention to adopt. The model can be utilized to increase farmers' intention to adopt. Ministry of Agriculture and Food Security (KPKM) and stakeholders should develop policies and programmes to improve subjective norms and behavioural control towards the system.

Keywords: Web GIS system, Bio DOF Map, spatial analysis, Theory of Planned Behaviour

INTRODUCTION

Technology plays a vital role in both agriculture and commerce. According to Kernecker et al. (2016), smart farming encompasses many technologies such as agricultural automation, robotics, precision agriculture, and management information systems. The integration of ICT in smart farming initiated a Third Green Revolution. The Fisheries Biosecurity Control Management System (BioDOF-Map) GIS web-based system was developed by the Department of Fisheries (DOF) and the Malaysian Fisheries Agency (MYSA). This system utilizes daily remote sensing satellite images obtained from the MYSA Earth Station located in Temerloh, Pahang. The technique implemented in July 2018 was implemented in Johor in February 2019. DOF and MYSA developed this system using their internal expertise, resources, and information and communication technology. Therefore, its expansion does not result in an increase in government expenditure. This technique additionally enhanced the proficiency of agency personnel. Online GIS systems utilize spatially dispersed data and require a computer, tablet, or smartphone with internet connectivity. HTTP and machine-generated URLs are interconnected. This research endeavour involves the development, creation, implementation, evaluation, and distribution of a web-based Geographic Information System (GIS) application. The application incorporates User Acceptance Testing (UAT), accurate attestation, a user manual, and training to improve the utilisation of remote sensing and GIS in the management and monitoring of fisheries biosecurity. The project seeks to comply with the biosecurity criteria set by the European Union and other countries for exporting ornamental fish. This system was developed by the Department of Fisheries (DOF) based on CAR audit DG (SANTE)/2015-7562, which aimed to evaluate animal health control in aquaculture farms exported to the European Union.

Bio DOF-Map was expanded and rebranded on October 13, 2022, by DOF and MYSA.

The five modules consist of a view, searching widget, edit widget, basic, and aquaculture farm information. Module 4 focuses on the measurement of widgets. The ultimate component comprises printer widgets. Mobile devices running Android, iOS, and Windows operating systems can access the system. The device tracks the transmission of disease and sends notifications to a dashboard based on internet monitoring conducted by fishery officials. Integrate a module for analyzing system modules.

Farmers are unfamiliar with the system. The present study employed the Theory of Planned Behaviour to examine the attitudes, subjective norms, and perceived behavioural control of Malaysian aquaculture ornamental fish producers towards the adoption of Bio DOF-Map. The TPB paradigm encompasses various human behaviours, including the utilisation of information technology (Ajzen 1991; 2002). The TPB posits that behaviour is influenced by attitude and subjective norms (Zhang et al., 2019). Behaviour intention quantifies the level of willingness. Individuals' attitudes reflect their level of approbation for or dislike towards certain actions. Subjective Norms (SN) quantifies the external significance of pressure on an individual. Members encompass relatives, colleagues, and additional individuals. SN asserts that significant individuals require specific conduct. Task easiness is measured by perceived behavioural control.

This study 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, to determine the respondents' level of intention to adopt the BioDOF-Map system, to identify the respondents' attitude, subjective norm and perceived behavioral control level toward intention to adopt the BioDOF-Map system, to identify the relationship between the level of attitude, subjective norms and perceived behavioral control and respondents' intention level to adopt the BioDOF-Map system and to examine the most influential factors that influences the respondents' intention to adopt BioDOF-Map system.

MATERIALS AND METHOD

Data Collection

This study used quantitative analysis and was based on questionnaire surveys. The responses were restricted to ornamental aquaculture farmers in Malaysia. Simple random sampling techniques were chosen for the study. Structured dichotomous choice and multiple-choice questions are in the questionnaire. The questionnaire contains both dichotomous choice and multiple categories questions, both of which are structured.

The questionnaire examines the factors associated with five (5) categories: Demographic characteristics of the respondents, containing 14 questions, Part 2: Respondent's perception towards the intention to adopt the BioDOF-Map system, containing 1 contingency question and 1 level of measurement question which has 12

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questions on the intention to adopt. Part 3: Respondent's attitude towards intention to adopt the BioDOF-Map system, which consists of 12 questions on the intention to adopt. Part 4: Respondent's subjective norm towards intention to adopt the BioDOF-Map system, which consists of 9 questions on the intention to adopt. Part 5: Respondent's perceived behavioral control towards the intention to adopt the BioDOF-Map system, which consists of 7 questions on the intention to adopt.

The researcher used many library and online sources to gather secondary data. To gather statistics, multiple government agencies including the Department of Fisheries were consulted. Papers, studies, seminars, and research on off-farm work and rural poverty are now easily accessible. Data was obtained from multiple government entities. Additionally, the internet was utilized to collect geospatial information system (GIS) data of importance. The aforementioned components created the sampling frames, corroborated the study's findings using data from other regions or nationally representative samples, and provided a contextual framework for the study locations.

The authorized entity, JUPEM, provided maps for spatial data collection. These maps showed roads, rivers, streams, settlements, paddy lots, land usage Malaysian boundary, geographic name, and administrative boundaries. The maps enhance comprehension of significant subjects, such as land preservation and strategic development. The study will utilize periodicals, books, online resources, and government institutions to collect geographical data. Acquiring information enhances comprehension of a subject.

Data Integration

The integration of pertinent socioeconomic and spatial data was undertaken to ascertain the geographical impact on the development of agricultural systems. Daman et al. (2000) have established a correlation between spatial data and the concepts of space and shape.

Geographic Information System (GIS) is a field of study. Spatial data refers to data that accurately depicts the dimensions and positions of space. Non-spatial data refers to attribute data that encompasses spatial information. Spatial and non-spatial data are both components of geographical data. The relationship between farming populations and their spatial characteristics can be identified by combining an agricultural systems approach with data gathered from geographical sources (K.C, K. B., 2005). An analysis was conducted to determine how the geographical factors affect the development of agricultural systems by integrating relevant socioeconomic and spatial data.

Data Analysis Techniques

In this study, the survey results were analyzed using SPSS 25.0 for Windows statistical software. After the questionnaire was completed, the responses were transformed into numerical values and subjected to analysis using descriptive statistics, specifically 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, and regression analysis was utilised for Objective 4. 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 a integrated centralised database. The data that was acquired was analysed using the subsequent statistical methodologies.

RESULTS AND DISCUSSION

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 ageing 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 (Bernama, 2021).

Income Level of the Respondents

The income level of the respondent ranges between below 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 with the findings of Constanza, et. al. (2021) who find out that aquaculture interventions increase the recipients' production value, income, total expenditures, and food consumption.

Spatial Analysis on Location of Farmland for the Respondents

The connection of the distance between a residential dwelling and the placement of an aquaculture farm is shown in Table 1, Figure 1 and Figure 2. The data reveals that a significant majority of 69.06% (n=192) of individuals, with 58.63% engaged in aquaculture production and 10.43% involved in cage culture fisheries, reside within proximity (2-3 kilometers) to their farms. 16.9% (n=47) of respondents reside at a considerable distance (more than 4 kilometers) from their farm. Among these respondents, 16.55% engage in aquaculture production, while 0.36% are involved in cage culture fisheries. The remaining respondents stay within a close distance (2-3 km) from their farm. 12.95% (n=36) of the respondents reside within a 1-kilometer distance from their farm. Among these respondents, 10.79% engage in aquaculture production, while 2.16% are involved in cage culture fisheries. Han, Peng and Xu (2022) investigation revealed that the lengthening of commute times has an adverse effect. The longer the journey, the less satisfied one is with their job and life in general.

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.

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. Prior studies on online green advertising have mostly concentrated on individual interactions between users and the green advertisements, rather than the online interactions among users who have seen the same green advertisement (Ghose & 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) and Abandu, Kivunike, Okot, and Lamunu (2019) 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 results of this study align with previous research that discovered a substantial and favorable association between attitude and participation at a statistically significant level of 1% (Al-Subaiee, et al., 2005). The results indicate a strong and significant positive relationship between subjective norms and intention to adopt. The correlation coefficient (r) is 0.325, which is statistically significant at a threshold of 0.01 (p=.000). This discovery indicates a strong correlation between the subjective norms of MAFs and their intention to utilize 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 (Tellis & Ackerman, 2001), this study hypothesized that Subjective norms might influence consumption behaviour and could be a determinant of customers' adoption behaviour of mobile data services

The results indicate a strong and significant relationship between perceived behavioral 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 level of perceived control over one's behavior toward the MAFs (Mobile Application Frameworks) increases, there is a commensurate rise in the intention to embrace the system. Personal ingenuity has been found to have an impact on the acceptability of information technology, as demonstrated by the research conducted by Saga and Zmud in 1993.

The Most Influential Factor Influencing Adoption of the BioDOF-Map system.

The regression analysis conducted in this study demonstrated a statistically significant association between attitude and intention to adopt (β=0.635, t=20.704, p=0.05) is shown Table 7. This finding provides evidence that the mindset of MAFs has a substantial impact on their intention to adopt the BioDOF-Map system. Furthermore, the findings presented in Table 7 demonstrate a statistically significant association between subjective norms and the desire to adopt (β=-0.025, t=-2.361, p=0.05). The subjective norms of MAFs have an impact on their intention to embrace the BioDOF-Map system. In addition, the findings presented in Table 4.14 demonstrate a statistically significant association between perceived behavioural control and intention to adopt (β=0.373, t=12.138, p=0.05). This suggests that the user's perception of their ability to manage their behaviour has an impact on their intention to adopt the BioDOF-Map system. Hence, it can be asserted that all the predictor variables examined in the study have a substantial impact on the desire of MAFs to adopt the BioDOF-Map system. Except for the facilitation condition, all these criteria were found to be significant predictors of the desire to adopt open data technologies (Zuiderwijk et al., 2015).

CONCLUSIONS

The research confirms the validity of ideas and literature on technology adoption and acceptability, with a specific focus on the adoption of GIS systems. Prior research conducted in several fields and within the western setting has established a theoretical correlation between attitude, subjective norms, and perceived behavioral control. This study in Malaysia demonstrated the correlation between the factors for the first time. This study also added to the literature on intention to embrace ICT technology, specifically a web-based GIS system, as a paradigm for agricultural extension. This model can be used to understand MAFs' intention to adopt the BioDOF-Map system to boost productivity and reduce poverty. The study's public intention to use ICT technology theory could be expanded. Thus, while research on Malaysian agricultural and related activities is available, little is known about their plan to use online web-based GIS systems. There has been no research conducted to determine the most accurate predictor of Malaysia's MAF by studying the connection between attitude, subjective norms, and perceived behavioral control. Therefore, this study's originality 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 behavioral control.

On the practical implication, this study's empirical results can help policymakers determine MAF intention policy, which could have a favourable impact. The literature was lacking in theoretical and empirical investigations into the elements of interest, leaving policy-makers unsure how to continue. In most prior studies on such issues, one government

has utilised policy instruments to encourage farmers to produce fish. This study uses theory of planned behaviour characteristics including attitude, subjective norms, and perceived behavioural control to estimate MAFS intention to use a GIS web-based system. The MAFS, DOF, and extension organisation can use this study's findings to create aquaculture farmer requirements. This study found that Malaysian MAFs are skilled and moderately interested in using the BioDOF-Map. Supported by positive opinion of system adoption. This educates stakeholders like the Ministry of Agriculture and Food Security, extension unit, policy makers, and aquaculture farmers about methods to improve MAF's farmer information dissemination and DOFs' farmer motivation. MAF attitudes must also be curtained. This study also helps Malaysian MAFs, DOF, and the Ministry of Agriculture and Food Security understand the variable's present level. This would direct efforts to raise attitude from moderate to high, information subjective norms, and perceived behavioural control from low to high.

The results also showed that MAFs' attitudes better predict their propensity to adopt a GIS web-based system. This showed that policymakers needed to diversify their ways to improve MAFs' views and periodically check for adjustments and corrections. The findings also explained the link between attitude, subjective norms, and perceived behavioural control. They also established a roadmap for extension-based aquaculture farmer participation in management methods.

The study presented recommendations to all key stakeholders, including the Ministry of Agriculture and Food Security, Department of Fisheries Malaysia, extension unit, aquaculture farmers, and policymakers. The recommendations would help stakeholders design extension programmes and policies that would enable aquaculture farmers to participate meaningfully and profitably in agricultural practices that reduce poverty and increase aquaculture productivity through farm monitoring and ICT use.

Several recommendations for future study should be taken into account, such as doing more testing to determine if attitude, subjective norms, and perceived behavioral control remain the most prominent predictors of intent to utilize the BioDOF-MAP system. It remains 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 judgments regarding any significant alterations to the system in a broader sense, or a consistent trend across various forms of technology adoption. Further research is needed to investigate and evaluate the spatial interactions across farms which may represent an additional important determinant of the nature and magnitude of a regulations impact on aquaculture farmers and on off-farm employment participation.

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Table 1. Distribution of House and Aquaculture Farm Location

We extend our sincere gratitude to all research colleagues, field support personnel, programmers, and data processing members for their dedicated effort and commitment in this project.Distance to Farm Location	**N (278)**	**Percentage**	**Total Percentage**	**Farm Activity**
House Compound	3	1.08%	1.08%	Aquaculture production
	0	0.00%		Cage Culture Fisheries
Nearby (1 kilometer)	30	10.79%	12.95%	Aquaculture production
	6	2.16%		Cage Culture Fisheries
Close Distance (2-3 kilometers)	163	58.63%	69.06%	Aquaculture production
	29	10.43%		Cage Culture Fisheries
Far Distance (more than 4 kilometers)	46	16.55%	16.91%	Aquaculture production
	1	0.36%		Cage Culture Fisheries
Total	**278**	**100%**		

Table 2. Level of Respondents' Intention to Adopt

Variables	n	%	Mean	SD	Min.	Max.
Level of the intention to adopt			4.55	.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	.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				

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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				

Table 6 Correlation between Independent and Dependent Variable (Intention)

Independent Variables	**Pearson Coefficient**	**P – Value**
Attitude	0.980**	.000
Subjective Norms	0.325**	.000
Perceived Behavioral Control	0.966**	.000

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

Table 7 Multiple Regression Analyses among the Variables

Model	**R**	**R Square**	**Adjusted R Square**	**B**	**Beta**	**t**		**Sig.**
Predictors	.987	.974	.974	-.036		-.410		.682
Attitude				.713	.635	20.704		.000
Subjective Norms				-.042	-.025	-2.361		.019
Perceived Behavioral Control				.335	.373	12.138		.000
Durbin Watson		2.171						
F Value		3437.535						

* Significant at 0.05 level
a. Dependent Variable: Intention to adopt

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Figure 1. Distribution of House and Aquaculture Farm Location (Peninsular Malaysia)

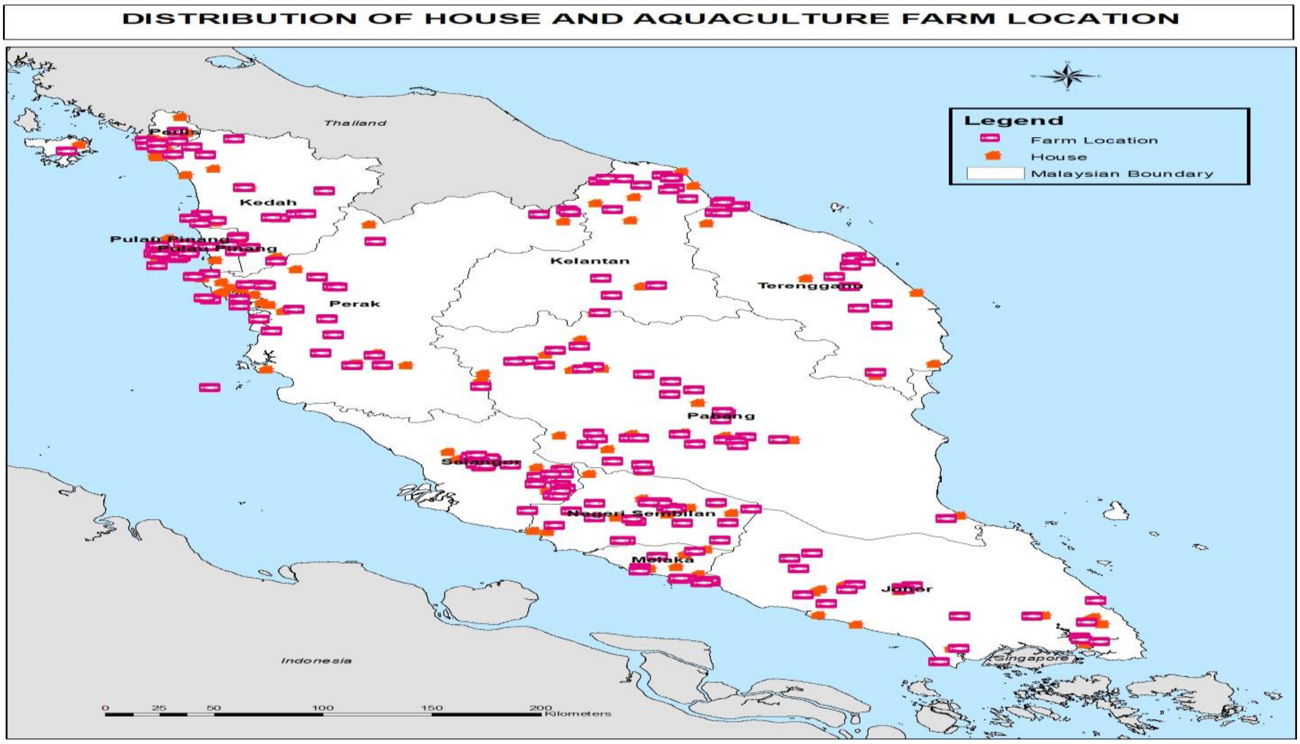
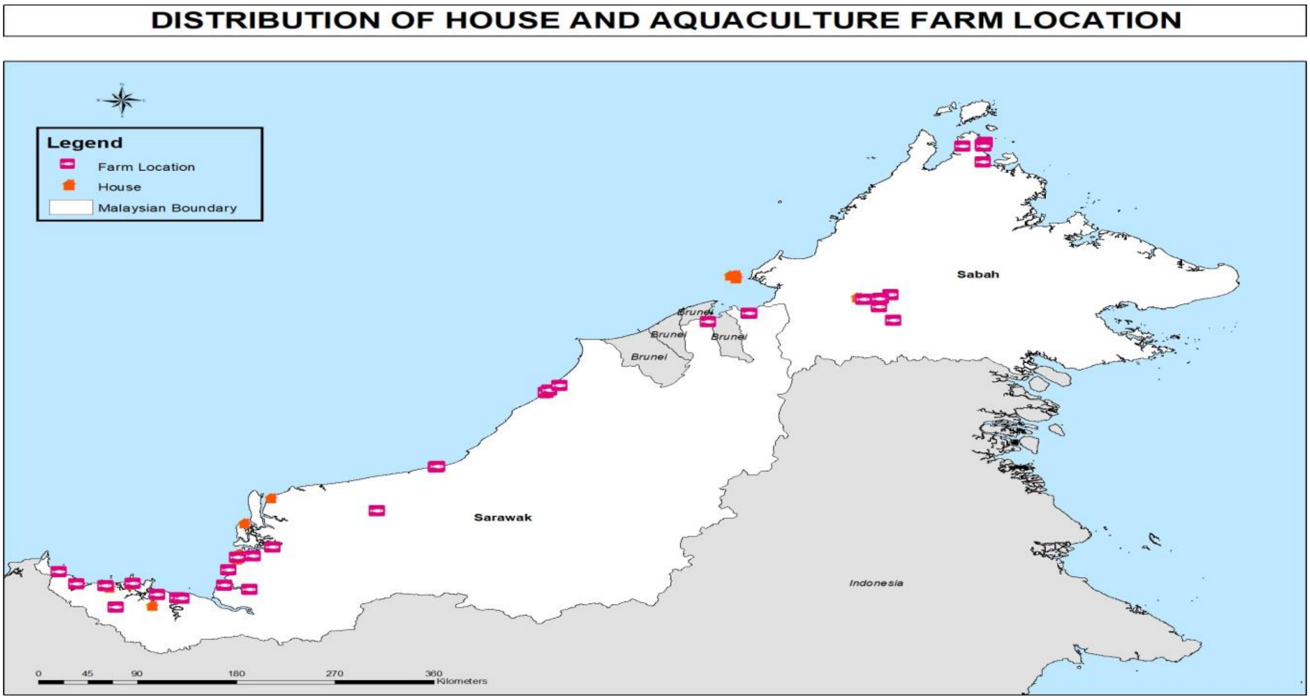


Figure 2. Distribution of House and Aquaculture Farm Location (Sabah and Sarawak)



List of Table

1. Distribution of House and Aquaculture Farm Location
2. Level of Respondents' Intention to Adopt
3. Level of Respondents' Attitude towards Intention to Adopt
4. Respondents' Level of Subjective Norms towards Intention to Adopt
5. Respondents' Level of Perceive Behaviour Control towards Intention to Adopt

6. Correlation between Independent and Dependent Variable (Intention)
7. Multiple Regression Analyses among the Variables

List of Figure

1. Figure 1: Distribution of House and Aquaculture Farm Location (Peninsular Malaysia)
2. Figure 2: Distribution of House and Aquaculture Farm Location (Sabah and Sarawak)

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