Does Demographic Backgrounds Affect Agricultural Drone Technology in Granary Areas?

Nur Ieffah Muhammad Khalil, Norsida Man*, Nurul Nadia Ramli

Department of Agribusiness and Bioresource Economics, Faculty of Agriculture, Universiti Putra Malaysia, 43400 Serdang Selangor

***Corresponding Author**

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ABSTRACT

The adoption of technology in paddy sector appears to have coincided with the advancement of the country's development, as the agricultural sector is likewise undergoing the Industrial Revolution 4. Over the years, the Malaysian rice production system has faced a number of challenges, including extreme weather conditions, poor soil fertility and nutrient management, farmers' lack of awareness and knowledge, reluctance to use genetically modified planting materials, and poor technology deployment. Despite the adoption of drone in the paddy farming is seem gradually increasing, the factor effecting the adoption remains unclear. Thus, this study investigates the association between socio-demographic profiles and their adoption towards drone technology in selected granary areas. A cross-sectional study was conducted among 384 paddy farmers using a self-administered questionnaire, selected through cluster random sampling. Result found that there are no association between age, education level, experience, farm size and income. The finding recommend that government should provide opportunities for all paddy farmers regardless their background in adopting drone technology to improve the modernization in paddy industry.

Keywords - smart farming, drone, paddy farming, demographic

INTRODUCTION

Agriculture is the most essential industry in the world as its produce food to feed people and animals while serve as the major source of raw materials in various industries such as health, fabric and construction. As an important staple crop in Asia, the production of rice needs to increase to cater the demand forcing this sector to face many changes through technological and innovation breakthrough. Modern farming industry is important through the adoption of technology for sustainable production thus become the main focus to be discussed to ensure the adequacy food resources and raw materials while respecting the ecological, economic and social limits that ensure the persistency and stability of this sector. Smart farming has a real potential to deliver a more productive and sustainable agricultural production, based on a more precise and resource-efficient approach. Since the concept of smart farming is vast, this paper focuses on adopting drone technology in paddy farming. Even though the adoption of agriculture technologies has lot of benefit, the overall adoption is still low (Degieter et al., 2023). Psychological studies that focusing on drone in agriculture also limited (Michels et al., 2020) such as from Zheng et al. (2019), Hsieh et al. (2020) and Zuo et al. (2021) however, these papers were not focusing on the socio-demographic factors that affect the drone adoption. Thus, this paper will discuss on the demographic characteristics that might affect the adoption of drone technology in granary areas in Peninsular Malaysia.

LITERATURE REVIEW

Numerous studies have aimed to establish factors to determine the adoption of agriculture technologies and whether socio-demographic plays a significant role in the adoption too. According to Loevinsohn et al. (2013), farmers' decisions about whether and how to adopt new technology are conditioned by the dynamic interaction between characteristics of the technology itself and the array of conditions and circumstances.

1) Association between Age and Agricultural Technology Adoption

Age may influence the adoption of agriculture technologies. Typically, younger adults tend to adopt latest technology as they have high probability of keeping up with latest technology. Khan et al. (2022) found the older farmers is negatively correlated with mobile internet technology (MIT), indicating that young farmers are more likely to adopt agriculture technology. Paxton et al. (2011) believed that younger people will adopt modern technologies as they are more knowledge and have side jobs. However, older farmers were better at analyzing technological information than younger farmers, who gathered farming expertise and experience over time as stated from Mignouna et al. (2011). Their study demonstrated that there is a positive relationship between age and adoption, implying that the older the farmer, the greater the likelihood of adopting the technology. Thus, the hypothesis as follow:

H_1: There is significant association between age with the level of drone adoption behaviour.

2) Association between Education Level and Agricultural Technology Adoption

Knight et al (2020) stated that educated farmers are pioneer to early innovation and are influence to the less schooling thus reduce the risk in farming operation. Khan et al. (2022) found that education and the adoption of MIT is highly correlated in which educated farmers know how to maximize the technology existed. Kőmíves et al (2019) believed that higher education is essential for agricultural development worldwide. Adapting technologies to local agriculture is beneficial for developing countries, while ongoing training is crucial for maintaining knowledge in developed countries. Modern farmers need continuous access to new information, expertise, and skills. Thus, the hypothesis as follow:

H_2: There is significant association between education level with the level of drone adoption behaviour.

3) Association between Experience and Agricultural Technology Adoption

Ullah et al. (2023) found that farming experience positively influences farmers' adoption of agricultural technology, specifically hand tractor technology. This is likely attributed to farmers' observations of technology performance and learning by doing. Zaman et al. (2023) also supports this idea, noting that farmers are more inclined to adopt smart farming technology after seeing others do so. According to Ahmad et al. (2024), farmers with lack of expertise face challenge to adopt smart farming as knowledge and technical skill are important in adopting technologies. The adoption of agricultural technology is influenced by the farmer's level of experience. Initially, adoption rates increase as experience grows, but eventually plateau or decrease at higher experience levels (Ainembabazi and Mugisha, 2014). Therefore, the hypothesis as follow:

H_3: There is significant association between experience with the level of drone adoption behaviour.

4) Association between Farm Size and Agricultural Technology Adoption

In a study by Udimal et al. (2017), it was found that larger farms are more likely to adopt new technology due to lower risk and higher wealth, allowing them to cover the costs of operation and maintenance. Large farms also have the capacity to experiment with new technology before expanding its use across the entire farm. Small farmers, on the other hand, tend to opt for capital-saving and less risky farming methods, while larger farmers prioritize labor-saving methods. Khan et al (2022) added that large farms require complex decision-making and organization, highlighting the critical need for advanced technologies in agriculture. Thus, the hypothesis as follow:

H_4: There is significant association between farm size with the level of drone adoption behaviour.

5) Association between Income and Agricultural Technology Adoption

The income of farmers directly impacts their ability to adopt new technologies, as costs associated with gas, maintenance, and spare parts can be significant. Hall and Khan (2003) suggest that business owners, like farmers, must ensure there will be resources available in the future to cover the cost of investments in new production

methods. This minimizes risks associated with adopting new technologies, making adoption dependent on both price and resource availability. In adopting agricultural technology, Prokopy et al. (2008) and Zheng et al. (2019) found that income was of the key factor and had a positive association with adoption agricultural technology. In Malaysia's paddy industry, usually there are 2 seasons that farmers planting paddy hence the term use basically main season that are around August to February as it usually during humid weather whereas Mac to July as the off-season due to the dry weather (Dorairaj and Govender, 2023). Therefore, the hypothesis as follow:

H_5: There is significant association between main season income with the level of drone adoption behaviour.

H_6: There is significant association between off-season income with the level of drone adoption behaviour.

6) Unified Theory of Acceptance and Use of Technology (UTAUT)

Venkatesh et al. (2003) developed the Unified Theory of Acceptance and Use of Technology (UTAUT) model to understand the behavioural acceptance and usage of technologies. This model consists of four main construct that affect the psychological behaviour of the user which is performance expectancy, effort expectancy, social influence and facilitating conditions. In the field of agriculture technology, UTAUT model has been widely applied such as from Molina-Maturano et al. (2021), Xie et al. (2022), Nkandu and Phiri (2022) and Dino et al. (2023). Therefore, the dependent variable in this study applied the UTAUT model to investigate the association of socio-demographic towards the level of drone adoption behaviour.

METHODOLOGY

The study areas chosen by dividing into four zone areas in the Peninsular Malaysia by using cluster random sampling that included Integrated Agricultural Development Area (IADA) Pekan, IADA Barat Laut Selangor (BLS), Kemubu Agricultural Development Authority (KADA) and Muda Agricultural Development Authority (MADA). By applying Krejcie and Morgan (1970) formula, the sample size was 384. Respondents were ask using self-administered questionnaire using open ended and closed ended questions. The collected data was analysed using SPSS version 22 software. The descriptive analysis was done to observe the response gathered that include respondents' characteristics. In addition, to identify the association between socio-demographic profiles of respondents towards the adoption level of drone technology among respondents, Chi-square analysis was done. Chi-square looks at the significant difference between observed frequencies (or values that are taken from the study) and expected frequencies (values that are generated by theory). To assess the level of behavioural adoption of drone among the respondents, Likert scale question designed with 5-point scale was adapted where scale 1 – strongly disagree, 2 – disagree, 3 – moderate, 4 – agree and 5 – strongly agree.

FINDINGS AND DISCUSSION

1) Demographical Background of the Respondents

Table I present the frequency and percent distribution of the sociodemographic information of the respondents in this study. The results indicate that more than a quarter percent (25.8%) aged 50 to 59 years old and 23.4% aged between 30-39 years old. This shows that the involvement in paddy farming among younger and older people. In term of marital status, majority of the respondents were married with 88.5% while 9.9% were single and 1.6 were widow/widower. Almost half 42.7% of the respondents had SPM/STPM certificate while 22.4% of them at least finished the secondary school. Regarding the farming experience, 31.5% of them had 11 to 20 years of farming experience and 29.9% had less than 10 years of experience, 14.8% had 21 to 30 years of experience, 10.4% had 31 to 40 years of experience meanwhile small percentage of 7.6% and 5.7% of them had 41 to 50 years and more than 50 years of experience in paddy farming respectively. For farm size, 34.4% of the respondents have below 5.99 acres size land, 28.4% had 6.00 to 10.99 acres land and only 9 respondents have 26.00 to 30.99 acres.

For income, 31.3% earn below than RM10,000 in the main season, followed by 22.7% earn between RM10,001 to RM20,000, 19.5% earn more than RM50,001, 10.2% earn between RM20,001 to RM30,000. For the off-season income, 33.3% of the respondent earn below than RM10,000 followed by 21.9% of them earn between RM10,001 to RM20,000. There are 4 respondents do not earn income during off-season in which it is in IADA

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Pekan due to the poor irrigation in their paddy areas. They mentioned that the paddy land is being utilize by planting pumpkin and other cash crop until the main season start.

Table I. Demographical Background of the Respondents

Characteristics	**Frequency**	**Percent**
Age (years old)		
Below 20	2	0.5
20 to 29	36	9.4
30 to 39	90	23.4
40 to 49	59	15.4
50 to 59	99	25.8
60 to 69	66	17.2
More than 70	32	8.3
Marital Status		
Married	340	88.5
Single	38	9.9
Widow/widower	6	1.6
Education Level		
Never attend school	5	1.3
Primary school	55	14.3
Secondary school	86	22.4
SPM/STPM certificate	164	42.7
Vocational/Technical	13	3.4
Diploma degree holder	31	8.1
Bachelor degree holder	29	7.6
Master or PhD holder	1	0.3
Years of Farming Experience		
Less than 10 years	115	29.9
11 to 20 years	121	31.5
21 to 30 years	57	14.8

31 to 40 years	40	10.4
41 to 50 years	22	5.7
More than 50 years	29	7.6
Farm Size		
Below than 5.99	132	34.4
6.00 to 10.99	109	28.4
11.00 to 15.99	60	15.6
16.00 to 20.99	30	7.8
21.00 to 25.99	17	4.4
26.00 to 30.99	9	2.3
More than 31.00	27	7.0
Main Season Income		
Below than RM10000	120	31.3
RM10001 - RM20000	87	22.7
RM20001 - RM30000	39	10.2
RM30001 - RM40000	37	9.6
RM40001 - RM50000	26	6.8
More than RM50001	75	19.5
Off-Season Income		
Below than RM10000	128	33.3
RM10001 - RM20000	84	21.9
RM20001 - RM30000	47	12.2
RM30001 - RM40000	36	9.4
RM40001 - RM50000	23	6.0
More than RM50001	62	16.1
None	4	1.0

2) Level of Drone Adoption Behaviour

Table II present the frequency, mean and standard deviation for all ten measurement items for construct “Drone

Adoption Behaviour" among the farmers. According to the table shown, 63.8% of them highly agreed that when they were using drone, it can "reduce working time and work loaded" (Mean =4.61, SD = 0.549). This indicate that drone had successfully reduced farmers time spent in paddy field and reduce heavy farming activities such as spraying pesticide that farmers usually need to carried on their back and wade through the.

The low contribution item to measure the drone adoption behaviour variable is they are using drone because it "benefit the environment" (Mean = 3.86, SD =1.223). Almost half of them (47.7%) believe that using drone will not give benefit to the environment because pesticide and herbicide that they are using are chemical thus will affect the environment.

Table II. Drone Adoption Behaviour

Statement	**Frequency (%)**					**M**	**SD**
	1	**2**	**3**	**4**	**5**		
Reduce working time and work loaded.	0 (0.0)	1 (0.3)	9 (2.3)	129 (33.6)	245 (63.8)	4.61	.549
Reduce the exposure to unsafe and unhealthy working condition.	0 (0.0)	1 (0.3)	19 (4.9)	121 (31.5)	243 (63.3)	4.58	.600
Drone have good performance after other farmers used it.	1 (0.3)	7 (1.8)	13 (3.4)	139 (36.2)	224 (58.3)	4.51	.678
More effective compare to conventional method.	9 (2.3)	11 (2.9)	25 (6.5)	134 (34.9)	205 (53.4)	4.34	.900
Service provider have experience and skills.	10 (2.6)	7 (1.8)	20 (5.2)	160 (41.7)	187 (48.7)	4.32	.864
More effective to the growth of my crop.	10 (2.6)	15 (3.9)	20 (5.2)	167 (43.5)	172 (44.8)	4.24	.914
Reduce the occurrence of pest and diseases attacks.	22 (5.7)	25 (6.5)	33 (8.6)	150 (39.1)	154 (40.1)	4.01	1.125
Many service providers around me can perform the task.	27 (7.0)	19 (4.9)	18 (4.7)	187 (48.7)	133 (34.6)	3.99	1.108
Reduce operation cost in fertilization and pesticides spraying.	37 (9.6)	29 (7.6)	33 (8.6)	133 (34.6)	152 (39.6)	3.87	1.280
Benefit the environment.	33 (8.6)	16 (4.2)	72 (18.8)	115 (29.9)	148 (38.5)	3.86	1.223
Overall						**4.23**	**0.924**

Note. 1 = Strongly Disagree, 2 = Disagree, 3 = Moderate, 4 = Agree, 5 = Strongly Agree.

M = Mean, SD = Standard Deviation

Table III show the behaviour level of drone adoption among farmers. 87.5% of them had high level of usage behaviour. The overall mean value is 4.23 (SD = 0.924) elucidated that the respondents use the drone frequently

when there is need to do activities in paddy field using the drone.

Table III. Drone Adoption Behaviour Level

Level of Drone Adoption Behaviour	Frequency	Percentage
Low (1-2.33)	1	0.3
Moderate (2.34-3.66)	48	12.5
High (3.67-5.00)	335	87.5
Mean = 4.23		
SD =0.924		

3) The Association between Respondents' Demographic Profile and Level of Drone Adoption

Chi-square analysis was done to determine the association of the selected socio-demographic (age, education level, experience in paddy farming and income earn during main and off-season) with the dependent variable (the adoption of drone). Table IV presented the result.

Table IV. Association between Socio Demographic Profiles and Drone Adoption

Socio-demographic	Df	Significance value (p-value)	Hypothesis
Age	12	0.581	Reject H_1
Education Level	14	0.650	Reject H_2
Experience	10	0.920	Reject H_3
Farm Size	12	0.973	Reject H_4
Main Season Income	10	0.671	Reject H_5
Off Season Income	12	0.883	Reject H_6

From Table IV, there is no significant association between the age, education level, experience, farm size and income in main and off-season. The p-value for age (0.581), education level (0.650), experience (0.920), farm size (0.973), main season income (0.671) and off-season income (0.883) are more than the alpha value 0.05. Therefore, fail rejected the null hypothesis. Result indicates that either young or older farmers have no significant effect towards the drone adoption. This is supported by Zuo et al. (2021) that found age of the farmers was not statistically significantly associated with the choice to use drones. Aubert et al. (2012) also found that the age of farmers and farm size do not affect the adoption of precision techniques. This show that regardless farmers are adopting the drone technology regardless of their farm size. Ruzzante et al. (2021) found education has no effect on agriculture technology. Riddell and Song (2012) explained that even though previous studies have shown a positive correlation between education level and technology adoption however, this correlation may be due to other factors not necessarily education itself, which might be unobserved variables that are correlated with education and technology adoption.

Perhaps, the non-significant result towards the drone adoption in this study could be due to other influential factors that were not been studied in this research such as study from Akudu et al. (2012) applied logit model

and found that farm size, expectation gain from the technology adoption, access to credit and extension services are the factors that significantly influence the adoption of technology. Likewise, longitudinal design might be result to significant result in this research as it an improve the understanding of technology adoption process overtime and improve the ability to predict the time-varying variable on adoption.

CONCLUSION

Based on the findings, it can be concluded that young and older farmers both involve in paddy farming and adopt the drone technology. Majority of them are married and attain SPM/STPM certificate. Some reason as they are not pursuing on higher education level due to become the breadwinner of the family thus this explained that they have 11 to 20 years of farming experience. The study found that there are no association between the selected demographic profiles on drone adoption level. Hence, this could be suggested that government should provide a face-to-face practical training for every paddy farmer to adopt drone regards of their age or education level. The establishment of relevant programs according to age and education levels can provide better opportunity to increase the level of drone use. It is also suggested that the government establish a center area in each locality to disseminate latest drone technology development to assure that each farmer is kept up to date on the progress of drones, particularly in Malaysia as they are showing a high level of adoption regardless of background. Subsidies and incentives need to be expanded not only to companies but to individual farmers who want to adopt drones meanwhile government partnership with bank should loosen the credit facilities conditions to support farmers.

SUGGESTION FOR FUTURE RESEARCH

It is suggested that future researcher should adding other demographic factors that might affect the drone technology adoption. A new study can also be done by focusing on the three largest organizations which is MADA, KADA and IADA as this may provide interesting data. It is also suggested test on different analysis as this might reveal strong result.

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CO-AUTHOR CONTRIBUTION

We confirmed that there is no conflict of interest in this article. Nur Ieffah Muhammad Khalil carried out the fieldwork and prepare for the data analysis and discussion. Norsida Man involve in the fieldwork and wrote the literature review. Nurul Nadia Ramli contribute to the ideas and wrote the research methodology, conclusion and suggestion for future research.

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