Research Inventy: International Journal of Engineering And Science
Vol.13, Issue 9 (September 2023), PP 25-29
Issn (e): 2278-4721, Issn (p):2319-6483, www.researchinventy.com

The Intention to use Drone Technology in Agriculture: A Case of Nakhon Si Thammarat Province, Thailand

Thiwa Keawinsuan, Jintanee Ru-Zhue and Somnuk Aujirapongpan
School of Accountancy and Finance, Walailak University, Nakhon Si Thammarat, 80160, Thailand.

Abstract: *This research aims to study the factors influencing the acceptance of drone technology affecting the intention to use drones for agricultural purposes among farmers in Nakhon Si Thammarat province. The sample group in the study comprises farmers who have and have not used drones for agriculture, specifically those involved in rice farming or perennial fruit cultivation. Data was collected through a survey from 388 households. This research utilizes the Unified Theory of Acceptance and Use of Technology (UTAUT 2) as its theoretical framework. The study found that older farmers have a higher average intention to use drone technology for agriculture than younger farmers. Those with larger agricultural land areas have a higher average intention to use than those with smaller areas. The level of acceptance of drone technology among those who have previously used it averaged at a very high level (4.33), while the group that had never used it held an overall positive view with an average rating of 3.85. The factors that positively influence the intention to use drone technology for agriculture are: performance expectancy at 66.9%, social influence at 63.1%, price value at 53.3%, facilitating conditions at 35.9%, and hedonic motivation at 35.3%. The results of this research can be utilized to analyze and support the adoption of drone technology for agriculture, which is likely to grow in the future.*
Keywords: *Farmers, Drone Technology, Agriculture, Thailand*

Date of Submission: 27-08-2023 Date of Acceptance: 08-09-2023

I. INTRODUCTION

Technological advancements have led to the development of unmanned aerial vehicles (UAVs) that can be applied across various sectors, including agriculture. These drones have the potential to revolutionize traditional agricultural practices, especially in precision applications like spraying fertilizers, plant hormones, herbicides, and pesticides with enhanced efficiency and accuracy.

Forecasts from 2018 estimate that the UAV market value will grow from an initial 350 billion US dollars. By 2025, it is expected that the market value will rise to 3.2 trillion US dollars, as reported by UNCTAD in 2021. This indicates a clearer and ever-growing target for businesses that need to increasingly adopt and adapt to these technologies.

The integration of unmanned aerial technology in agriculture has the potential to increase productivity, reduce resource wastage, and enhance overall crop yields. However, the successful adoption of such technology relies on the willingness of farmers to embrace its daily use in their agricultural practices. Various factors play a significant role in determining the farmers' intention to incorporate unmanned aerial vehicles into their farming operations.

Nakhon Si Thammarat province, a significant agricultural hub in Thailand, especially for rice farming, is the largest in the southern region (as stated by the Office of Agricultural Economics in 2021). The province also sees an increasing trend in fruit cultivation. This research aims to provide valuable insights into the key factors influencing the adoption of UAVs for agricultural purposes in this region. Such in-depth information can pave the way for effective strategies to promote the successful integration of drones in the agricultural practices of the area.

II. LITERATURE REVIEW

The Unified Theory of Acceptance and Use of Technology 2 (UTAUT2), proposed by Venkatesh, Thong & Xu (2012), serves as a theoretical framework aiming to elucidate the determinants influencing the acceptance and utilization of new technologies. This model is an extension of the original UTAUT, which was developed to comprehend the adoption of technologies in various contexts. UTAUT2 incorporates additional structures and variables to provide a more comprehensive understanding of user behavior and technological acceptance. It mainly considers four primary variables: Performance Expectancy, Effort Expectancy, Social Influence, and Facilitating Conditions. Additionally, it introduces three more factors: Hedonic Motivation, Price Value, and Habit. These are further refined based on age, gender, and experience.

Regarding the acceptance of agricultural technology, research by Grace Fox et al. (2021) focused on the initial acceptance of farmers towards mobile digital platforms for farm management. It was found that social influence acted as a mediator, enhancing the performance expectancy and effort expectancy, making it easier for farmers to accept the mobile digital platform. In contrast, for the group of ongoing users, they perceived the efficiency of the platform to foster trust and saw it as a driving social influence for continued use of the mobile digital platform. Moreover, this group of users believed that obstacles could affect their effort expectancy, which might deter them from future system use. This aligns with the innovation acceptance decision presented by Everett M. Rogers (2003), suggesting that users who have decided to use the system may later decide not to continue adopting it.

In the context of adopting unmanned aerial vehicles (UAVs) for agriculture, a study by Lee & Heo (2020) in South Korea found that every primary variable within the UTAUT framework influenced the intention to use UAVs. Notably, Performance Expectancy (r=0.61), Social Influence (r=0.41), Effort Expectancy (r=0.38), and Facilitating Conditions (r=0.11) had significant impacts.

Research by Michels M. et al. (2021), which utilized the main variables of the TAM framework, identified the factors influencing the intention to use UAVs as Perceived Ease of Use (0.22), Perceived Usefulness (0.24), Attitude Towards Usage (0.30), and Job Relevance (0.31).

Additionally, a study by Attila Bai et al. (2021) in Hungary revealed that UAVs are typically used in large-scale areas, full-time agriculture, professions related to agriculture, and tasks related to agriculture, all of which invariably influence the intention to deploy UAVs.

III. RESEARCH METHODOLOGY

The population and sample used in the research on the acceptance of agricultural drone technology in Nakhon Si Thammarat province consisted of rice and perennial fruit farmers, both retail and wholesale traders, who have the authority to make decisions on the land they cultivate. Due to the unclear proportion of each type of farming, the Cochran formula (Cocchran, 1963) was employed. Samples were randomly selected based on probability, using a stratified random sampling method without proportional allocation. They were divided into 4 groups:

- 97 households that have used drones in rice farming.
- 97 households that have never used drones in rice farming.
- 97 households that have used drones in perennial fruit orchards.
- 97 households that have never used drones in perennial fruit orchards.

This totals 388 households. The sample of users was drawn from the UAV service provider network in Nakhon Si Thammarat, while the non-users were sourced from a network of community leaders engaged in agriculture.

Data gathered from online questionnaires were analyzed using the statistical software SPSS. Descriptive statistics included frequency, percentage, and standard deviation, while inferential statistics employed tests for differences among sample groups such as the Mann-Whitney Test and Kruskal-Wallis Test. Pearson Correlation was used for correlation analysis.

IV. RESULTS

The analysis reveals the number and percentage of the sample based on individual factors, geographical factors, and the differences in individual and geographical factors that influence the acceptance of agricultural drones among farmers in Nakhon Si Thammarat province as follows:

Table 1. Results of the study on individual and geographical factors.

Variables	Sample Groups	Ever used		Never used		Mean	U test	H test
		N	%	N	%			
Type of crops grown	Rice	97	25.0%	97	25.0%	4.26	18.44 (.718)	-
	Perennial fruit	97	25.0%	97	25.0%	4.34		
Time spent on farming	Full-time farmers	175	45.1%	117	30.2%	4.50	5.43 (.000)*	-
	Part-time farmers	19	4.9%	77	19.8%	3.68		
Age of farmers	Less than 24 years old	5	1.3%	5	1.3%	3.53	-	40.67 (.000)*
	24-33 years old	35	9.0%	26	6.7%	4.17		

Variables	Sample Groups	Ever used		Never used		Mean	U test	H test
		N	%	N	%			
	34-43 years old	57	14.7%	55	14.2%	4.04		
	44-53 years old	80	20.6%	55	14.2%	4.50		
	54 years and older	17	4.4%	53	13.7%	4.56		
Size of cultivation area	Less than 15 acres	47	12.1%	151	38.9%	4.14	-	35.184 (.000)*
	15-30 acres	79	20.4%	32	8.2%	4.35		
	31-45 acres	42	10.8%	7	1.8%	4.57		
	More than 45 acres	26	6.7%	4	1.0%	4.67		

*p-value < 0.05

From Table 1, it is evident that the intention to use drones for agriculture in rice fields and perennial fruit gardens does not differ. Regarding the time spent on agriculture, most of the survey respondents practice farming full-time. Full-time farmers have a higher intention to use drones than those who farm as a side occupation, with an average difference of -0.68.

The age distribution of the respondents who have used drones is mostly between 44 to 53 years. For those who have never used drones, the ages are predominantly between 34 to 43 years and 44 to 53 years. When comparing the average intention to use drone technology for agriculture, it was found that farmers aged below 24 have a lower average difference in intention to use the technology than those aged 44-53 years and those aged 54 and above, with average differences of -0.96 and -1.02, respectively. Farmers aged 24-33 years have an average difference in intention to use the technology that is lower than those aged 44-53 years and those aged 54 and above, with average differences of -0.32 and -0.38, respectively. Farmers aged 34-43 years have an average difference in intention that is lower than those aged 44-53 years and those aged 54 and above, with average differences of -0.46 and -0.51, respectively.

In terms of drone usage on agricultural land sizes, most respondents who have used drones operate on lands between 15 – 30 acres. In the group of those who have never used drones, most have lands less than 15 acres. When comparing the average intention to use drone technology for agriculture, it was found that farmers with land sizes less than 15 acres have a lower average difference in intention to use the drone technology for agriculture than those with land sizes of 31-45 acres and those with more than 45 acres, with average differences of -0.43 and -0.53, respectively.

Table 2. Analysis of the relationship between technology acceptance factors and the intention to use drone technology for agriculture.

	Hypothesis	Finding	
		Users	**Non-Users**
H1	Expectations regarding efficiency are related to the intention to use.	(.560)**	(.701)**
H2	Social influence is correlated with the intention to use.	(.727)**	(.425)**
H3	Convenience is associated with the intention to use.	(.367)**	(.074) n.s.
H4	Motivation based on preferences is related to the intention to use.	(.603)**	(-0.006) n.s.
H5	Price value is correlated with the intention to use.	(.525)**	(.503)**

From Table 2:

The analysis of the relationship between technology acceptance factors and the intention to use drone technology for agriculture reveals the following:

For the factor of expected efficiency:

- Farmers who have used drones before show a correlation of 56.0%.
- Farmers who have never used drones exhibit a correlation of 70.1%.

Regarding the influence of social factors:

- Farmers who have used drones before demonstrate a correlation of 72.7%.
- Those who have never used them show a correlation of 42.5%.

Concerning facilitating conditions:

- Farmers who have used drones before have a correlation of 36.7%.
- For farmers who have never used them, no correlation was found.

For the motivational factor related to preference:

- Farmers who have used drones before indicate a correlation of 60.3%.
- Those who haven't used drones show no correlation.

Concerning the price value factor:

- Farmers who have previously used drones show a correlation of 52.5%.
- Those who have never used them have a correlation of 50.3%.

V. DISCUSSIONS

The intention of farmers to use unmanned aerial vehicles (drones) for agriculture, whether in rice fields or perennial fruit orchards, is consistent. This could be due to the design of this innovation which is intended to fly over gardens, farms, and paddy fields regardless of the land's gradient or altitude; the drone can operate efficiently. The application of fertilizers, hormones, weed elimination, and pest control are conducted in a similar manner, thus there are no significant differences in usage.

75.3% of the participants were full-time farmers. This might suggest that part-time or occasional farmers were not motivated to participate in the survey. Nevertheless, the data still reflects the interest of full-time farmers in sharing information regarding the use of drones in agriculture. This research also discovered that full-time farmers have an average intention value of more than 0.82. This corresponds with the findings of Attila Bai et al. (2020) which stated that full-time farmers are more inclined to use drones in their fields compared to part-time farmers.

The majority of the farmers, both users and non-users of drones, fall within the age range of 44 to 53 years. This is different from the data provided by Waleerat Suphanrachat (2019), which indicates that the average age of most farmers is above 55 years. One reason for this discrepancy might be that this online survey was less accessible to individuals aged 54 years and above. Additionally, other research has found that older farmers tend to have a greater intention to use drones in agriculture than their younger counterparts. This could be because older individuals have witnessed numerous innovations throughout their lives, and these innovations have consistently made agricultural tasks more convenient. Those of older age have experienced the decision-making process for adopting various technologies, such as tractors and water pumps.

Regarding the use of unmanned aerial vehicles (drones) in relation to land size for agriculture, respondents who have used them predominantly operate on land areas ranging from 15 to 30 acres. This is larger than the average landholding size of Thai farmers as reported in the 2017 agricultural census, where Thai agricultural households have an average farming area of 14.3 acres (National Statistical Office, 2018). However, in the group that has never used drones, most possess less than 15 acres of land, consistent with the data from the National Statistical Office. Upon a detailed comparison based on land size, it was found that farmers with less than 30 acres have, on average, a lower intention to use drones for farming compared to those with farming areas of 31 to 45 acres and over 45 acres. It is noteworthy that drone technology for agriculture might be primarily adopted for larger agricultural areas, aligning with the findings of Attila Bai and colleagues (2020) as mentioned in previous research.

The relationship between the factors of technology acceptance and the intention to use drones for agriculture is as follows: For the group that has previously used them, all five factors align with the UTAUT 2 theory, ranked in order of their correlation strengths: Social Influence (r=.727), Hedonic Motivation (r=.603), Performance Expectancy (r= .560), Price Value (r=.525), and Facilitating Conditions (r=.367). Those who have experienced using the technology might have already adjusted their performance expectations and assessed the value for money. Using the technology might also reduce the operation time and enhance the pleasure of using, leading to a higher hedonic motivation over time. The factor of facilitating conditions is only slightly correlated. This group may not be as concerned about performance, price value, and personal preference as they are about the technology's sustainability. After using the technology, the significance of social influence seems to increase. Social influence can spur the diffusion of innovation as Everett M. Rogers (2003) suggested, "Social systems can rapidly influence the spread of innovation."

For the group that has never used drones, there's a correlation between technology acceptance factors and the intention to use drones in agriculture across three factors: Performance Expectancy (r=.701), Price Value (r=.503), and Social Influence (r=.425). Those who haven't used the technology might focus on efficiency and the cost-effectiveness, both intrinsic factors that could directly impact their farming operations.

VI. RECOMMENDATIONS

It is evident that in Nakhon Si Thammarat province, there is an intention to use drone technology for agriculture, even among some groups who have not yet adopted it. This suggests a growing trend towards increased usage in the future. The early adopters, a group of farmers who have already utilized this technology, will play a significant role in propelling the growth of drones in agriculture. This research could be beneficial for central agencies overseeing the agricultural sector, who might need to prepare for both the advantages and challenges presented by this technology as its adoption expands. While there are undeniable benefits, there might also be subsequent issues to address, such as misunderstandings regarding legal regulations, safety concerns, and environmental implications, all of which have sustainability implications.

This research can be instrumental in informing and benefiting the residents of Nakhon Si Thammarat and those interested in the study. Some areas might share similar contexts, making this research pertinent and applicable to them.

Conflict of interest

There is no conflict to disclose.

REFERENCES

[1]. Abdulla, I.Q., 2014. Synthesis and Bai, A., Kovách, I., Czibere, I., Megyesi, B., & Balogh, P. (2022). Examining the adoption of drones and categorization of precision elements among Hungarian precision farmers using a trans-theoretical model. Drones, 6(8), 200. https://doi.org/10.3390/drones6080200

[2]. Cochran, W. G. (1963). Sampling techniques (2nd ed.). John Wiley and Sons, Inc.

[3]. Fox, G., Mooney, J., Rosati, P., & Lynn, T. (2021). A study of initial adoption and continued use of a mobile digital platform by family-operated farming enterprises. Agriculture, 11(12), 1283. https://doi.org/10.3390/agriculture11121283

[4]. Lee, J.-D., & Heo, C.-M. (2020). The effect of technology acceptance factors on behavioral intention for agricultural drone service by mediating effect of perceived benefits. Journal of Digital Convergence, 18(8), 151-167.

[5]. Michels, M., von Hobe, C. F., Weller von Ahlefeld, P. J., et al. (2021). The adoption of drones in German agriculture: A structural equation model. Precision Agriculture, 22(2), 1728–1748. https://doi.org/10.1007/s11119-021-09809-8

[6]. National Statistical Office. (2018). Survey of employment status of the population. Retrieved from https://www.pier.or.th/abridged/2018/09/

[7]. Office of Agricultural Economics. (2021). Agricultural land use. Retrieved from https://mis-app.oae.go.th/

[8]. Rogers, E. M. (2003). Diffusion of innovations (5th ed.). Free Press.

[9]. Supanantachat, W. (2019). Returns from research and development investments in agriculture by the public and private sectors in Thailand. Kasetsart Journal of Social Sciences, 47(5), 1077-1088.

[10]. UNCTAD. (2021). Forging ahead at the digital frontiers: Catching technological waves innovation with equity. In Technology and Innovation Report 2021 (pp. 16). United Nations Publications.

[11]. Venkatesh, V., Thong, J. Y. L., & Xu, X. (2012). Consumer acceptance and use of information technology: Extending the unified theory of acceptance and use of technology. MIS Quarterly, 36(1), 157-178. https://doi.org/10.2307/41410412antimicrobial activity of Ibuprofen derivatives. Natural Science 6, 47–53.