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PAPER

Dairy Farmers' Intention to Use High-Precision Area-Level Weather Warning Technology in Dairy Farms in Thailand Through an Application on Mobile Phones

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ABSTRACT

Data from information technology has been crucial in advancing the agricultural and livestock industries, especially for Thai dairy farms located in tropical regions where sudden weather changes can occur. This study uses the technology acceptance model (TAM) and the innovation diffusion theory (IDT) to predict the Thai dairy farmers' intention to use a high-precision area-level weather warning technology through a mobile phone application. A questionnaire was collected from dairy farm owners in Thailand's central and northeastern regions, and the data was analyzed using stepwise multiple linear regression. The main factor influencing the acceptance of this technology was its compatibility with existing technology, and it needed to be available on mobile phones for instant access. The role of technology had to provide dairy farmers with information for decision-making, especially during extreme weather conditions, to mitigate potential damage. Training sessions and workshops on the implementation of this technology were necessary, and young farmers could share content on social media to promote its benefits. Service providers should set up call centers to help dairy farmers make decisions. This study identifies factors that can increase farmers' intentions to use digital technology. By addressing these factors, the adoption of technology can improve the efficiency and productivity of dairy farming in Thailand.

KEYWORDS

precision farming, farmer's intention, mobile application, digital technology

1 INTRODUCTION

Information derived from integrating information technology and mobile phone systems plays a vital role in industrial enhancement [1]. In the livestock industry sector, mobile applications are used as management tools for dairy herd management [2] [3]. In addition, information technology can be used to create new strategies, develop

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business plans, lower costs, and improve work efficiency [4–6]. In the livestock sector, information technology also reduces steps and increases capability [7]. However, inefficient management directly affects the efficiency and profitability of the dairy farm [2].

The advancement of technology to support dairy farming includes, for example, dairy farm management systems, dairy cow treatment systems, feeding systems, automatic milking systems, and other IOT systems on dairy farms. Such systems were initially computer software introduced by developers or service providers [2] [8]. According to Rose et al. [9], farmers who used smartphones or computers regularly were more likely to use new software and applications than those without smartphone or computer experience. Moreover, the new generation of farmers tended to make use of these systems for an extended period of time because they were familiar with these technologies and their interfaces. These mobile applications gave farmers instant access to high-precision technologies via smartphones and promoted dairy farmers' decision-making processes using data processing systems with supporting information displayed.

Michels et al. [2] mentioned that high-precision technologies for farm management were well accepted by dairy farmers. It has been proven that these technologies could increase the productivity and efficiency of dairy farms. Some widely used dairy industry technologies are herd management, farm management, and sensor applications. However, in the dairy livestock sector, dairy farms in a tropical environment encountered extremely high heat or humidity leading to heat stroke in dairy cows [10]. As a result, milk production decreased, and farm incomes were low [11–13]. In addition, high humidity increased the number of microorganisms, which was the cause of mastitis or a high microorganism count in raw milk [14]. Farmers typically implemented necessary measures according to different seasonal weather conditions; however, dramatic changes in the weather did not allow enough time for farmers to adjust their plans, resulting in unexpected losses in farm management [15]. As it happened, dairy farms in cold climates, such as Central Europe, the Northern USA, and Canada, also experienced heat stress, which caused an economic loss worth 1.63 to 2.36 billion dollars in the dairy cow industry in the United States [11].

Zhang et al. [16] stated that precision milk production was beneficial to farm management and helpful in decision-making to create economic benefits. Also, the ability to predict the weather and manage the consequences of bad weather was practically useful for farmers. However, farmers in different regions had different methods for weather forecasting [17]. Some learned through their experience, while others used official information from the meteorological department in that country. In the study by Zuma-Netshiukhwi, et al. [17], it was clear that farmers needed to integrate their knowledge with science in order for technologies to work at their full potential. Technology acceptance among farmers also led to the intention to use notification technologies and weather forecasts available on smartphones. This study, therefore, focuses on factors affecting farmers' decisions to use high-precision area-level weather warning technology on dairy farms in Thailand through an application on mobile phones. The data were directly collected from farm owners, who were key decision-makers in farm management, in order to explore factors promoting the acceptance of operating system technology on mobile phones.

2 MATERIAL AND METHODS

2.1 Technology acceptance model

The technology acceptance model (TAM) was developed based on the theory of reasoned action (TRA; Ajzen and Fishbein, 1980) and was extensively developed based on the theory of planned behavior (TPB; Ajzen, 1991). The model was first used by Davis in 1989 to explain how information technology was accepted. It is also widely used to define the acceptance of other technologies. TAM is a model most commonly used to identify influential factors in technology acceptance and adoption. Positive attitudes toward technology lead to the intention to use it, which is an intrinsic factor with respect to perceived usefulness and ease of use. These factors directly affect users' attitudes toward the use of technology. Meanwhile, ease of use directly affects perceived usefulness [18]. Billanes and Enevoldsen [19] mentioned in their literature review on the use of TAM that it was used in various industries, such as information technology, health systems or technologies, mobile payment, internet banking, mobile or internet applications, autonomous vehicles, blockchain, e-learning systems, NFC, and smart glasses.

The TAM was initially used to predict technology acceptance in various aspects. Venkatesh and Davis [20] later developed TAM2, which also included social influence factors and subject norms. It was used as a tool to evaluate cognitive instrumental processes, leading to the intention of use and perceived usefulness, which covered job relevance, output quality, and result demonstrability, as well as perceived ease of use, which encouraged users to use new technologies.

2.2 TAM in agricultural extension studies

The TAM has been extensively used in the agricultural and livestock industries to measure the acceptance of technologies for farm management to boost efficiency and lower costs [21] [22]. It has also been used to explain the acceptance of technologies for dairy livestock [23–26]. This model has been proven to be a well-recognized tool for examining users' acceptance of not only information technology but also other technologies in academic and industrial contexts.

2.3 Innovation diffusion theory

In 2003, Rogers introduced innovation diffusion theory (IDT) to explain technology adoption by various industries. IDT comprises five key innovation characteristics: relative advantage, compatibility, complexity, trialability, and observability [27].

A relative advantage is the degree to which innovation could generate higher user benefits. Compatibility refers to the extent to which the values of innovation, users' past experiences, and needs are consistent. Complexity refers to the degree of difficulty that users experience when trying to understand and use innovation. Trialability is the capacity and frequency with which innovations are effectively tested. Observability refers to the extent to which users can see innovation. These characteristics explain the adoption and decision-making processes of users.

2.4 Integration of innovation diffusion theory and technology acceptance model

Moore and Benbasat [28] pointed out some similarities between the IDT and the TAM. Perceived usefulness and relative advantage were factors that helped explain possible advantages for users, and perceived ease of use and complexity tended to point in the same direction. The operation must be simple, with a few steps. The other three factors of IDT, including compatibility (CPT), trialability (TRI), and observables

(OBS), did not align with any aspects of TAM; therefore, these factors were added to predict farmers' technology acceptance in more aspects.

Billanes and Enevoldsen [19] explained the importance of integrating trust (TT) with TAM. The trust factor impacted perceived usefulness, perceived ease of use, and attitudes toward using technology. Building trust requires facilitating conditions (FC) that technology service providers have to create to make users feel contented and receive services related to the values of technology (Mohammad et al., 2017). In the study on factors affecting farmers' decision-making in distant areas by Verma and Sinha [29], social influence (SI) was one of the key factors used to explain technology acceptance more adequately.

2.5 IDT and TAM in agricultural extension studies

Many studies have used IDT and TAM as the research framework to predict technology acceptance in the agricultural and livestock industries. The main objective of these studies was to identify factors or causes affecting users' acceptance of technologies for farming and livestock products and services, which could be used to develop policies or strategies to increase productivity [30–32].

2.6 Questionnaire

In this study, we integrated the IDT and TAM to study the factors affecting dairy farmers' intentions to use high-precision area-level weather warning technology on dairy farms in Thailand through an application on mobile phones (Figure 1). The primary source of data was used in this study, and a questionnaire was developed for data collection. The first part of the questionnaire was general information about the respondents (6 items). The second part concerns the importance of using high-precision area-level weather warning technology on Thai dairy farms through a mobile phone application (27 items), as shown in Table 1. The questionnaire was distributed to 500 farms in Saraburi and Nakhon Ratchasima, where the highest number of dairy cows were raised in Thailand, as illustrated in Figure 2. Finally, 461 questionnaires were completed and returned.

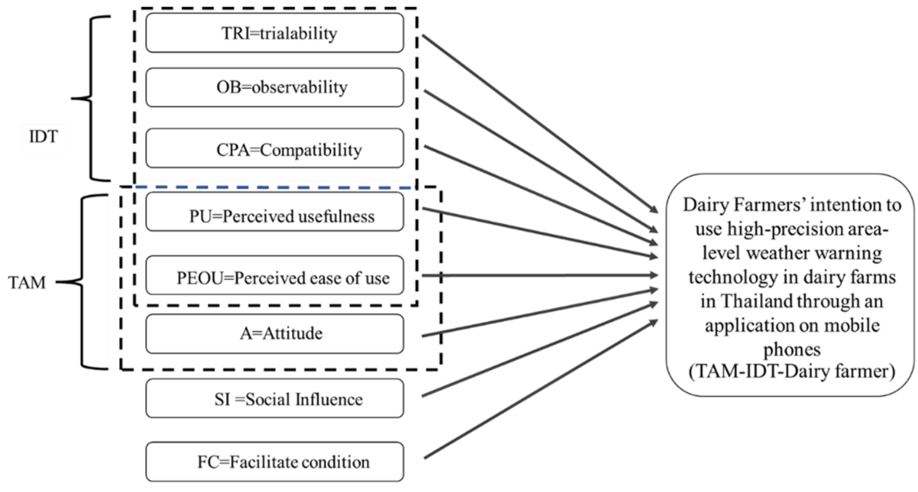

Fig. 1. The use of an integrated research model to predict farmers' intentions to use high-precision area-level weather warning technology in dairy farms in Thailand by using an application on mobile phones

Rank	Province	Dairy Farms	
		No.	Frequency
1	Saraburi	2,655	16.34
2	Nakorn Ratchasima	2,381	14.65
3	Ratchaburi	2,175	13.39
4	Lopburi	1,512	9.31
5	Changmai	1,070	6.59

Fig. 2. Saraburi province and Nakorn-Rachasrima province from where the dairy farmers took part in this study

Table 1. Questionaire used for the study

Item	Statement (Degree of Intention to Use)
PU1	High-precision area-level weather warning technology for mobile operating systems helps reduce and mitigate damage caused by heat stroke and high levels of microorganisms to enhance the quality of cow milk.
PU2	HPWW provides warnings and suggestions that help maintain the price of raw milk during sudden changes in weather conditions.
PU3	HPWW enables farmers to manage dairy farms through a smartphone application more efficiently than using the SW system on computers.
PEOU1	HPWW should have a friendly user interface that makes it easy for farmers to understand.
PEOU2	HPWW should have simple operating steps.
PEOU3	HPWW can provide weather warnings and practical suggestions that are easy to understand.
A1	You want HPWW to help elevate the dairy industry in Thailand.
A2	You want to use HPWW to reduce and mitigate damage caused by sudden changes in weather conditions, resulting in reduced costs in dairy farms.
A3	You want to use HPWW for continuous follow-up and more convenient access to information compared with computer software.
BI1*	You think that you will use HPWW to avoid problems caused by sudden changes in weather conditions, and there will be a system that sends out pre-warning messages to an application on mobile phones in your farms.
BI2*	You think that you will use HPWW to create collaboration among workers in your dairy farms as they are informed of the situations and can take action immediately after receiving the warnings.
BI3*	You think that you will use HPWW on your mobile phone to lighten the workload and allow more time for your personal life.
Comp1	You want to use HPWW because it enables you to receive the warnings and adapt the suggestions according to your farms' usual practices.
Comp2	You want HPWW to be compatible with your farms' SW or current operating systems.
Comp3	You think that using HPWW on your mobile phone fits your working style better than computer software.

(Continued)

Table 1. Questionaire used for the study *(Continued)*

Item	Statement (Degree of Intention to Use)
TRA1	You think that you want to try out HPWW to determine the efficiency of the warning system and the ability to reduce health problems in dairy cows, such as heat stroke and mastitis.
TRA2	You think that HPWW trials will help you to better decide on investing in this technology.
TRA3	You think that you want to try out HPWW to compare it with the existing system accessed through computers and to perceive its usefulness, leading to actual usage.
OBV1	You want to observe significant changes in farm management and production when using HPWW.
OBV2	You want to see a significant decrease in the number of problems caused by sudden changes in weather conditions when using HPWW on your mobile phone compared with computer software.
OBV3	You want to see your workers use HPWW on your farms and can work on mobile phones.
SI1	Farmers in the nearby areas who have used HPWW have increased your interest in using the same technology.
SI2	Farmers who use social media platforms to promote the use of technology have an influence on your decision to use HPWW.
SI3	Successful young, smart farmers who have used HPWW have increased your interest in using the same technology.
FC1	Full support from related organizations, such as DEPA and the Thai Meteorological Department, and related service providers, such as technology developers and government agencies, by providing information about HPWW for dairy farms has an influence on your decision to use HPWW.
FC2	You want service providers to set up call centers for farmers to consult about the warning system and suggestions when using HPWW.
FC3	You think that it is helpful to have HPWW service providers' experts introduce all features and provide clear instructions through a mobile phone application.

Note: * = Dependent variable.

3 METHODOLOGY

3.1 Study areas

The areas of this study included two provinces, Saraburi and Nakhon Ratchasima, located in the central and northeastern regions of Thailand. From the total number of 509,524 milk cows in Thailand, farmers in these two provinces raised the highest number of dairy cows, 18% and 15%, respectively. Dairy farmers received support from both the government and private sectors in terms of equipment, medicine, and vaccines.

3.2 Sample

This research population was made up of dairy farmers in Saraburi, and the samples in this study were dairy farm owners. The developed questionnaire was distributed at the local MCC's monthly meeting. The data collection was monitored by local veterinarians, animal husbandry, and researchers who had provided continuous support in the area. This group of people regularly communicated with farmers and shared information about new technologies and their potential benefits. In this study, they presented the operation of a weather pre-warning mobile application using graphs, illustrations, and flowcharts in order for farm owners to respond to the questionnaire.

3.3 Data analysis

The collected data were organized and analyzed using the Statistical Package for the Social Sciences (SPSS version 22). Multiple linear regression was used to predict the quantitative dependent variables for the IDT and TAM factors. The scores for the intention to use the proposed technology were the dependent variable; the intention to use was determined by the respondents using a 5-point rating scale, ranging from strongly disagree (1) to strongly agree (5). Multiple linear regression was then used to analyze the intention to use, while stepwise regression was used for forward selection and backward elimination.

4 RESULTS

4.1 Descriptive statistics

As illustrated in Table 2, the respondents were 461 farm owners in Saraburi and Nakhon Ratchasima, 63% of whom were male. Considering their educational background, 28% of respondents received a college diploma or a vocational certificate, while 26% of them graduated from a high school, 23% of them finished a junior high school, 20% of them had a bachelor's degree, and the rest (3%) had other educational backgrounds. Regarding age groups, 9.6% of respondents were under 30 years old, 28.2% were 31–40 years old, 42% were 41–50 years old, and 20.0% were 51 years and older.

The majority of the respondents (69%) experienced sudden severe weather conditions and were unable to deal with them appropriately. All respondents were dairy farm owners with at least three years of experience.

Table 2. The demographic profile of the respondents and general information about their farms

Variables	Categories	Frequency	Percent
Gender	Male	300	62.89%
	Female	177	37.11%
Education	Elementary School	133	27.88%
	High school	129	27.04%
	Diploma	116	24.32%
	Bachelor's Degree	93	19.50%
	other	6	1.26%
Encountered bacteria problem in raw milk	Yes	317	66.46%
	No	160	33.54%
	Mean (Min-Max)	**Median**	**SD**
Age of responder (year)	43.5 (18–69)	44	8.51
Experienced in dairy farming (year)	9.5	10	5.53
Number of milking cows	15 (2–80)	14	7.70
Number of dry cows	5.6 (0–18)	5	4.13
Revenue from raw milk (ThaiBaht per month)	89.704 (7.300–350.000)	77.254	56.923

Note: n = 461.

4.2 Reliability testing

The questionnaire was validated regarding discrimination and reliability using item-total correlation and Cronbach's alpha. The reliability results were based on the intention to use technology for dairy farm management. The questionnaire was tested with a group of 30 samples, and Cronbach's alpha was 0.811. It was found that Cronbach's alpha was higher than 0.60, meaning that the questionnaire was reliable and could be used for data collection.

4.3 Inferential statistics analysis: TAM/IDT integration model

Stepwise multiple linear regression was used to identify the intention to use HPWW technology. Each dependent variable was rated on five levels, including; 1. Strongly disagree–extremely low level, 2. Disagree–low level, 3. Neutral–moderate level, 4. Agree–high level, and 5. Strongly agree–extremely high level.

Table 3. The relationships between dependent and independent variables

	Comp	A	PU	FA	SI	PEOU	BI
Comp		.505**	.441**	.407**	.304**	.257**	.617**
A			.571**	.417**	.272**	.366**	.545**
PU				.357**	.214**	.295**	.517**
FA					.331**	.261**	.465**
SI						.115**	.348**
PEOU							.180**
BI							

From Table 3, the relationships between dependent and independent variables can be explained as follows:

1. Compatibility of new technology with the existing ones had a positive correlation with attitude at a moderate level (r = 0.505), perceived usefulness at a moderate level (r = 0.441), facilitating condition at a moderate level (r = 0.407), social influence at a low level (r = 0.304), and perceived ease of use at a low level (r = 0.257), with the statistical significance at the .05 level.
2. Attitude had a direct correlation with perceived usefulness at a moderate level (r = 0.571), facilitating condition at a moderate level (r = 0.417), social influence at a low level (r = 0.272), and perceived ease of use at a low level (r = 0.366), with the statistical significance at the .05 level.
3. Perceived usefulness was positively correlated with facilitating condition at a low level (r = 0.357), social influence at a low level (r = 0.214), and perceived ease of use at a low level (r = 0.295), with the statistical significance at the .05 level.
4. Facilitating condition was directly correlated with social influence at a low level (r = 0.331), and perceived ease of use at a low level (r = 0.261), with the statistical significance at the .05 level.
5. Social influence positively correlated with perceived ease of use at a low level (r = 0.115), with the statistical significance at the .05 level.

Table 4. Stepwise multiple linear regression

Coefficients[a]						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
G	(Constant)	–.054	.184		–.292	.771
	comp	.389	.041	.363	9.371	.000
	A	.215	.045	.203	4.779	.000
	PU	.214	.043	.197	5.004	.000
	FA	.170	.041	.154	4.179	.000
	SI	.071	.023	.105	3.115	.002
	PEOU	–.072	.024	–.098	–2.944	.003
R = .744, R Square = .544, Adjusted R Square = .548, S.E. = .454, F = 8.666, Sig. = .000**						

Notes: a. Dependent Variable: Intention; b. Predictors in the Model: (Constant), comp; c. Predictors in the Model: (Constant), comp, A; d. Predictors in the Model: (Constant), comp, A, PU; e. Predictors in the Model: (Constant), comp, A, PU, FA; f. Predictors in the Model: (Constant), comp, A, PU, FA, SIg. Predictors in the Model: (Constant), comp, A, PU, FA, SI, PEOU.

As shown in Table 4, the variables that correlated with behavior intention with statistical significance at the .05 level were compatibility (COMP), attitude (A), perceived usefulness (PU), facilitating condition (FA), social influence (SI), and perceived ease of use (PEOU). This information could be used to write the following equations for predicting behavior and intention:

Raw score equation:

$$Y_{BI} = -0.054 + 0.389\,(X_{com}) + 0.215\,(X_{A}) + 0.214\,(X_{PU}) + 0.170\,(X_{FA}) + 0.071\,(X_{SI}) + (-0.072)\,(X_{PEOU}) \quad (1)$$

Standard score equation:

$$Z_{BI} = 0.335\,(X_{com}) + 0.161\,(X_{A}) + 0.160\,(X_{PU}) + 0.116\,(X_{FA}) + 0.017\,(X_{SI}) + (-0.126)\,(X_{PEOU}) \quad (2)$$

From these equations, the explanations are as follows:

1. If the compatibility variable is increased by 1 unit while other variables are constant, the intention to use is increased by 0.389 raw score units and 0.335 standard score units.
2. If the attitude variable is increased by 1 unit while other variables are constant, the intention to use is increased by 0.215 raw score units and 0.161 standard score units.
3. If the perceived ease of use variable is increased by 1 unit while other variables are constant, the intention to use is increased by 0.214 raw score units and 0.160 standard score units.
4. If the facilitating condition variable is increased by 1 unit while other variables are constant, the intention to use is increased by 0.170 raw score units and 0.116 standard score units.

5. If the social influence variable is increased by 1 unit while other variables are constant, the intention to use is increased by 0.071 raw score units and 0.0017 standard score units.

Considering the standardized beta coefficient values, the COMP was the highest-scoring variable with a beta value of 0.389. A was the second highest-scoring variable with a beta value of 0.215, while PU had a beta value of 0.214, FC had a beta value of 0.170, and (SI had a beta value of 0.071. These variables were directly correlated with the intention to use with the statistical significance at the .05 level.

5 DISCUSSION

The findings showed that the complexity, trialability, and observability of this high-precision area-level weather warning (HPWW) technology were not critical factors affecting Thai farmers' intention to use this technology. Technology developers usually attempted to make new technology easy for farmers to operate and offered demonstrations or trials to gain acceptance. However, this study revealed that crucial factors affecting dairy farmers' intention to use the technology were its compatibility with existing technology in dairy farms and HPWW technology itself. This is because dairy farmers have already started to use software for farm management to record farm activities, such as nutrition and diet, incomes, and expenses. Incorporating HPWW technology as part of the farming system, farmers wished that it came in the form of a mobile application that could be used with the SW system that they already had [31]. It is also essential to prevent redundancy in operating various programs for farm management, and farmers prefer mobile applications to computer software or websites due to convenience. Most farmers always carry a mobile phone; therefore, whenever a warning is sent, the data generated from HPWW technology can be used to deal with sudden high heat or humidity from heavy rain. A pre-warning message might help them mitigate damage that may possibly be caused by immediate changes in weather conditions. Technology developers, therefore, need to pay attention to the compatibility of the new technology with the operating systems farmers initially had.

The user interface designs and user experience on the mobile application are also significant [33]. They inform farmers of the warnings and provide practical suggestions that farmers can adopt to minimize the losses. Farmers are familiar with using mobile phones to check product prices and other farm-related information [34]. However, if it is not a pre-warning sent to a mobile phone, farmers might not be interested in this technology [35].

Attitude, perceived usefulness, facilitating conditions, and SI are directly correlated with using HPWW technology on mobile devices. This technology helps with farmers' perception, decision-making, and damage control regarding the severe weather conditions that most dairy farms have experienced. As Thailand has a tropical climate, properly dealing with sudden high heat helps reduce heat stroke in dairy cows, leading to better health and increased raw milk production. This is because heat stroke causes stress and poor appetite in dairy cows. As a result, the cows produce less milk while still requiring healthy food daily, leading to financial losses. When storms strike or high humidity hits, it causes the number of microorganisms in raw milk to increase, and the prices will be cut based on the government's purchase price criteria. A high level of microorganisms in dairy farms could result in mastitis, and the infected farms must pause their deliveries and lose their income for several weeks. A pre-warning and some suggestions sent to farmers' mobile phones would create a positive attitude toward the technology and boost the intention to use it [3].

Regarding perceived usefulness, warnings and suggestions must be sent to farmers in advance so they have enough time to choose practices appropriate to their environment to mitigate possible damage. This is in line with the study by Bewley [36], which found that the perceived usefulness of technology derives from highly accurate information that is necessary for maximizing the efficiency of existing dairy farm management systems. A sufficiently high precision of information can lessen or mitigate possible damage and decrease operating costs for solving severe weather-related problems. This is important because cost reduction is one of the key factors affecting the intention to use new technologies in dairy agribusiness.

Concerning the facilitating conditions of HPWW technology, service providers or government agencies should organize workshops where farmers learn how to use the technology on their smartphones [3]. Simulations can also help farmers stay calm and take appropriate action when they receive a warning message. This would help increase their intention to use HPWW technology on their mobile phones. In addition, there should be call centers or line chat sessions where farmers can consult experts in their time of need. With this type of support, the intention to use the mobile application in dairy farm management could be improved [3] [29]. Regarding maintenance centers, farm weather observing systems must be monitored and upgraded to achieve more accurate data generation. This directly affects farmers' acceptance of this mobile technology [32].

Finally, SI also impacts the acceptance of technology regarding innovation diffusion. For example, Young Smart Farmers is a new generation of farmers who initially implement technologies in their farm management and achieve impressive results. These young farmers are skilled in using social media to advertise their farms and sell high-quality raw milk. They also share their dairy farm management techniques on social media, enabling the technologies to cross the chasm [27]. These farmers are considered early adopters who communicate with and pass on important information to the other two main groups of users, the early majority and the late majority. Having these farmers organize and promote farm management activities through online channels could help influence people in the community to accept information technology on a mobile operating system [37].

6 CONCLUSION AND LIMITATION

However, in Thailand, there has never been HPWW technology on an SW system or a mobile application. Only weather forecasts announced by the Meteorological Department are available. Hourly forecasts are updated only one day before on the website, which farmers must access daily to predict possible weather conditions in their farms' areas. In short, HPWW technology has not been used in Thailand before. This study explores the factors affecting the intention to use HPWW technology at its fullest potential when integrated into industries by service providers and government agencies. In the future, there should be studies on the outcomes of the implementation of HPWW technology to explore related factors before and after use. The findings could be used to formulate policies to improve dairy farmers' digital technology skills that will enable them to use other advanced technologies. The scope of the study can also be expanded by investigating specific factors that support their use of technology on mobile devices in different regions of Thailand.

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8 REFERENCES

[1] G. Fox, J. Mooney, P. Rosati, and T. Lynn, "AgriTech innovators: A study of initial adoption and continued use of a mobile digital platform by family-operated farming enterprises," *Agriculture*, vol. 11, no. 12, p. 1283, 2021. https://doi.org/10.3390/agriculture11121283

[2] M. Michels, V. Bonke, and O. Musshoff, "Understanding the adoption of smartphone apps in dairy herd management," *Journal of Dairy Science,* vol. 102, no. 10, pp. 9422–9434, 2019. https://doi.org/10.3168/jds.2019-16489

[3] D. Barrios, M. Olivera-Angel, and L.G. Palacio, "Factors associated with the adoption of mobile applications (Apps) for the management of dairy herds," *Revista de Economia e Sociologia Rural,* vol. 61, no. 4, p. e264382, 2023. https://doi.org/10.1590/1806-9479.2022.264382

[4] L.E. Vargas-Ortiz, V.V. Villalba-Vimos, C.A. Severiche-Sierra, E.A. Bedoya-Marrugo, A.F. Castro-Alfaro, and H.E. Cohenpadilla, "TICs y gestión de la innovación en MiPyMEs: un análisis con experimentos factoriales para las utilidades," *Revista Espacios,* vol. 40, no. 13, p. 24, 2019.

[5] E.L.D.G.S. Silva, C.M.M. Oliveira, A.B. Mendes, and H.M.G.F.O. Guerra, "Technology and Innovation in Agriculture: The Azores Case Study," *International Journal of Interactive Mobile Technologies (iJIM),* vol. 11, no. 5, 2017. https://doi.org/10.3991/ijim.v11i5.7070

[6] M. Sobhana, V.R. Sindhuja, V. Tejaswi, and P. Durgesh, P., "Deep ensemble mobile application for recommendation of fertilizer based on nutrient deficiency in rice plants using transfer learning models," *International Journal of Interactive Mobile Technologies (iJIM),* vol. 16, no. 16, pp. 100–112, 2022. https://doi.org/10.3991/ijim.v16i16.31497

[7] C. Tse, H.W. Barkema, T.J. DeVries, J. Rushen, E. Vasseur, and E.A. Pajor, "Producer experience with transitioning to automatic milking: Cow training, challenges, and effect on quality of life," *Journal of Dairy Science,* vol. 101, no. 10, pp. 9599–9607, 2018. https://doi.org/10.3168/jds.2018-14662

[8] O. Debauche, S. Mahmoudi, A.L.H. Andriamandroso, P. Manneback, J. Bindelle, and F. Lebeau, "Cloud services integration for farm animals' behavior studies based on smartphones as activity sensors," *Journal of Ambient Intelligence and Humanized Computing,* vol. 10, no. 12, pp. 4651–4662, 2019. https://doi.org/10.1007/s12652-018-0845-9

[9] D.C. Rose, *et al.*, "Decision support tools for agriculture: Towards effective design and delivery," *Agricultural Systems,* vol. 149, pp. 165–174, 2016. https://doi.org/10.1016/j.agsy.2016.09.009

[10] J.W. West, "Effects of heat-stress on production in dairy cattle," *Journal of Dairy Science,* vol. 86, no. 6, pp. 2131–2144, 2003. https://doi.org/10.3168/jds.S0022-0302(03)73803-X

[11] L. Polsky and M.A.G. von Keyserlingk, "Invited review: Effects of heat stress on dairy cattle welfare," *Journal of Dairy Science,* vol. 100, no. 11, pp. 8645–8657, 2017. https://doi.org/10.3168/jds.2017-12651

[12] D.L. Hill and E. Wall, "Dairy cattle in a temperate climate: The effects of weather on milk yield and composition depend on management," *Animal,* vol. 9, no. 1, pp. 138–149, 2015. https://doi.org/10.1017/S1751731114002456

[13] S. Gupta, A. Sharma, A. Joy, F.R. Dunshea, and S.S. Chauhan, "The impact of heat stress on immune status of dairy cattle and strategies to ameliorate the negative effects," *Animals*, vol. 13, no. 1, p. 107, 2023. https://doi.org/10.3390/ani13010107

[14] Z. Zhang, *et al.*, "Influences of season, parity, lactation, udder area, milk yield, and clinical symptoms on intramammary infection in dairy cows," *Journal of Dairy Science,* vol. 99, no. 8, pp. 6484–6493, 2016. https://doi.org/10.3168/jds.2016-10932

[15] A. Nardone, B. Ronchi, N. Lacetera, M.S. Ranieri, and U. Bernabucci, "Effects of climate changes on animal production and sustainability of livestock systems," *Livestock Science,* vol. 130, no. 1, pp. 57–69, 2010. https://doi.org/10.1016/j.livsci.2010.02.011

[16] F. Zhang, J. Upton, L. Shalloo, P. Shine, and M.D. Murphy, "Effect of introducing weather parameters on the accuracy of milk production forecast models," *Information Processing in Agriculture,* vol. 7, no. 1, pp. 120–138, 2020. https://doi.org/10.1016/j.inpa.2019.04.004

[17] G. Zuma-Netshiukhwi, K. Stigter, and S. Walker, "Use of traditional weather/Climate knowledge by farmers in the south-western free state of South Africa: Agrometeorological learning by scientists," *Atmosphere*, vol. 4, no. 4, pp. 383–410, 2013. https://doi.org/10.3390/atmos4040383

[18] F.D. Davis, R.P. Bagozzi, and P.R. Warshaw, "Extrinsic and intrinsic motivation to use computers in the workplace1," *Journal of Applied Social Psychology,* vol. 22, no. 14, pp. 1111–1132, 1992. https://doi.org/10.1111/j.1559-1816.1992.tb00945.x

[19] J. Billanes and P. Enevoldsen, "A critical analysis of ten influential factors to energy technology acceptance and adoption," *Energy Reports,* vol. 7, pp. 6899–6907, 2021. https://doi.org/10.1016/j.egyr.2021.09.118

[20] V. Venkatesh and F.D. Davis, "A theoretical extension of the technology acceptance model: Four longitudinal field studies," *Management Science,* vol. 46, no. 2, pp. 186–204, 2000. https://doi.org/10.1287/mnsc.46.2.186.11926

[21] F. Caffaro, M. Micheletti Cremasco, M. Roccato, and E. Cavallo, "Drivers of farmers' intention to adopt technological innovations in Italy: The role of information sources, perceived usefulness, and perceived ease of use," *Journal of Rural Studies,* vol. 76, pp. 264–271, 2020. https://doi.org/10.1016/j.jrurstud.2020.04.028

[22] N. Adnan, S.M. Nordin, and Z. bin Abu Bakar, "Understanding and facilitating sustainable agricultural practice: A comprehensive analysis of adoption behaviour among Malaysian paddy farmers," *Land Use Policy,* vol. 68, pp. 372–382, 2017. https://doi.org/10.1016/j.landusepol.2017.07.046

[23] S. Tohidyan Far and K. Rezaei-Moghaddam, "Determinants of Iranian agricultural consultantsâ intentions toward precision agriculture: Integrating innovativeness to the technology acceptance model," *Journal of the Saudi Society of Agricultural Sciences,* 2015.

[24] S. Naspetti, *et al.*, "Determinants of the acceptance of sustainable production strategies among dairy farmers: Development and testing of a modified technology acceptance model," *Sustainability*, vol. 9, no. 10, p. 1805, 2017. https://doi.org/10.3390/su9101805

[25] R.L. Schewe and D. Stuart, "Diversity in agricultural technology adoption: How are automatic milking systems used and to what end?," *Agriculture and Human Values,* vol. 32, no. 2, pp. 199–213, 2015. https://doi.org/10.1007/s10460-014-9542-2

[26] G.L. Flett, A. Greene, and P.L. Hewitt, "Dimensions of perfectionism and anxiety sensitivity," *Journal of Rational-Emotive and Cognitive-Behavior Therapy,* vol. 22, no. 1, pp. 39–57, 2004. https://doi.org/10.1023/B:JORE.0000011576.18538.8e

[27] E.M. Rogers, "Diffusion of innovations," 5th edition ed. New York: Free Press, p. 551, 2003.

[28] G.C. Moore and I. Benbasat, "Development of an instrument to measure the perceptions of adopting an information technology innovation," *Information Systems Research,* vol. 2, no. 3, pp. 192–222, 1991. https://doi.org/10.1287/isre.2.3.192

[29] P. Verma and N. Sinha, "Integrating perceived economic wellbeing to technology acceptance model: The case of mobile based agricultural extension service," *Technological Forecasting and Social Change,* vol. 126, pp. 207–216, 2018. https://doi.org/10.1016/j.techfore.2017.08.013

[30] L. Yi-Hsuan, H. Yi-Chuan, and H. Chia-Ning, "Adding innovation diffusion theory to the technology acceptance model: Supporting employees' intentions to use E-learning systems," *Journal of Educational Technology & Society,* vol. 14, no. 4, pp. 124–137, 2011.
[31] F.-C. Tung, S.-C. Chang, and C.-M. Chou, "An extension of trust and TAM model with IDT in the adoption of the electronic logistics information system in HIS in the medical industry," *International Journal of Medical Informatics,* vol. 77, no. 5, pp. 324–335, 2008. https://doi.org/10.1016/j.ijmedinf.2007.06.006
[32] M.S. Sharifzadeh, C.A. Damalas, and G. Abdollahzadeh, "RETRACTED: Perceived usefulness of personal protective equipment in pesticide use predicts farmers' willingness to use it," *Science of The Total Environment,* vol. 609, pp. 517–523, 2017. https://doi.org/10.1016/j.scitotenv.2017.07.125
[33] M. Rojas-Osorio and A. Alvarez-Risco, "Intention to use smartphones among Peruvian university students," *International Journal of Interactive Mobile Technologies (iJIM),* vol. 13, no. 3, 2019. https://doi.org/10.3991/ijim.v13i03.9356
[34] E. Beza, J.V. Silva, L. Kooistra, and P. Reidsma, "Review of yield gap explaining factors and opportunities for alternative data collection approaches," *European Journal of Agronomy,* vol. 82, pp. 206–222, 2017. https://doi.org/10.1016/j.eja.2016.06.016
[35] E. Beza, P. Reidsma, P.M. Poortvliet, M.M. Belay, B.S. Bijen, and L. Kooistra, "Exploring farmers' intentions to adopt mobile Short Message Service (SMS) for citizen science in agriculture," *Computers and Electronics in Agriculture,* vol. 151, pp. 295–310, 2018. https://doi.org/10.1016/j.compag.2018.06.015
[36] J. Bewley, "Precision dairy farming: Advanced analysis solutions for future profitability," in *The First North American Conference on Precision Dairy Management*, vol. 16, 2010.
[37] J.D.D. García-Villegas, *et al.*, "Use of information and communication technologies in small-scale dairy production systems in central Mexico," *Experimental Agriculture,* vol. 56, no. 5, pp. 767–779, 2020. https://doi.org/10.1017/S0014479720000319

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