Technology Readiness for Internet of Things (IoT) Adoption in Smart Farming in Thailand

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Abstract **- Smart farming, an Internet of Things (IoT) application that uses a combination of sensor networks and artificial intelligence (AI) techniques to optimize growing conditions, is a developing technology that shows promise for farming in Thailand to improve yield and optimize resource use. However, smart farming technology cannot be effective if technological readiness conditions are not in place for its deployment or if farmers do not adopt the technology. This research investigates technology readiness for IoT adoption in smart farming using a survey of Thai firms (n = 395). An extended technology acceptance model (TAM) was deployed for investigation. The study showed that IoT readiness, perceived usefulness (PU), e-learning and institutional support influenced adoption intentions. The implication of this research is that while Thai farmers are not yet ready to adopt smart farming, e-learning and institutional support could be used to prepare farmers for IoT-based smart farming adoption. This study is the first readiness study for smart farming adoption, contributing to the literature on smart farming which is to date mainly technical implementation research.**

Keywords - Internet of Things; smart farming; technology readiness

I. INTRODUCTION

This research is concerned with the technological readiness of farms in Thailand for smart farming. Smart farming uses a combination of environmental sensor networks and artificial intelligence-based analysis to evaluate conditions such as light levels, soil quality, humidity and precipitation, and temperature in real time [1]. While smart farming data is currently used to support human intervention, there are increasingly tools available that can use inputs from sensor networks to automatically regulate the environment; for example, moisture sensors can be used to automatically adjust irrigation levels [2]. Thus, smart farming can be used to both avoid wasted resources or lost crops due to human error in provision of water and nutrients or use of crop chemicals and to cope with rapidly changing growing conditions [2].

Smart farming is likely to be particularly relevant in Thailand in future. Today, Thailand's agricultural sector accounts for about 8.5% of the total GDP, with key agricultural products including rice, rubber, corn, sugarcane, coconut, palm oil, and livestock and fisheries [3]. Despite the importance of this sector, especially for rural employment, it faces several key challenges including labor shortages and the high vulnerability of Thailand to climate change [4]. These conditions in Thailand's agricultural industry demand solutions like smart farming, which help maximize yields under uncertain conditions.

Despite the clear importance of smart farming in Thailand, the state of Thai farms to implement it is uncertain, largely because of technological readiness. The Internet of Things (IoT) is a fundamental requirement for smart farming's combination of sensor networks and processing and control units to work effectively. IoT networks combine sensors and processors via low-power signals such as Wi-Fi or NFC to collect and analyze data and make command and control decisions [5]. The IoT is used in smart farming not just for communication and control of automated or semi-automated growing equipment, but also for coordination of harvests and sales and avoidance of waste [6]. The field of agriculture is no stranger to the adoption of new technologies, from the Green Revolution to the use of mobile phones for knowledge transfer and market information [7] [8]. What remains to be seen is whether farmers are prepared for IoT and smart farming and, if not, which actions can be taken to facilitate readiness. To date, there has been little research that could be identified that addresses farmer technology readiness for IoT, as most of the studies such as those discussed above have focused on technical implementation of smart farming.

The aim of this research was to evaluate technology readiness for IoT to facilitate smart farm implementation in Thailand. Objectives included investigating the current implementation of smart farming and evaluating technological readiness for IoT-based smart farming, leading to recommendations for implementing IoT. The research begins with a literature review of key theories and concepts including the technology acceptance model (TAM), elearning, IoT readiness and trust and institutional support. The methodology is explained. This is followed by the presentation and discussion of the study results and the conclusion.

II. LITERATURE REVIEW

The literature on smart farming is primarily at the implementation level [1][2][6] and as a result there is little information on adoption readiness. However, there is existing knowledge and models on technology adoption, including the technology acceptance model (TAM), elearning, organizational factors, and trust and institutional support, which are known to influence information technology adoption generally and which could be applied here.

A. Technology Acceptance Model (TAM)

This research is based on the technology acceptance model (TAM). The TAM is one of the most frequently used model of technology use, and serves as the basis for other models such as the UTAUT model [9]. The TAM is intended to predict actual System use (S) through Behavioral Intention (BI), which in turn is predicted by Perceived Usefulness (PU) and Perceived Ease of Use (PEU) [9] [10] [11]. Additionally, there is an internal relationship between PEU and PU [9]. Although there are some known problems such as inconsistent effects of the PEU construct, meta-analyses have shown that the TAM is generally reliable for predicting technology adoption [12] [13]. Previous studies have also validated the use of the TAM for explaining agricultural contexts [14] [15] [16] [17] Thus, the first three hypotheses of the study are expressed as follows:

- Hypothesis 1: PU of IoT influences BI to adopt IoT.
- Hypothesis 2: PEU of IoT influences BI to adopt IoT.
- Hypothesis 3: PEU of IoT influences PU of IoT.

B. Elearning

Reference [16], who investigated the adoption of precision farming, provided a key insight into technology adoption – farmers required education to understand what the technology was and how it could be useful to them. This finding was confirmed in a study on agricultural technology in Thailand [17]. One of the ways such technology training is commonly provided in Thailand is through e-learning, or the use of ICTs for knowledge transfer [18]. As in many other countries [7] [19], e-learning is used in government and private agricultural extension programs to reach farmers and provide information about new technologies and farming practices. E-learning does have some barriers to use, including age and existing technology skills, which can make it less accessible to some people [20]. Thus, it is not a perfect solution for providing knowledge about new technologies. While e-learning has been proposed as a training tool for IoT implementation [21], in practice there is very little research about training users for IoT generally, including the effectiveness of IoT [22]. Thus, this study had the opportunity to investigate the effect of e-learning for IoT implementation. The hypotheses proposed for this study include:

- Hypothesis 4a: E-learning participation positively influences PU of IoT.
- Hypothesis 4b: E-learning participation positively influences PEU of IoT.

C. Organizational Factors in IoT Readiness

There were several organizational factors that could affect technology readiness for IoT implementation (IoT readiness).

IT Readiness is the availability of sufficient resources and organizational knowledge to implement IoT systems effectively [23] [24] [25]. IT readiness includes availability of external resources such as high-speed fixed or mobile Internet and electrical grid capacity [26]. It also includes general IT systems (such as internal networks) and specific IT systems required to support the system [27].

Another factor is Business Process (BP) readiness, which is the extent to which organizational processes are aligned to the organization’s implementation challenges and can be changed to meet new system needs [28]. While IOT can often streamline business processes, the organization needs to have change capability and willingness to allow for this change [29].

Organizational Culture (OC) readiness is the extent to which the organizational culture is prepared for change and technology implementation [30]. OC readiness also reflects organizational priorities, such as investment in IT readiness [31] and preparedness for challenges of IoT such as new security challenges and work practices [32].

Human Resources (HR) readiness is the extent to which the organization has, or can acquire, the needed skills, knowledge and manpower to implement the technology [33]. Technical skills are the primary requirement here, since IoT implementation requires highly specialized technical skills [27] [33]. However, general skills in the organization are also required, since the whole organization will need to use the system [34].

Decision-Maker (DM) readiness, including optimism, innovation, discomfort, and security, are aspects of the main decision-maker attitude toward implementation of new technology [35]. This aspect is particularly important in this study because most farms in Thailand are small firms under control of individual decision-makers [36].

Following this research, factors in IoT readiness are proposed as follows:

- Hypothesis 5a: Information technology (IT) readiness influences IoT readiness.
- Hypothesis 5b: Business process (BP) readiness influences IoT readiness.

- Hypothesis 5c: Organizational culture (OC) readiness influences IoT readiness.
- Hypothesis 5d: Human Resources (HR) readiness influences IoT readiness.
- Hypothesis 5e: Decision-maker (DM) readiness influences IoT readiness.

D. IoT Readiness and Behavioral Intention

This research also argues that IoT readiness affects behavioral intention (BI) of IoT adoption. This finding is based in previous studies, which have routinely shown that technology readiness is a factor in technology adoption, although there is little evidence from IoT adoption [22] [37] [38]. Following this research and integrating IoT readiness into the TAM, the next three hypotheses of the framework state:

- Hypothesis 6a: IoT readiness positively influences PU of IoT.
- Hypothesis 6b: IoT readiness positively influences PEU of IoT.
- Hypothesis 7: IoT readiness positively influences BI for IoT adoption.

E. Trust and Institutional Support

Finally, there are two external factors that are considered here, including trust and institutional support.

Trust is critical for IoT adoption because IoT systems have a lot of complexity and are often poorly designed, leading to security risks (whether real or perceived) [39]. However, relatively little knowledge is available about trust in IoT systems [40]. Thus, this research contributes to understanding about the role of trust in IoT implementation. The hypothesis used in this study is as follows:

- Hypothesis 8: Trust in IOT positively influences BI for IoT adoption.

Finally, this research investigates the effect of institutional support. This is a context-specific factor, which was considered because Thai agriculture depends heavily on external institutional support from government agencies, non-governmental organizations (NGOs), universities, and cooperatives [41]. Previous research has already shown that climate-smart farms in Thailand are heavily dependent on this external institutional support for [42]. A study from Viet Nam, focusing on smart forestry, also supported the importance of external support, as without this support the technology implementation was less successful [43].Thus, the final hypothesis of the research is:

- Hypothesis 9: Institutional support positively influences BI for IoT adoption.

F. Conceptual Framework

The conceptual framework (Figure 1) shows the relationships expected between the organizational and decision-maker factors and the behavioral intention (BI) to use IoT for smart farming practices. As this conceptual framework shows, it is expected that PU and PEU of IoT for smart farming, along with Trust, Institutional Support, and Technology Readiness, will influence BI (adoption intention). PU and PEU are expected to be influenced by E-learning and Technology Readiness. Technology Readiness is expected to be influenced by IT Readiness, BP Readiness, OC Readiness, HR Readiness and DM Readiness.

III. RESEARCH METHODOLOGY

The research was conducted at the farm level. Data was collected using an online survey of farm owners and managers in Thailand (n = 395). Respondents were recruited from online farming forums and through NGOs working in agricultural education and extension projects in the provincial areas of Thailand. Most of the sample (n = 253, 64%) were family farms or smallholdings with fewer than 10 employees. Smaller groups were medium-sized farms with 10-25 employees (n = 119, 30%) or large firms with 26+ employees (n= 23, 6%). The questionnaire was designed for the research (see Table 1 for details). Coefficient alpha was used to evaluate the Likert scales, with all scales indicating a good internal consistency at around $\alpha = .800$ or higher. Analysis was conducted in SPSS. Multiple regression was used to test the hypotheses, with significance at $p < .05$.

TABLE I. SUMMARY OF THE INSTRUMENT

Scale	Items	Sample Item	α
Perceived Usefulness (PU)	3	IoT would contribute to my farm.	.802
Perceived Ease of Use (PEU)	3	I would not find it hard to learn to use IoT tools.	.824
Behavioral Intention (BI)	3	I am planning to implement IoT systems.	.801
E-Learning (ELEARN)	3	I have participated in an e-learning module on IoT for farming.	.799
Technology Readiness (TR)	4	My farm is ready for IoT.	.915
IT Readiness (IT)	4	My farm has a WiFi network.	.901
BP Readiness (BP)	4	My farm can change the way we work to implement new tools.	.857
OC Readiness (OC)	4	My organization accepts change.	.826
HR Readiness (HR)	4	My farm has an IT specialist.	.869
Decision-Maker Readiness (DM)	4	I am optimistic about IoT.	.875
Trust (TRUST)	3	IoT is a secure technology.	.819
Institutional Support (ISUPP)	3	Government agencies provide support for IoT implementation.	.812

IV. RESULTS AND DISCUSSION

The results of the survey (Section A) were developed via multiple regression. These results are then compared to the theoretical model in the Discussion, which helps provide context for the findings.

A. Results

A series of four multiple regression tests was used to evaluate the theoretical hypotheses. The results are shown in Table 2. The tables include beta of individual coefficients, along with R^2 and adjusted R^2 of each model.

Model 1 evaluated factors in TR. Significant factors in order of effect included DM, IT, BP, and OC. However, HR was not a significant factor. The model predicted 48.9% of variance in TR.

Model 2 evaluated factors in PU. Significant factors included ELEARN and TR, but PEU was not significant. The model predicted 50.3% of variance in PU.

Model 3 evaluated factors in PEU. The only significant factor was ELEARN, while TR was not a significant factor. This model predicted 21.3% of variance in PEU.

Finally, Model 4 investigated the factors in BI. Significant factors included TR, ISUPP, and PU. Factors including PEU and TRUST were not significant. This model predicted 55.4% of variance in the model.

TABLE II. SUMMARY OF REGRESSION FINDINGS

	Model 1	**Model 2**	**Model 3**	**Model 4**
Dependent	TR	PU	PEU	BI
Intercept	.294	.598	1.21	.259
IT	.306***			
BP	.268**			
OC	.182**			
HR	.105			
DM	.429***			
ELEARN		.471***	.201**	
TR		.406***	.080	.268***
PEU		.151		.075
PU				.392*
TRUST				.115
ISUPP				.214**
R^2	.494	.517	.218	.558
Adj. R^2	.489	.503	.213	.554
Note: * p < .05 ** p < .01 *** p < .001				

Table III summarizes the hypothesis acceptance. This shows that most hypotheses are accepted. The exceptions are H3 (PEU → PU), 5D (HR → TR), 6B (TR → PEU), and H8 (TRUST → BI). These hypotheses are mixture of the core variables, but mainly address the relationship of PEU within the model. It also indicates that HR Readiness is not significant to Technology Readiness, and generalized Trust is not a factor in adoption.

TABLE III. HYPOTHESIS SUMMARY

Hypothesis	**Relationship**	**Accepted?**
1	PU → BI	Yes
2	PEU → BI	Yes
3	PEU → PU	No
4a	ELEARN → PU	Yes
4a	ELEARN → PU	Yes
4b	ELEARN → PEU	Yes
5a	IT → TR	Yes
5b	BP → TR	Yes
5c	OC → TR	Yes
5d	HR → TR	No
5e	DM → TR	Yes
6a	TR → PU	Yes
6b	TR → PEU	No
6c	TR → BI	Yes
7	TRUST → BI	No
8	ISUPP → BI	Yes
9	TR → PEU	No

B. Discussion

This research's findings mainly supported the proposed conceptual framework (Figure 1). The TAM was partially effective at explaining the adoption of IoT for farming, although the effect of the PEU was not significant. Although this does not completely reflect the model, it is not inconsistent with previous studies using the TAM, which have shown that PEU has an inconsistent effect on the adoption of various technologies [9] [11]; Turner, et al., 2010). Some possible reasons for this inconsistency could be that some respondents have already taken e-learning training on IoT, reducing the perceived difficulty involved with adoption, or that it is perceived as being only as difficult as existing farming technologies. These reasons could reduce the importance of PEU for adoption since it would not be viewed as a barrier.

Of the five factors in IoT technology readiness, HR readiness was the only one found to be non-significant. It is not clear why this is the case, since it is known that organizations require high-level and specialist technical skills [27] [33]. One reason could be that farm managers expect to hire contractors or outsource their specialist IT requirements, which would reduce the relevance of internal HR resources on effective implementation.

Other relationships were also supported. E-learning was found to be significant for PU and PEU, which validates the idea that e-learning could be used to facilitate implementation [21]. Technological readiness for IoT was also found to be a significant factor in PU and BI, although not PEU. This supports the notion that technological readiness is a significant factor in implementation intention for IoT. In keeping with previous research into smart farming implementation in Thailand and Viet Nam [42] [43] institutional support was also a significant factor. However, trust was not a significant factor. This may be related to

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relatively low levels of technological understanding, paired with reliance on external support in general.

V. CONCLUSION AND RECOMMENDATIONS

This research has evaluated technological readiness for IoT implementation in Thailand using the TAM framework and a set of context-specific extensions. The findings showed that perceived usefulness of the IoT system, along with perceived ease of use, technological readiness, and institutional support for implementation affected intention to implement an IoT system for smart farming. The study also identified factors in technological readiness and the role of e-learning in the implementation decision process. Therefore, the findings did support the conceptual framework and identified the conditions that need to be in place before Thai farmers will consider implementing IoT systems. The implication of these findings is that e-learning and institutional support can be used to develop readiness for IoT implementation, and that organizations do need to have specific readiness conditions in place to consider IoT implementation. Thus, policymakers and program designers should consider developing programs that help farms develop or find such resources.

There are some limitations to this study. The findings are mainly derived from small farms. While most firms in Thailand are small farms, it is likely that large farms would be the first adopters of IoT technologies to automate farming. Thus, their perspective may be more relevant to the early practitioner. Another limitation is that practical factors such as cost and availability of subsidies or other supports was not considered, even though this can have a significant effect on the ability to implement IoT. There are several areas for future research. Implementation studies for smart farming, for example case studies in farms undergoing smart farm transformation, could provide useful information about success and failure factors in implementation and shed more light on the role of technological readiness. An IoT maturity model would also be a useful generalized tool for evaluating IoT readiness and implementation success.

REFERENCES

[1] A. Seegolam. A. Sukhoo and V. Bhoyroo. "ICT as an enabler to achieve sustainable development goals for developing countries: A proposed assessment approach". eChallenges e-2015 Conference. Vilnius, Lithuania, 2015.

[2] K. Dharani. S. Subalakshmi and D. Balamurugan. "Automatic agriculture irrigation with periodic camera trapped pictures and land monitoring using wireless sensor networks". *International Journal of Research in Engineering and Technology*, vol. 2(5), pp. 255-260, 2014.

[3] CIA. "Thailand." Internet: https://www.cia.gov/library/publications/the-world-factbook/geos/th.html, Jun. 27, 2017 [Sep. 9, 2019].

[4] M. Mainuddin. M. Kirby and C. T. Hoanh. "Adaptation to climate change for food security in the lower Mekong Basin". *Food Security*, vol. 3(3), pp. 433-450, 2011.

[5] F. Xia. L. T. Yang. L. Wang. and A. Vinel. "Internet of Things". *International Journal of Communication Systems*, vol. 25, pp. 1101-1102, 2012.

[6] L. Atzori. A. Iera and G. Morabito. "Understanding the Internet of Things: Definition, potentials, and societal role of a fast evolving paradigm". *Ad Hoc Networks*, vol. 56, pp. 122-140, 2017.

[7] H. Baumüller. (2012, May). "Facilitating agricultural technology adoption among the poor: The role of service delivery through mobile phones". *ZEF Working Paper Series*. No. 93). Avialable: https://www.econstor.eu/bitstream/10419/88382/1/773376690.pdf [Sep. 9, 2019].

[8] G. Feder and D. L.Umali. "The adoption of agricultural innovations: A review". *Technological Forecasting and Social Change*, vol. 43(3-4), pp.215-239, 1993.

[9] M. Y. Chuttur. "Overview of the technology acceptance model: Origins, development and future directions". *Working Papers on Information Systems*, vol. 9(37), pp. 9-37, 2009.

[10] F. D. Davis."A technology acceptance model for empirically testing new end-user information systems: Theory and results." Dcotoral Thesis, Massachusetts Institute of Technology, USA, 1985.

[11] V. Venkatesh and F. D. Davis. "A model of the antecedents of perceived wase of use: Development and test". *Decision Sciences*, vol. 27(3), pp. 451-481, 1996.

[12] W. R. King and J. He "A meta-analysis of the technology acceptance model". *Information and Management*, vol. 43, pp. 740-755, 2006.

[13] M. Turner. B. Kitchenham. P. Brereton. S. Charters and D. Budgen. "Does the technology acceptance model predict actual use? A systematic literature review". *Information and Software Technology*, vol. 52, pp. 463-479, 2010.

[14] B. Aleke. U. Ojiako. and D. Wainwright. "ICT adoption in developing countries: Perspectives from small-scale agribusinesses", *Journal of Enterprise Information Management*, vol. 24(1), pp. 68-84,2011.

[15] S. M. Islam. and Å. Grönlund. "Factors influencing the adoption of mobile phones among farmers in Bangladesh: Theories and practices". *International Journal on Advances in ICT for Emerging Regions*, vol. 4(1), pp. 4-14, 2011.

[16] M. Reichardt. C. Jürgens. U. Klöble. J. Hüter and K. Moser. "Dissemination of precision farming in Germany: acceptance, adoption, obstacles, knowledge transfer and training activities". *Precision Agriculture*, vol. 10(6), pp. 525-545, 2009.

[17] A. Tubtiang and S. Pipatpanuvittaya. "A study of factors that affect attitude toward deploying smart-farm technologies in Tanud subdistrict, Damnoen Saduak district in Ratchaburi province". *Journal of Food Science and Agriculture*, vol. 1(1), pp. 144-148, 2015.

[18] B. Holmes and J. Gardner. *E-learning: Concepts and practice*. Thousand Oaks, CA: Sage. 2006.

[19] J. C. Aker. "Dial "A" for agriculture: A review of information and communication technologies for agricultural extension in developing countries", *Agricultural Economics*, vol. 42(6), pp. 631-647,2011.

[20] Y. Wang. M. Wu and H. Wang. "Investigating the determinants and age and gender differences in the acceptance of mobile learning". *British Journal of Educational Technology*, vol. 40(1), pp. 92-118, 2009.

[21] E. Osipov and L. Riliskis. "Educating innovators of future Internet of Things". *IEEE Frontiers in Education Conference*. OK, USA, 2013.

[22] A. Whitmore. A. Agarwal and L. D. Xu. "The Internet of Things - a survey of topics and trends. Information Systems Frontiers", vol. 17, pp. 261-274, 2015.

[23] A. Haug, S. G. Pederson and J. S. Arlbjørn. "IT readiness in small and medium-sized enterprises". *Indusrial Management and Data Systems*, vol. 111(4), pp. 490-508, 2011.

[24] A. Molla. V. Cooper and S. Pittayachawan. "The green IT readiness (G-readiness) of organisations: An exploratory analysis of a construct and instrument". *Communications of the Association for Information Systems*, vol. 29(1), pp. 67-96, 2011.

[25] Z. Yang. J. Sun. Y. Zhang and Y. Wang. "Understanding SaaS adoption from the perspective of organizational users: A tripod

readiness model". *Computers in Human Behavior*, vol. 45, pp. 254-264, 2015.

[26] C. Kloch. E. B. Petersen. and O. B. Madsen. Cloud based infrastructure, the new business possibilities and barriers. *Wireless Personal Communications*, vol. 58(1), pp. 17-30, 2011.

[27] P. Leitão. A. W. Colombo and S. Karnouskos. "Industrial automation based on cyber-physical systems technologies; Prototype implementations and challenges". *Computers in Industry*, vol. 81, pp. 11-25, 2016.

[28] M. G. Aboelmaged. "An empirical analysis of ERP implementation in a developing country: Toward a generic framework", *International Journal of Enterprise Network Management*, vol. 3(4), pp. 309-331, 2009.

[29] L. D. Xu. W. He and S. Li. "Internet of Things in industries: A survey. *IEEE Transactions on Industrial Informatics*", vol. 10(4), pp. 2233-2243, 2014.

[30] T. Oliveira and M. F. Martins. "Literature review of information technology adoption models at firm level". *The Electronic Journal of Information Systems Evaluation*, vol. 14(1), pp. 110-121, 2011.

[31] D. Clausing and M. Holmes. "Technology readiness". *Research - Technology Management*, vol. 53(4), pp. 52-59, 2010.

[32] D. Boss. H. Guenter. G. Grote and K. Kinder."Controllable accountabilities: the Internet of Things and its challenges for organisations". *Behaviour and Information Technology*, vol. 32(5), pp. 449-467, 2013.

[33] T. Oliveira. M.Thomas and M. Espadanal. "Assessing the determinants of cloud computing adoption: An analysis of the manufacturing and service sectors". *Information and Management*, vol. 51, pp. 497-510, 2014.

[34] A. Bhimani. and L. Willcocks. "Digitisation, 'big data' and the transformation of accounting information". *Accounting and Business Research*, vol. 44(4), pp. 469-490, 2014.

[35] A. Parasuraman and C. L. Colby. "An updated and streamlined Technology Readiness Index (TRI)". *Journal of Service Research*, vol. 18(1), pp. 59-74, 2015.

[36] J. Rigg. A. Salamanca and E. C. Thompson. "The puzzle of East and Southeast Asia's persistent smallholder". *Journal of Rural Studies*, vol. 43, pp. 118-133, 2016.

[37] S. Chen. H. Chen and M. Chen. "Determinants of satisfaction and continuance intention towards self-service technologies". *Industrial Management and Data Systems*, vol. 109(9), pp. 1249-1263, 2009.

[38] C. Lin. H.Shih and P. J. Sher. "Integrating technology readiness into technology acceptance: The TRAM model". *Psychology and Marketing*, vol. 24(7), pp. 641-657, 2007.

[39] S. Sicari. A.Rizzardi. L. A. Grieco and A. Coen-Porisini. (2015). "Security, privacy and trust in Internet of Things: The road ahead". *Computer Networks*, vol. 76, pp. 146-164, 2015.

[40] N. Andrie. P. Pédelahore. F. Howland. K. Descheemaeker. É. Vall. O. Bonilla-Findji. E.Chia. Climate-smart farms? Case studies in Burkina Faso and Colombia. In *Climate Change and Agriculture Worldwide Dordrecht*. The Netherlands: Springer, 2016, pp. 143-154.

[41] V. Klyuev. (March, 2015). "Structural transformation - how does Thailand compare?" *International Monetary Fund*. Aavialable: https://www.imf.org/external/pubs/ft/wp/2015/wp1551.pdf [Sep. 9, 2019].

[42] N. Andrieu. P. Pédelahore. F. Howland. K. Descheemaeker. É. Vall. O. Bonilla-Findji. E.Chia. Climate-smart farms? Case studies in Burkina Faso and Colombia. In *Climate Change and Agriculture Worldwide* Dordrecht. The Netherlands: Springer, 2016, pp. 143-154.

[43] E. Simelton. C. V. Dam and D. Catacutan, "Trees and agroforestry for coping with extreme weather events: Experiences from northern and central Viet Nam". *Agroforestry Systems*, vol. 89(6), pp. 1065-1082, 2015.

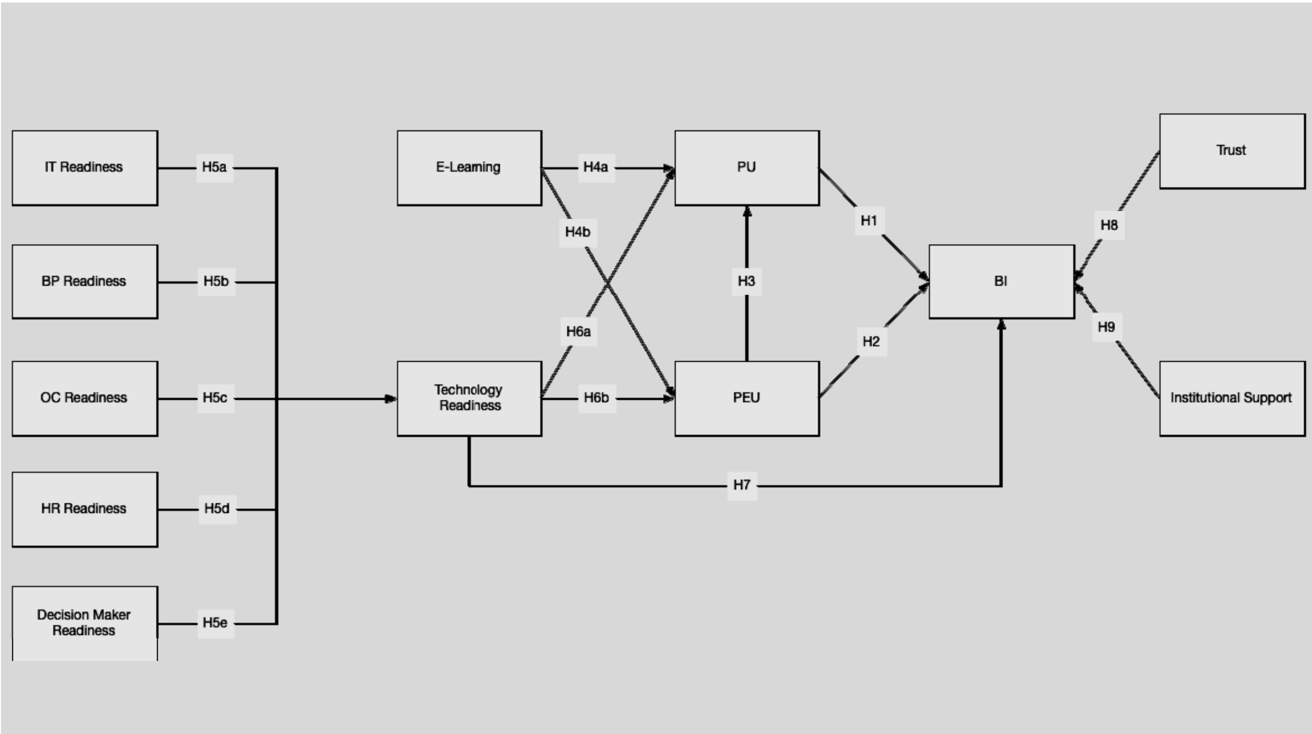

Figure 1. Conceptual framework