THE INTENTION TO USE DRONE TECHNOLOGY IN THAILAND'S CONSTRUCTION INDUSTRY

PINDA NAPAPORN

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....
Miss Pinda Napaporn
Candidate

....
Assoc. Prof. Vichita Ractham,
Ph.D.
Advisor

....
Assoc. Prof. Sooksan Kantabutra,
Ph.D.
Chairperson

....
Asst. Prof. Duangporn Arbhasil,
Ph.D.
Dean
College of Management
Mahidol University

....
Ronald Surachai Thesenvitz,
Ph.D.
Committee member

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Pinda Napaporn

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PINDA NAPAPORN 6149078

M.M. (ENTREPRENEURSHIP MANAGEMENT)

THESIS ADVISORY COMMITTEE: ASSOC. PROF. VICHITA RACTHAM, Ph.D., RONALD SURACHAI THESENVITZ, Ph.D., ASSOC. PROF. SOOKSAN KANTABUTRA, Ph.D.

ABSTRACT

Drones are widely perceived as gadgets of leisure that are utilized for aerial photography with photos and video from a top view. In fact, drones are used in various types of industry and business. It can be used in the construction industry for moving and assembling the building materials. However, in the construction industry in Thailand, drones may be used only for monitoring the progress of the construction works. Therefore, the objective of this study is to examine the users' perceptions on the effect of drone technologies in business performance focusing on the business core functions. This research also examines the acceptance of drone technology in part of the Heavy-Duty Lifting Process from the users with limited or no experience with the use of drone technology within Thailand's construction industry. The study employed the structural equation modeling (SEM) as a theoretical framework to guide the study. The framework of this study is relevant to the seven factors which are self-efficacy, perceived usefulness and perceived ease of use and relative advantage, compatibility, and attitude toward using and behavioral intention to use. Two hundred and fifty samples participated in this survey study by answering the online questionnaires about their attitudes toward the use of drone technology in the construction industry. The numerical data was used to identify the factors which impact the technology acceptance for the adoption of drone technology in the construction industry. Data were analyzed using SPSS and AMOS for Windows. The results suggested that the relative advantage of drone technology to the users' work was found to be the strongest determinant of intention to adopt the technology. The ease of use was found to be the strongest predictor of the perceived usefulness followed by the relative advantages of the target technology.

KEY WORDS: Drone Technology/ Intention to Use/ Technology Acceptance

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CHAPTER I
INTRODUCTION

Over the past decade, technology has continuously and rapidly grown, driven by the demand in organizations that focus on their core businesses. The use of technologies in the business strategies is advantages for the significant competition in business world at this moment (Zubielqui and Boyle, 2016). During the time when organizations are under pressure to become more efficient, innovative, and ambitious, drones are developed. Thus, changing the direction of how the businesses are functioning drones support the inspection process by making it safer, cheaper and less time consuming. During the past few years, drones are widely perceived as the gadgets of leisure that are utilized for aerial photography with photos and video from a top view. The name of this technology is also known as Unmanned Aerial Vehicles or UAVs, which have many advantages over traditional kinds of technologies. They are cheaper, faster, and safer (Puri, 2005). Moreover, UAVs have the potential to fly in bad weather or dangerous conditions. Another advantage of UAVs is that it can be used to record the networks of roads at a certain time, and can report the disaster to the emergency base station. They can select the best route and inform the police cars as needed (Puri, 2005). Many industries are interested in using this technology because of its efficiency. Drones also have many applications in inspection of infrastructure, operations in military and agriculture and delivery services, search and rescue operations, etc. These create many opportunities for entrepreneurs to gain more advantages in using this technology for their own business. Moreover, drones are used in infrastructure parts within several countries. For example, the United Kingdom is using drones in the domestic railway system for the maintenance plan through 3D digital analysis. In Japan, they invented drones to inspect and repair the large infrastructure such as bridges and walkways, with the prominent features in flattening with pillars. This allows the easier and more effective way in surveying and detecting the damages (PwC, 2018).

1.1 Problem Statement

In Thailand's construction industry, drones can be used only for monitoring of the working progress. According to PwC (2016), drones may also be used as construction tools for moving and assembling the building materials. Compared to human beings, using drones in the construction industry can reduce injuries and deaths. Regarding to the advantages of using drones in the construction industry, this research aims to determine the intention to use drone technology in part of the heavy-duty lifting process in Thailand's construction industry.

1.2 Objective

The objective of the research is to determine the users' perceptions on the effects of using drone technology in the business performance on business core functions. Moreover, this study is to better understand the users' motivations in using drone technologies in part of the heavy-duty lifting process.

1.3 Scope of Study

This research examines the acceptance of drone technology in part of the heavy-duty lifting process of the users who have limited or no experience with drone technology in Thailand's construction industry. The study explores the relationship between theory and research empirically in terms that how the drone technology is beneficial to the construction industry, and how the users perceive of the use of the technology. The numerical data is used to identify the factors which impact the technology acceptance for adoption of technology in Thailand's construction industry. The data will be collected in the form of questionnaires-based survey research.

1.4 Expected Benefit

1.4.1 To identify the relationships between the relevant determinants effecting the intention to use drone technology

1.4.2 To publish the result of this study as a basic information for business development

1.4.3 To create the competitiveness as well as the adaptation to this transformation in the business strategy to the market

CHAPTER II
LITERATURE REVIEW

This chapter is to review about drone technology and present the framework and relative research on the social-psychological theories including the construct of intention theory as a key predictor of behaviour. The theories and models are most frequently utilized in the behavioural research in which describe the role of intention and the users' acceptance on the behaviour of prediction.

2.1 History of Drones

Drone was created as part of military operations after World War I in 1916 by the U.S. Army as "an aerial torpedo". During World War II, they also began experimenting drones with radio-controlled aircraft and remote-controlled aircraft. In that period, it became the first mass- manufacturing of UAVs Technology in the United States. Although the U.S. could breakthrough in mass-production of drones for the military, this technology is still often considered unreliable and expensive. In 1990, there was a mini version of UAVs which were used for the searching of terrorists in the middle eastern countries. Nowadays, drones have become popular in many industries. According to PWC (2016) the value of drones from global view in 2015 are 127.3 billion US dollar which can be divided into 35.5% in Infrastructure, 25.5% in Agriculture and 10.2% in Transport and 8.2% in Security,6.9% in Media & Entertainments and 5.3% in Insurance, 4.9% in Telecommunication, and 3.4% in Mining.

2.2 Applications of Drones

It is hard to classify all types of drone. There is a wide multiplicity of applications. According to Hassanalian and Abdelkefi (2017), they classified the possible application of drones as Figure 1.

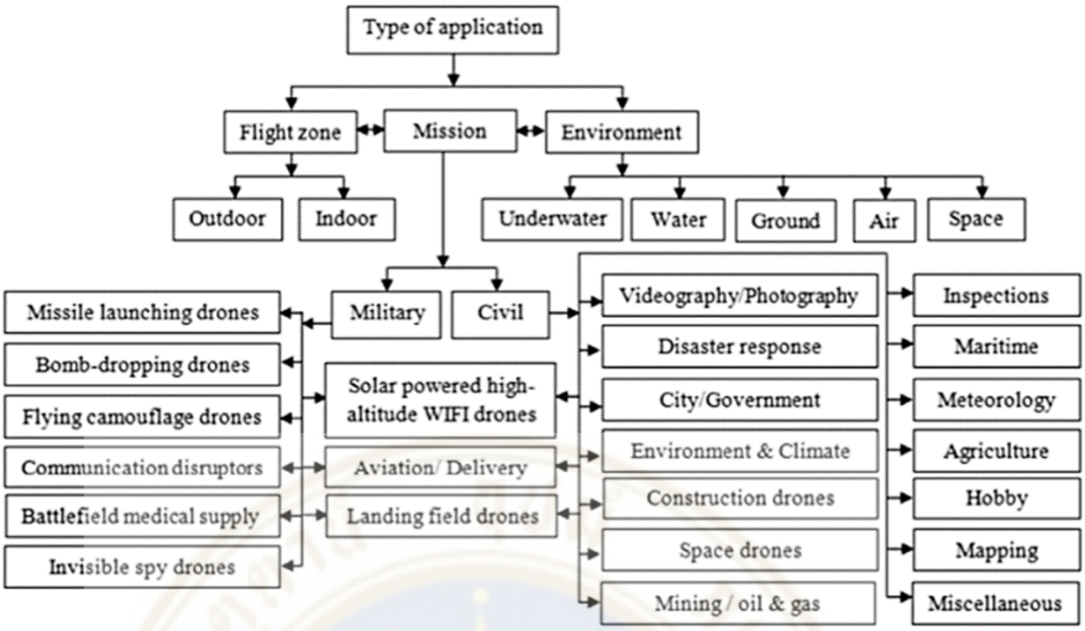


Figure 1: Applications of drones

The Figure 1 shows how is drone being developed, and the application of drone in each part of organizations. This is the important information about the application for drones, and its' intended usages, which can be subcategorized based on types, sizes, and weights.

2.3 Construction Drones

According to Schriener and Doherty (2016), the construction industry currently uses the technology called Unmanned Aircraft Systems (UAS) technology as well. From the review of literatures, there were various publications that used UAS on the construction sites and considering using it in the future. According to Tatum and Liu (2016), They summarize the advantages of drone technology in 3 categories which are aerial photography, inspections, and safety/security monitoring.

Table 2.1: The advantages of construction drone technology

Aerial Photography (Molla, D., 2016)	To prepare photos and video of the construction site
	To show progress on a project
	To identify issues with the constructability of planned installations
Inspections (Pritchard, L.,2016).	To escalate the pipeline inspection process and safety
	To reduce the harsh conditions in steep climates
	To examine an exterior leak on a high-rise building
	To capture picture from various angles
Safety/Security Monitoring	To integrate into the security alarm system
	To stream videos to other real time devices.

From the previous studies, drone technology has developed rapidly from the past. Nowadays, drones can carry a payload of 200 kg. For example, the Volocopter presented the demonstration of its VoloDrone. It is a fully electric and heavy-lift utility drone that can carry a payload of 200 kg. With a standardized payload attachment, it can serve various purposes from transporting boxes, liquids, to equipment and beyond. The first flight of the VoloDrone demonstrator is in October 2019. These are the VoloDrone applications.

Table 2.2: The advantages of VoloDrone

Agricultural	To increase productivity in the areas of plant protection, seed sowing, forest management, and frost control
Logistics	To the package delivered safely, securely and on time To time-critical medical or spare part deliveries
Infrastructure	To be maintenance and site planning To assist in daily operations.
Public Services	In the crisis, it can be quickly deployed to provide disaster relief, air rescue, or support humanitarian aid.

2.4 Diffusion of Innovation Theory

The Diffusion and Innovation Theory classifies the kind of adopters into five categories based on the innovativeness by using a bell curve (Rogers et al., 2002).

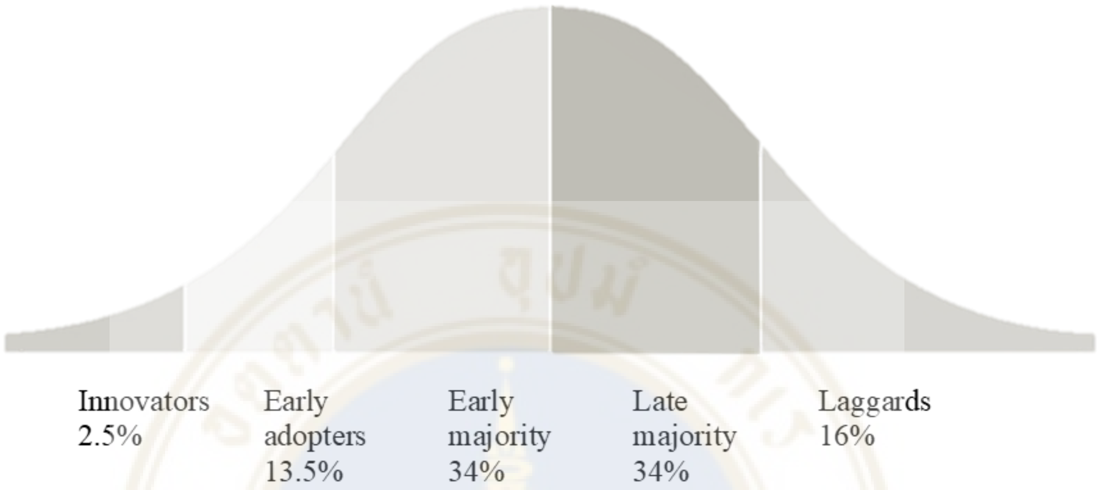


Figure 2: Adopter Categorization (Rogers, 2002)

In the Figure 2, the percentage shows the portion of population types. From the theory and the information on the Figure 2, it could be concluded that the innovators took a shorter period to adopt new technology than laggards. The time frame of adoption also depends on the society system.

Rogers also introduced the theory of perceived attribute that will have an impact on its adoption process. Those attributes can be considered a part of this study framework.

Table 2.3: Definition of an innovation's attributes

Relative advantage (Rogers et al., 2002)	defined as the degree to which an innovation is perceived as being better than the idea it supersedes
Compatibility (Rogers et al., 2002)	defined as the degree to which an innovation is perceived as consistent with the existing values, past experiences, and needs of potential adopters
Complexity (Rogers et al., 2002)	defined as the degree to which an innovation is perceived as relatively difficult to understand and use
Trialability (Rogers et al., 2002)	defined as the degree to which an innovation may be experimented with on a limited basis
Observability (Rogers et al., 2002)	defined as the degree to which the results of an innovation are visible to others

2.5 Technology Acceptance Model (TAM)

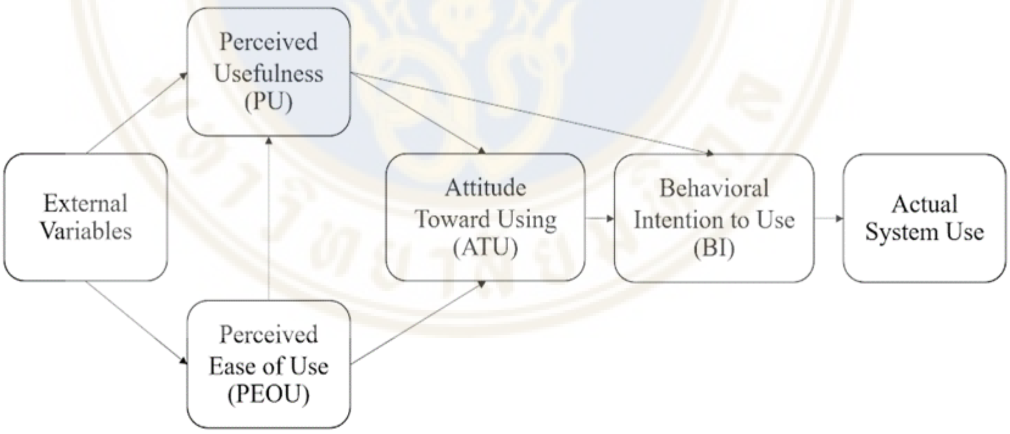


Figure 3: The Original TAM

The Figure 3 explains, the Technology Acceptance Model (TAM) introduced in 1986 by Fred Davis. It is the most universally used model which can explain users' acceptance behavior. The model is developed from the Theory of Reasoned Action (TRA) which is the social psychology theory which showed that the influence attitudes can lead to behavioral intention. The goal of TAM is to provide a description of the determinants of technology acceptance. It can explain the behavior across a wide range of systems or technologies. In other words, TAM explains the belief-attitude-intention-behavior relationship. Moreover, TAM was tended to focus on two cognitive beliefs, which are the perceptions of usefulness and the ease of use. Moreover, social influence could play role in the development of the adoption intentions (Davis et al., 1989).

Table 2.4: Definition of factors on TAM theory

Perceived Usefulness (PU)	Defined as a level of a personal trust that utilizing of technology will make it easier to complete their works (Venkatesh et al.,2003)
	Defined as the degree to which individuals believe technology would support his or her job performance in terms of the advantages of using a technology, especially to enhance the productivity, effectiveness and the performance in working
	Defined as the level of acceptance and the use of information technology inculding word processing software (Davis et al, 1989), spreadsheet software (Mathieson, 1991), and different end-user productivity software (Adams at al., 1992)
	In the consumer's part, the motivations for online retail shopping behavior is found the positive relationship between PU of the new interactive media and ATU these media (Childers et al., 2001).
	In Context of This Study PU can be defined as a level of the users' confidence that using drone will support his or her work performances. **The Hypothesis of This Study** H1: The higher the PU on drone technology, the more positive effect on ATU in drone technology. H2: The higher the PU on drone technology, the more positive effect on BI in drone technology.

Table 2.4: Definition of factors on TAM theory (cont.)

Perceived Ease of Use (PEOU)	Defined as a level of trust by individuals that technology can utilize and move forward to execution (Venkatesh et al.,2003)
	Defined as the degree of individuals believe technology would be free of effort, which will be lead to the behavioral intention to use People have different level of capacity in adoption of the new technologies due to different learning capacity (Davis et al., 1989)
	In contrast to the perceived complexity by Rogers (1983), the more complex a technology is, the harder it is to understand, and the less likely to be adopted (Attewell et al., 1992).
	Both PU and PEOU have been used to accurately predict the BI of such applications as an office automatic package (Davis et al., 1989), smart card payment system (Plouffe et al., 2001), and microcomputer usage (Igbaria et al., 1995). In the consumer context, the PEOU has the significant positive effect on ATU touch screen self-service (Dabholkar and Bagozzi et al., 2002) and the online shopping media (Childers et al. 2001).
	In Context of This Study The PEOU can be defined as a level of users' beliefs that using drone would be free of effort. **The Hypothesis of This Study** H3: The higher the PEOU on drone technology, the more positive effect on PU in drone technology. H4: The higher the PEOU on drone technology, the more positive effect on ATU in drone technology.
Attitude Toward Using (ATU)	Defined as a person's feelings about performances in both positive and negative way (Ajzen, 1989; Cohen and Areni, 1991; Ajzen and Fishbein, 2000)

Table 2.4: Definition of factors on TAM theory (cont.)

Attitude Toward Using (ATU) (count.)	Not only does attitude involve with the affection issues which are likes and dislikes, but it is also determined by the person's beliefs (Ajzen and Fishbein, 1980).
	Refers to the evaluative judgment in adoption of technology, and when the adoption occurs in a voluntary setting, ATU has shown to have high correlation with BI (Davis et al. 1989)
	Harrison, Mykytyn, and Riemenschneider (1997) examined the decisions to adopt the information systems in a small business, they found that ATU is an antecedent of intentions to adopt information systems.
	In Context of This Study The ATU can be defined as an antecedent of intentions to adopt drone technology. **The Hypothesis of This Study** H5: The higher the ATU on drone technology, the more positive effect on BI in drone technology.
Behavioral Intention to Use (BI)	Defined as an individual's desire to act or to do something (Miftah &Wulandari et al., 2015)
	Defined as the degree that an individual has determined consciously about the plan to agree or disagree to some specific future behaviors (Davis et al., 1989)
	In Context of This Study the BI can be defined as a level of intention to use of drone technology in Thailand's construction industry.

2.6 The Theoretical Model of This Study

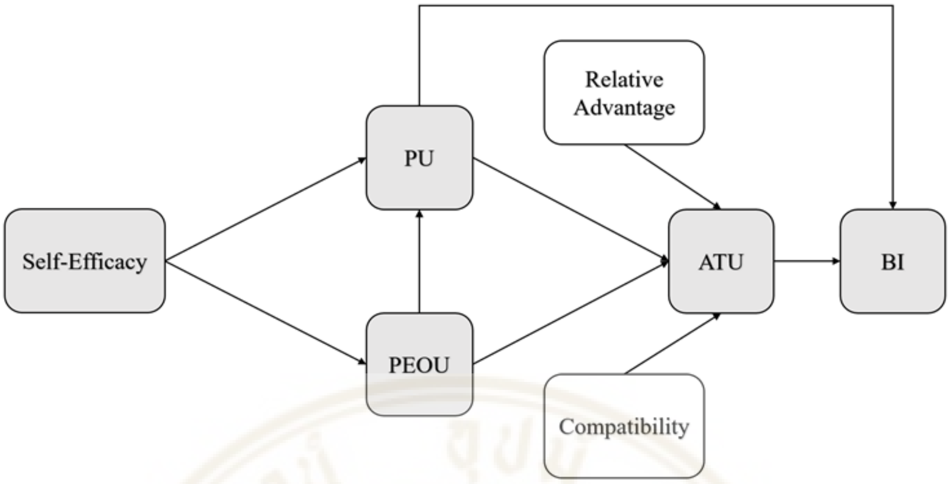


Figure 4: The Framework of This Study

The figure showed the combination of 2 theories which are TAM theory and perceived attribute theory. This framework added 3 variables which are self-efficacy, relative advantage, and compatibility.

Table 2.5: Definition of other variables

Self- Efficacy (SE) as External Variable	Davis et al. (1989) originally determined TAM and recommended that some external factors needed to be tested in the future research to find the reasons why users accept or reject technology at the end.
	Defined as the judgments of the individual's capability-with whatever skills they possess-to reflect self-confidence on his/her ability to perform a behavior (Bandura, 1982).
	Represents a key of PU and PEOU in term of technology usage, and the influences outcome is expected to be like the perceived usefulness (Compeau, Higgins, and Huff et al., 1999)
	The Hypothesis of This Study H6: The higher the SE on drone technology, the more positive effect on PU in drone technology. H7: The higher the SE on drone technology, the more positive effect on PEOU in drone technology.

Table 2.5: Definition of other variables (cont.)

Compatibility (CP) as Latent Variable	Defined as the level of the individual user's perceptions on an innovation to be compatible with their current values, needs and past experiences (Moore & Benbasat et al., 1991)
	The correlations between ATU and BI were extremely low and usually not significant when there are incompatible measures. (Ajzen & Fishbein, 1977).
	CP scale is greater comparing between the past attitude and later behavior (Courneya & McAuley, 1993).
	The Hypothesis of This Study H8: Having CP in the model provides a better fit than a model without CP. H8a: the users' perceptions on CP of an innovation has a positive relationship with the ATU on drone technology.
Relative Advantage (RA) as Latent Variable	Defined as a measurement of the profitability, social benefits and time saving (Tomatzky and Klein 1982)
	RA is one of the best predictors, and it is positively related to an innovation adoption rate. (Rogers et al., 2002)
	The Hypothesis of This Study H9: Having RA in the model provides a better fit than a model without RA. H9a: the users' perceptions on RA of an innovation has a positive relationship with the ATU on drone technology.

2.7 Research Hypothesis

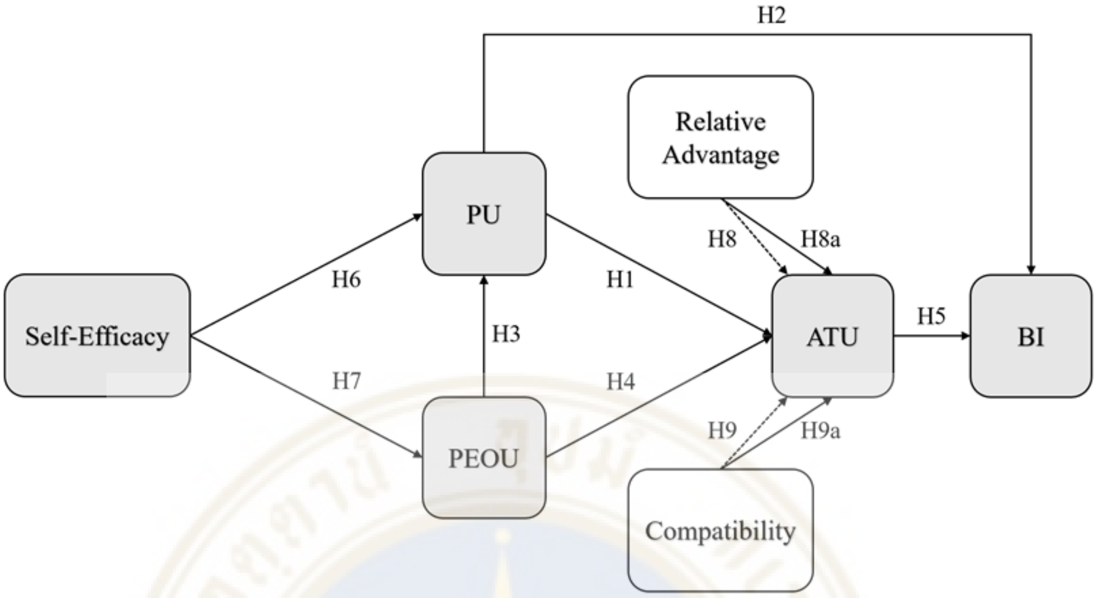


Figure 5: The Framework of This Study with Hypothesis

Table 2.6: Summary of research hypothesis

Hypothesis
H1: The higher the PU on drone technology, the more positive effect on ATU in drone technology.
H2: The higher the PU on drone technology, the more positive effect on BI in drone technology.
H3: The higher the PEOU on drone technology, the more positive effect on PU in drone technology.
H4: The higher the PEOU on drone technology, the more positive effect on ATU in drone technology.
H5: The higher the ATU on drone technology, the more positive effect on BI in drone technology.
H6: The higher the SE on drone technology, the more positive effect on PU in drone technology.
H7: The higher the SE on drone technology, the more positive effect on PEOU in drone technology.
H8: Having CP in the model provides a better fit than a model without CP.

Table 2.6: Summary of research hypothesis (cont.)

Hypothesis
H8a: The CP has a positive relationship with the ATU on drone technology.
H9: Having RA in the model provides a better fit than a model without RA.
H9a: The RA has a positive relationship with the ATU on drone technology.

2.8 The Reference Questions from TAM Survey in Several Research

2.8.1 The Original Questions of TAM Survey (Davis et al., 1989)

In Term of Perceived Usefulness (PU)

Q1. Using (this product) supports me to achieve my work more quickly.

Q2. Using (this product) increase my performance.

Q3. Using (this product) in my work improves my productivity.

Q4. Using (this product) support my effectiveness on the task.

Q5. Using (this product) make easier to do my work.

Q6. I think (this product) is useful in my job.

In Term of Perceived Ease of Use (PEOU)

Q7. It is easy to apply (this product) in my jobs.

Q8. Using (this product) would be easy and understandable.

Q9. It would be simple to become expert at using (this product).

Q10. Using (this product) would be more flexible to do my job than a traditional one.

Q11. (this product) easy to use.

2.8.2 The Questions of TAM Survey (Fumei W. et al., 2018)

In Term of Attitude Toward Using (ATU)

Q12. Using (this product) is good.

Q13. My using (this product) is favourable.

Q14. It is a positive influence for me to use (this product) in my work.

Q15. I think it is valuable to use (this product) in my work.

Q16. I think it is a trend to use (this product) in my work.

In Term of Intention to Use (BI)

Q17. I tend to use (this product) in my work.

Q18. I increase the occurrences of using (this product) in my work.

Q19. I’d love to use (this product) in my work.

Q20. I will use (this product) to provide new approaches to the work process.

2.8.3 The Questions of TAM Survey (Songpol K. et al., 2004)

In Term of Self-efficacy (SE)

Q21. I can use (this product) without the help.

Q22. I would have time to learn and make (this product) useful.

Q23. I have the knowledge, background and skills enough to operate (this product).

Q24. I can use (this product) very well on my own.

In Term of Relative Advantage (RA)

Q25. (this product) saves time and effort more than other equipment performing the same tasks.

Q26. (this product) makes me perform various tasks better than through other means.

Q27. (this product) gives more value than other equipment performing the same task.

Q28. (this product) is better than other equipment performing the same activities.

2.8.4 The Questions of TAM Survey (Adam D. et al., 2013)

In Term of Compatibility (CP)

Q29. Using (this product) is compatible with all manner of my work.

Q30. I think using (this product) fits with the way I like to work.

Q31. Using (this product) fits in my job character.

Q32. In my work, usage of (this product) is significant.

CHAPTER III
RESEARCH METHOOLOGY

3.1 Research Method

This research study is a quantitative research gathering the data using a survey online questionnaire. The method is useful to collect the numerical data to analyze the determinants on the users' intentions to use drone technology in a part of the heavy-duty lifting process in the construction industry in Thailand. The interval scales and Likert scales ranking from level 1 (Strongly disagree) to 5 (Strongly agree) were used to collect the data on the samples' perceptions. The questionnaire also aimed to determine the respondents' characteristics.

3.2 Population and Sample Selection

3.2.1 Population

Purposive sampling is a sampling technique that the researchers use their own judgment in choosing the samples. The sampling is a non-probability which is done by regarding on the population's characteristics and study's objectives. Therefore, the population of this study is the people who have a working experience in the construction industry in Thailand.

3.2.2 Sample characteristics

The samples of this study were the people who have some working experience in the construction industry in Thailand. They were both males and females or working in the engineer or non-engineer fields, and could be either the current users of drone technology or non-users.

3.2.3 Sample size

The Taro Yamane's simplified formula was used to determine the sample size for this research. According to National Statistical Office of Thailand (2019), the number of labour force in Bangkok construction industry is 335,000. The estimated sample size is determined by using Yamane's formula (Israel, 1992) which approximately used as a population with 95% confidence level (Office, 2017).

$$n = \frac{N}{1 + N(e)^2}$$

When: n = sample size,
N = population (335,000), and
e = error of the sampling (0.05).

Thus, the sample size for this study can be calculated as follow:

$$n = \frac{335{,}000}{1 + 335{,}000(0.05)^2}$$

At the 95% confidence level, the sample size should be 400 respondents. Data collection is conducted through the online questionnaires that were distributed on a convenience-based to the construction workforce in Thailand. The questionnaires were administrated to the target respondents during March, 2020. The data collection process was monitored through Google Form application.

3.3 Research Instrument

The study used the survey method using the online questionnaires. Each part of questionnaire was separated as following:

Part 1: Screening Questions including 3 questions		
Are you working in the construction industry? (Yes, No)		Nominal Scale
Part 2: General Questions including 5 questions		
Ages: (18-25,26-35, 36-45, more than 45)		Ordinal Scale
Gender: (Male/ Female)		Nominal Scale
Experience: (1-5years, 6-10years, More than 10 years)		Ordinal Scale
Education Background: (Engineering, Non-engineering)		Nominal Scale
Positioning level: (Operational, Manager, Management)		Ordinal Scale
Q1	Have you ever known drone technology is used in your industry? (Yes, No)	Nominal Scale
Q2	Have you ever known drones can use in part of heavy-duty lifting equipment? (Yes, No)	Nominal Scale
Part 3: Specific Questions including 32 questions		
Code	Likert Scale from (1) to (5) (1) = strongly disagree, (2) = disagree, (3) = uncertain, (4) = agree, (5) = strongly agree	**Variables Relevant**
PU1	Using (drone technology) in my job would enable me to accomplish tasks more quickly.	Perceived Usefulness (PU)
PU2	Using (drone technology) would improve my job performance.	
PU3	Using (drone technology) in my job would increase my productivity.	
PU4	Using (drone technology) would enhance my effectiveness on the job.	
PU5	Using (drone technology) would make it easier to do my job.	
PU6	I would find (drone technology) useful in my job.	
EU1	I would find it easy to apply (drone technology) in my jobs.	Perceived Ease of Use (PEOU)
EU2	Using (drone technology) would be easy and understandable.	
EU3	It would be easy to become skillful at using (drone technology).	
EU4	Using (drone technology) would be more flexible to do my job than a traditional one.	
EU5	I would find (drone technology) easy to use.	
RA1	(Drone technology) would save me time/effort over other means of performing the same tasks.	Relative Advantage (RA)
RA2	(Drone technology) would enable me to perform many tasks better than through other means.	
RA3	(Drone technology) would provide a greater value than other ways of performing the same task.	
RA4	(Drone technology) would be better than other ways of performing the same activities.	

CP1	Using (drone technology) is compatible with all aspects of my work.	Compatibility (CP)
CP2	I think that using (drone technology) fits well with the way I like to work.	
CP3	Using (drone technology) fits into my work style.	
CP4	In my job, the usage of (drone technology) is important.	
ATU1	Using (drone technology) is good.	Attitude Toward Using (ATU)
ATU2	Using (drone technology) is favorable.	
ATU3	It is a positive influence for me to use (drone technology) in my job.	
ATU4	I think it is valuable to use (drone technology) in my job.	
ATU5	I think it is a trend to use (drone technology) in my job.	
BI1	I tend to use (drone technology) in my job.	Intention to Use (BI)
BI2	I increase the occurrences of using (drone technology) in my job.	
BI3	I'd love to use (drone technology) in my jobs.	
BI4	I will use (drone technology) to provide new approaches to the job process.	
SE1	I will use (drone technology) to provide new approaches to the job process.	Self-efficacy (SE)
SE2	I am able to use (drone technology) without the help of others.	
SE3	I have the necessary time to make (drone technology) useful to me.	
SE4	I have the knowledge and skills required to use (drone technology).	

3.4 Validity

The questionnaire was validated by consulting the advisor. Moreover, this study did the pilot test for the questionnaire by using 30 samples, and it was analyzed using the confirmatory factor analysis (CFA) to find the relationships between each factor, and to improve the questionnaire to be more accurate, and easy to be understood by the respondents.

3.5 Reliability

The results were analyzed using the Cronbach's alpha coefficient. The Cronbach value will show how stable the questionnaire is. The Cronbach's alpha of the questionnaire was between 0 to 1 ., which is more than 0.7. It means that the questionnaire is reliable. Moreover, the study adopted more criteria that are used to determine the reliability of the questionnaire. For example, the factor loading value should be more than 0.6 (Barclay et al.,1995), the constructed reliability (CR) value should be more than 0.7 (Hair et al., 2010), and the average variance extracted (AVE) value should be more than 0.5 (Fornell and Larker, 1981). The values of the factor loading, the constructed reliability and the average variance extracted of the questionnaire in this study was all reach the criteria stating above.

3.6 Data Collection

The survey was conducted using a google document as the online surveying. Quantitative data could be generated into the numerical data which would be converted into the useful information by mean of the statistics. The respondents answered questions in the questionnaires by choosing from the choices provided. This method can enroll the large number of respondents, and can analysis the large amount of data. The data was collected in March, 2020 by distributing the questionnaires via social media, for example, Line and Facebook, and only people who live in Bangkok were to respond the questionnaires.

3.7 Data Analysis

After gathering the data from questionnaires, SPSS and AMOS software were employed to analyze the data. The data was analyzed using descriptive statistics and inference statistic. As a multivariate statistical analysis, the data analysis method of this study is the structural equation modeling (SEM) which is the integration of factor analysis, path analysis, and multiple regression analysis, to analyze the structural relationships due to its’ latent variables.

CHAPTER IV
RESEARCH RESULT

This chapter represents key findings to answer the research questions relating to the topic "Intention to Use on Drone Technology in part of the heavy-duty lifting process in the Construction Industry in Thailand" from 250 responded questionnaires. This research finding consist of five parts as following.

4.1 Validity and Reliability Analysis

Table 4.1: Item Reliability, Construct Reliability, and Convergent Validity

Constructs	Items	Indicators	Factor Loading	Cronbach's alpha Values	CR	AVE
PU	6	PU1	0.80	0.87	0.90	0.59
		PU2	0.77			
		PU3	0.72			
		PU4	0.76			
		PU5	0.79			
		PU6	0.76			
PEOU	5	EU1	0.80	0.87	0.87	0.57
		EU2	0.74			
		EU3	0.73			
		EU4	0.74			
		EU5	0.75			
ATU	5	ATU1	0.64	0.86	0.87	0.55
		ATU2	0.73			
		ATU3	0.77			
		ATU4	0.80			
		ATU5	0.75			
BI	4	BI1	0.93	0.88	0.88	0.66
		BI2	0.91			
		BI3	0.89			
		BI4	0.84			
SE	4	SE1	0.78	0.87	0.87	0.63
		SE2	0.72			
		SE3	0.85			
		SE4	0.82			

Table 4.1: Item Reliability, Construct Reliability, and Convergent Validity (cont.)

Constructs	Items	Indicators	Factor Loading	Cronbach's alpha Values	CR	AVE
CP	4	CP1	0.77	0.85	0.86	0.60
		CP2	0.73			
		CP3	0.82			
		CP4	0.77			
RA	4	RA1	0.80	0.82	0.82	0.53
		RA2	0.72			
		RA3	0.73			
		RA4	0.67			

Note. Composite reliability (CR), and Average variance extracted (AVE)

From the Table 4.1, it shows that the value of Cronbach's alpha coefficient, Factor Loading and Composite reliability (CR) and Average Variance Extracted (AVE) pass the criteria, which means the questionnaire and construction of each variable are reliable.

4.2 Model Fit Test

Table 4.2: Model Fit Test

Fit Indices	Threshold	Values Before Adjusted	Values After Adjusted
CMIN/DF (Wheaton et al.,1977)	(≤ 5)	2.99	3.09
CFI (Heir et al., 2010)	(≥ .90)	0.84	0.90
RMR (Browne and Cudeck et al., 1993)	(≤ .08)	.071	.054
RMSEA (Browne and Cudeck et al., 1993)	(≤ .10)	.093	.092

Note. Chi-square/Degree of freedom (CMIN/DF), Comparative Fit Index (CFI), Root Mean Square Residual (RMR), and Root Mean Square Error of Approximation (RMSEA)

From the Table 4.2 it is found that the consistency values of structural equation model before the adjustment do not pass the criteria. Thus, the empirical model was revised by following the modification indices (Arbuckle et al., 2011). The principles and theories were reconsidered and reviewed to revise the model by cutting off some irrelevant variables one by one until the model was reached all of criteria. This means the structural equation model has the acceptable level of consistency with the empirical data.

4.3 Descriptive Analysis

Table 4.3: Demographic Information of Eligible Respondents

		Frequency (n)	Percent (%)
Gender	Male	154	61.6
	Female	96	38.4
Age	18-25 years old	17	6.8
	26-35 years old	97	38.8
	36-45 years old	51	20.4
	more than 45 years old	85	34.0
Education Background	Engineering	132	52.8
	Non-engineering	118	47.2
Working Experience	1-5 years	95	38.0
	6-10 years	38	15.2
	More than 10 years	117	46.8
Positioning level	Operational	101	40.4
	Manager	80	32.0
	Management	69	27.6

Table 4.3 informs about the respondents' demographic information. The 61.6% of respondents are males, and 38.4% are females. The 38.8% of respondents are at the aged of 26-35 years old. Meanwhile, the minority of respondents as 34.0% are more than 45 years old. However, it was found that at least 6.8% of respondents who are between 18 to 25 years old. Most of respondents have working experience more than ten years (46.8%). Meanwhile, the minority of respondents as 38.0% have working

experience between one to five years. The majority of respondents are in the operational level which is 40.4%, while there are only 27.6% in the management level.

Table 4.4: Realization of the use of drone technology in the construction industry

		Frequency (n)	Percent (%)
Q1	Yes	191	76.4
	No	59	23.6
Q2	Yes	100	40.0
	No	150	60.0

Note. *(Q1) Have you ever known drone technology is used in your industry?*
(Q2) Have you ever known drones can use in part of heavy-duty lifting equipment?

According to the Table 4.4, most of respondents as 76.4% already know that there is the use of drone technology in the industries. However, most of respondents as 60.0% which are 150 out of 250, do not know that drones can be used in a part of the heavy-duty lifting equipment.

Table 4.5: Mean and Standard Deviation of Technology Acceptance Factor

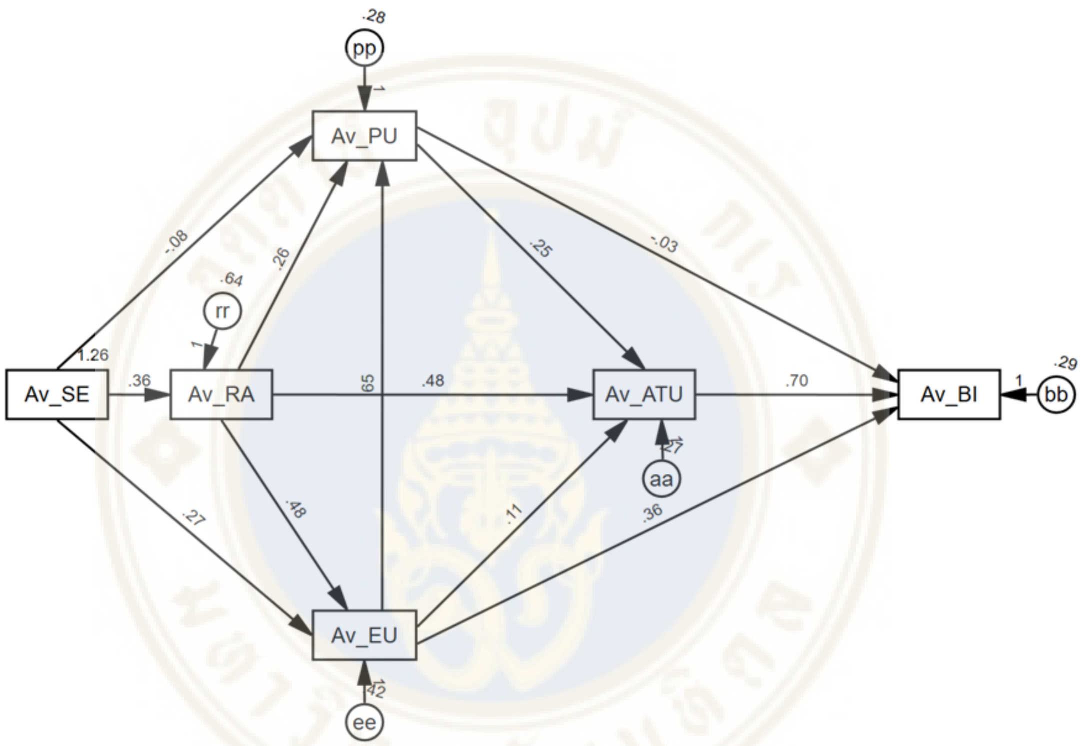
	Mean	S.D.
ATU	3.78	0.82
PU	3.76	0.88
RA	3.67	0.82
BI	3.56	0.98
PEOU	3.47	0.89
CP	3.27	0.89
SE	3.04	1.08

Note. Attitude Toward Using (ATU), Perceived Usefulness (PU), Relative Advantage (RA), Behavioural Intention to Use (BI), Perceived Ease of Use (PEOU), Compatibility (CP), and Self- Efficacy (SE)

Table 4.5 shows mean and standard deviation of technology acceptance factor, the technology acceptance factors in this study consists of seven dimensions as the table above. The factor that gains the highest average score is ATU (3.78) following by PU (3.76), RA (3.67), BI (3.56), PEOU (3.47), CP (3.27) and SE (3.04), respectively.

4.4 The Structural Equation Model (SEM) Analysis

This is the structural equation model after the revision by using the average value.



Note. Average Score of Self- Efficacy (Av_SE), Average Score of Relative Advantage (Av_RA), Average Score of Perceived Usefulness (Av_PU), Average Score of Perceived Ease of Use (Av_EU), Average Score of Attitude Toward Using (Av_ATU), and Average Score of Behavioural Intention to Use (Av_BI),

Figure 6: The Fixed Structural Equation Model Analysis

The Figure 6 shows the of the associations factors that are described by a structural path model. The associations were analysed using the fixed structural model and the standardized regression coefficients. The 70% of the variance in Av_ATU is explained by Av_BI which is the highest contributor. From the figure, it is clear that Av_EU (.36) significantly contributes to the variance in Av_BI, and Av_RA (.48) is the most significant contributor to explaining the variance in Av_ATU, following by

Av_PU (.25). Av_RA (.48) was also the most significant contributor to explaining the variance in Av_EU, followed by Av_SE (.27). The 65% of the variance in Av_EU that is explained by Av_PU is the second highest contributor in the figure, following by Av_RA (.26). Finally, Av_SE (.36) is the most significant contributor to explain the variance in Av_RA.

In this figure, there are the insignificant paths which are Av_SE to Av_PU, Av_EU to Av_ATU, and Av_PU to Av_BI. In addition to the hypothesis of the study that Av_RA will have only the positive influence on Av_ATU, Av_RA also has positive influence on Av_PU and Av_EU. Moreover, from the framework of the study, there was a prediction that Av_PU will have positive influence on Av_BI. However, after the analysis, the result shows in this figure that Av_PU has positive influence on Av_BI instead.

4.5 Hypothesis Test Result

H1: The higher the PU on drone technology, the more positive effect on ATU in drone technology. From the Figure 6, it is obviously that Av_PU (.25) significantly contributes to the variance in Av_ATU. Therefore, this hypothesis would be accepted.

H2: The higher the PU on drone technology, the more positive effect on BI in drone technology. From the Figure 6, there is the insignificant path between Av_PU to Av_BI. Therefore, this hypothesis would be rejected.

H3: The higher the PEOU on drone technology, the more positive effect on PU in drone technology. From the Figure 6, it is obviously that Av_EU (.65) significantly contributes to the variance in Av_PU. Therefore, this hypothesis would be accepted.

H4: The higher the PEOU on drone technology, the more positive effect on ATU in drone technology. From the Figure 6, there is the insignificant path between Av_EU to Av_ATU. Therefore, this hypothesis would be rejected.

H5: The higher the ATU on drone technology, the more positive effect on BI in drone technology. From the Figure 6, it is obviously that Av_ATU (.70) significantly contributes to the variance in Av_BI. Therefore, this hypothesis would be accepted.

H6: The higher the SE on drone technology, the more positive effect on PU in drone technology. From the Figure 6, there is the insignificant path between Av_SE to Av_PU. Therefore, this hypothesis would be rejected.

H7: The higher the SE on drone technology, the more positive effect on PEOU in drone technology. From the Figure 6, it is obviously that Av_SE (.27) significantly contributes to the variance in Av_EU. Therefore, this hypothesis would be accepted.

H8: Having CP in the model provides a better fit than a model without CP.

From the model fit test on the Table 4.2 by cutting off some irrelevant variables one by one until the model was reached all of criteria. There was cutting off the CP variable. Therefore, this hypothesis would be rejected.

H8a: CP has a positive relationship with ATU on drone technology. From the model fit test on the Table 4.2 by cutting off some irrelevant variables one by one until the model was reached all of criteria. There was cutting off the CP variable. Therefore, this hypothesis could not be tested.

H9: Having RA in the model provides a better fit than a model without RA. From the Table 4.6, it shows the results of the testing hypothesis (H9). It is shown that having RA in the model could provide a better fit than a model without RA. Therefore, this hypothesis would be accepted.

Table 4.6: Testing hypothesis (H9)

Fit Indices	Threshold	Values Having RA Variable	Values No RA Variable
CMIN/DF	(≤ 5)	3.16	4.92
CFI	(≥ .90)	0.99	0.99
RMR	(≤ .08)	.021	.036
RMSEA	(≤ .10)	.093	.126

Note. Chi-square/Degree of freedom (CMIN/DF), Comparative Fit Index (CFI), Root Mean Square Residual (RMR), and Root Mean Square Error of Approximation (RMSEA)

H9a: RA has a positive relationship with ATU on drone technology. From the Figure 6, it is obviously that Av_RA (.48) significantly contributes to the variance in Av_ATU. Therefore, this hypothesis would be accepted.

Table 4.7: Summary Hypothesis Test Result

Hypothesis	Result
H1: The higher the PU on drone technology, the more positive effect on ATU in drone technology.	ACCEPTED
H2: The higher the PU on drone technology, the more positive effect on BI in drone technology	REJECTED
H3: The higher the PEOU on drone technology, the more positive effect on PU in drone technology.	ACCEPTED
H4: The higher the PEOU on drone technology, the more positive effect on ATU in drone technology.	REJECTED
H5: The higher the ATU on drone technology, the more positive effect on BI in drone technology.	ACCEPTED
H6: The higher the SE on drone technology, the more positive effect on PU in drone technology.	REJECTED

Table 4.7: Summary Hypothesis Test Result (cont.)

Hypothesis	Result
H7: The higher the SE on drone technology, the more positive effect on PEOU in drone technology.	ACCEPTED
H8: Having CP in the model provides a better fit than a model without CP.	REJECTED
H9: Having RA in the model provides a better fit than a model without RA.	ACCEPTED
H9a: RA has a positive relationship with ATU on drone technology.	ACCEPTED

4.6 Standardized Total Effects

The value on this table is calculated by including the standardized direct and indirect effects.

Table 4.8: Standardized Total Effects

	Av_SE	Av_RA	Av_EU	Av_PU	Av_ATU
Av_RA	.448				
Av_EU	.551	.478			
Av_PU	.387	.581	.661		
Av_ATU	.390	.711	.287	.264	
Av_BI	.408	.573	.489	.133	.602

Note. Average Score (Av_)

The table 4.8 shows the standardized total effects value. The coefficient values between all factor are positive. The highest total effects value is Av_RA to Av_ATU which is .711. However, there are lesser total effects value on both Av_EU to Av_ATU and on Av_PU to Av_ATU which are .287 and .264, respectively.

CHAPTER V
RECOMMENDATION

This chapter summarizes the research findings, and discusses the limitations and the recommendations of the study. This research study aims to determine the samples' perceptions of the use of drone technology on the business performance and the business-critical functions as well as to better understand the users' motivations to use drone technology in part of the heavy-duty lifting process. The study also aims to explore and describe the relationship between the theory and the research empirically. The numerical data were used to identify the factors which impact the technology acceptance for the drone technology adoption in Thailand's construction industry. The data were collected as a survey research-based questionnaire.

5.1 Conclusion

The study aims to discover the key factors that influence the intention to use the drone technology. It could be concluded that almost all the factors which were predicted in the hypothesis, influenced the samples' intentions to use drone technology in part of the heavy-duty lifting process excluding CP. Moreover, the researcher found that PU was shown to have the less contribution to explain the variance in ATU since drone technology is not relevant to most of the samples' tasks. However, most respondents/samples have the positive attitudes on drone technology through the perceive of the relative advantage (RA). As a result, RA was the most significant contributor to explain the variance in ATU. With this result, the researcher assumes that only heavy-duty lifting function could not lead to the positive attitudes on drone technology. Moreover, the drone technology in the case of this study is quite new. There are only 40% of respondents who know that drone can be used in part of heavy-duty lifting equipment.

5.2 Limitations

The first limitation is the sample size that only 250 respondents participated in the study, and the perceptions of 250 samples could not represent the perceptions of all people in the industry. Moreover, there is the limitation of time to collect the questionnaire. Another limitation is that this study did not consider about the risk of using drone technology. Therefore, there are some concerns and anxiety regarding on the issue.

5.3 Recommendations

5.3.1 Management

Although technology has become an imperative tool for the daily operations in many organizations, people still used to the old ways of working. There are some following reasons which make the respondents hesitate to use drone technology.

- Lack of knowledge
- Lack of user involvement
- Lack of effective communication

Regarding to these limitations, the recommendation is that the organizations need to have a communication plan. Firstly, they should have the session to give a clear direction, information, and the expectation about the product so that people would have better understanding on the product. They should have chance to learn how this technology could support their operation process. Then, it should have the session that opens the chance for the users to have some involvements with the product by initially invite some employees who have the responsibility in relative task to try out the new technology. It is necessary to have the face-to-face communication as well as the first-handed experience with the new product.

Moreover, another recommendation is that there should be the cost-benefit analysis to compare the advantages and disadvantages between the old and the new technology in each organization. These differences could possibly influence the adoption opinions about to have or not to have this new technology.

5.3.2 Further Research

This quantitative research study could only test the determined hypothesis. Therefore, to gain more insightful view, a qualitative research study could be conducted with the more or less similar way to this study. This could gather more information about the actual influenced determinant effecting the intention to use of drone technology. The further research could explain the technology acceptance more deeply, and could provide the opportunity for the further investigation in many levels.

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