JURNAL INFOTEL
Informatics - Telecommunication - Electronics

Website Jurnal : http://ejournal.st3telkom.ac.id/index.php/infotel
ISSN : 2085-3688; e-ISSN : 2460-0997

Using field experiments to analyze changes in electronic data capture adoption decisions

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Received 19 October 2021, Revised 01 November 2021, Accepted 18 February 2022

Abstract — Lacovou presented research results in a framework that describes the role of the determinants of technology, organization, and environment simultaneously influencing the innovation adoption decision-making process. The Lacovou framework is an extension study of the Tornatzky framework. Tornatzky's framework addresses three determinants that influence innovation adoption. Unfortunately, Lacovou did not present how the decision process took place. Decisions can be rational or irrational. Ajzen and several other studies defined sound decisions as decisions based on consideration information or for a reason as. Previous research had not revealed the rational calculation process empirically in making innovation adoption decisions. Innovation adoption is someone's choice when they perceive the benefit and feel appropriate the innovation and will use or intend to use it. This study intends to reveal how the process of rational calculation in the decision-making adoption of innovations through the field experiment method. This study also reveals whether the decision of Small Medium Enterprises (SMEs) to adopt Electronic Data Capture (EDC) is rational. Research analysis using descriptive analysis method. Researcher can observe the rational calculation process through the field experiment method. The shift in decisions represented by changes in the data on the number of subjects who make adoption decisions illustrate the rational calculation process. The results show that the decision of SMEs in adopting EDC is primarily sound. The yields of this field experiment- research were confirming Lacovou framework. The study illustrates the simulation of the effect of a combination of perceived benefits, organizational readiness, and environmental factors simultaneously.

Keywords – adoption, EDC, rational, SMEs, field experiment

I. INTRODUCTION

Organizations and businesses cannot escape from economic, global, and technological developments. Firms and organizations were suggested to adapt to their changing environment. Cumming explains that one of the preventive steps for organizations to adapt is through innovation management [1].

The earliest effort to carry out innovation management is to understand the meaning of innovation. Roger [2] defines innovation as a user's new perception of an idea, practice, or object.

Tornatzky [3] identified three determinant factors that influence innovation adoption. The three were organizational context, technological context, and the external context (environment).

The technological context includes some factor determinants. Perceived benefit is one of them. Perceived benefit is the perceived usefulness someone feels when using innovation [4] [5]. Osakwe [6] calls it the term Expected benefit. Perceived benefit congruent with relative advantage in Roger's DOI model. Most of the previous studies said that the greater the perceived benefit, the greater the possibility to adopt the innovation.

Organizational readiness is one of the determinants of organizational context. Organizational readiness is defined as the availability of resources within the organization when needed for innovation adoption [6].

The availability of resources in the organization can be in the form of human resources potential, finance, experts, or technology tools. Previous studies have shown organizational readiness to positively affect innovation adoption decisions [6], [7]. The greater the company's finance, the more likely it is to adopt innovation [6]. The availability of experts and tools technological encourages the possibility of embracing innovation.

External pressure is one form of determinant in the environmental context. Previous research identified external pressure factors that influence innovation adoption at the organizational level. Some of them are external demand [8], partner pressure, competitive pressure, consumer pressure, supplier pressure. For example, pressure from competition causes environmental uncertainty, thereby increasing the adoption of innovations in the industry. Peer pressure (partner pressure) and consumer pressure (consumer pressure) influence firms to adopt innovation.

Many kinds of research on adopting innovations are related to positive traits towards adoption [9]. Innovation adoption researchers consider technological developments and innovation to be critical issues. Technology and innovation are critical factors in creating organizational capability and competitive advantage. On the other hand, the technological complexity factor has become a general premise to reject the adoption of innovation [8],.

Furthermore, in the context of technology and innovation, several previous research results show that organizational readiness is a determining factor for companies to adopt e-commerce [6]. The elements of Organizational readiness could be the readiness of technological resources[7], human resources, or finance readiness. Other research shows the different result. The readiness of technological and financial resources is sometimes not a determining factor in adopting innovations. These studies explain that if a company only has the potential of one of the readiness of human resources, finance, or technology, then one factor can play a role in substituting other factors. For example, the company has financial readiness but does not have technological resources. The financial readiness can substitute the unprepared technology or vice versa.

External environmental factors positively affect the firm's decision to adopt technology [5][15]. For example, external environmental factors such as competitive pressure, industry pressure, government support, information technology intensity encourage companies to adopt the technology.

The research indicates that the decision to adopt innovation is situational [4], [14]. The study shows that there is a rational calculation process in the decision-making process for innovation. The calculation process can be described as described by Ajenz [15]. The rational calculation process is a process through negotiation, consideration, and utilization of information. According to the Merriam Webster dictionary [16], the definition of rational is the compatibility between one's actions and the reasons for acting. Or it can also be understood as the compatibility between one's beliefs and motivations for believing.

Lacovou's research discusses the state of technology readiness factors, organizational readiness, and business pressures that influence the company's decision to adopt Electronic Data Interchange. The Lacovou framework illustrates the simulation of the effect of a combination of perceived benefits, organizational readiness, and environmental factors simultaneously into a framework[4], as shown in Table 1.

Table 1. Electronic Data Interchange adoption framework for SMEs by Lacovou

	Organisazional Category	Perceived benefit	Organizational readiness	External pressure
1	Unprepared adopter	High	Low	High
2	Ready adopter	High	High	High
3	Coerced adopter	Low	Low	High
4	Unmotivated adopter	Low	High	High
5	Technology initiator	High	High	Low
6	Non-adopter	High	Low	Low
7	Non-adopter	Low	Low	Low
8	Non-adopter	Low	High	Low

Source: Electronic Data Interchange and Small Organizations: Adoption and Impact of Technology, MIS Quarterly, Vol 19, no 4 (Dec 1995), pp 465 – 485, Lacovou, Benbasat, Dexter

Lacovou shows the influence of several determinants simultaneously on innovation adoption decisions. The effect of the combination of several factors simultaneously is one form of the rational calculation process. Unfortunately, Lacovou does not describe the process of analytical calculation. It needs to reveal how to know the method of rational calculation in decision-making. This study intends to show how the rational calculation process occurs in the innovation adoption decision-making process.

Electronic Data Capture (EDC) is one form of ICT-based technology innovation. It has a function as a payment medium for non-cash transactions by business actors. Vendors (primarily banks) provided EDC for business actors to serve consumers or business partners who want non-cash payments. From a technical point of view, the use of EDC is not complicated, does not require a unique knowledge base, the requirements for its use are not complex, does not require significant capital to procure. The procurement requirements are enough to open an account at the bank selected as a vendor and submit an application.

Based on its innovative nature, EDC will not be complicated and burdensome for business actors to use

it and facilitate their business. However, business actors, especially mainly SME entrepreneurs, have not been widely used this tool. Only a numbers of SMEs use it. This issue raises the question of why this happened. In the prediction, the rational decision-making process, which considers various aspects and utilizes available information, would cause the decision. For this reason, it is necessary to disclose whether the decision-making of EDC adoption by SMEs is rational. According to the issue, this purpose of research is to reveal whether SMEs deciding the use of EDC are rational.

This research is critical because it provides a new discourse in innovation adoption research. This study will investigate the process of decision that will lead to the nature of the decision. Decision nature could be rational or irrational decisions. This point of view will strengthen the premise of the determinant factor that Tornatzky has put forward in his framework, namely the Technology Organization Environment. Secondly, this study reveals the rational calculation mechanism through the relationship of determinant factors in influencing innovation adoption decisions. Empirically this research contributes to confirming the Lacovou framework, which implicitly develops a concept of controlling innovation investment decisions. Thirdly, this study provides insight into experimental research methods to uncover the innovation investment decision-making process.

SMEs have an essential role as a pillar of the economy. It have a lot of contribution to the development and resilience of the economy. The development of theory and knowledge related to SMEs have significant contribution to economic knowledge. This study discusses the topic of innovation investment decisions in SMEs. The final significance of this research is to contribute to the development of knowledge regarding the behaviour of innovation investment decisions in SMEs.

II. RESEARCH METHODS

This study reveals how rational calculations occur in the innovation adoption decision-making process. This research requires an analysis that can answer the "how" question. Among the various existing research methods, the field experiment method is the most suitable to meet the needs of this research because it can present the way with a relatively high degree of internal validity [17]. A field experiment is one method that has a mechanism that allows control of extraneous variables and ecological validity. The control mechanism compares between one condition and another. It can reduce the effect of differences in irrelevant factors such as the background of the subject and factors that interfere with the relationship between the variables tested [17]. Based on this background, the field experiment method became appropriate for this research. This study reveals the relationship between expected benefits, organizational readiness, external pressure, and innovation investment decisions (adoption / no adoption).

A. Experimental Matrix Design

High External Pressure (Ch)		Org. Rea. (A)	
		A_h	A_l
Ex. Be (B)	B_h	A_hB_h	A_lB_h
	B_l	A_hB_l	A_lB_l

Fig 1. Eksperimental Matriks Desain on HEP

Low External Pressure (Cl)		Org. Rea. (A)	
		A_h	A_l
Ex. Be (B)	B_h	A_hB_h	A_lB_h
	B_l	A_hB_l	A_lB_l

Fig 2. Eksperimental Matriks Desain on LEP

B. Experimental Factorial Design

Group kontrol	R		O
Group 1	R	X_{AlBlCh}	O
Group 2	R	X_{AlBhCh}	O
Group 3	R	X_{AhBlCh}	O

Fig. 3. Experimental Factorial Design

Symbol description:

R : Randomisation	O : observation
A : Organizational readiness	h : high
B : Expected benefit	l : low
C : External pressure	X : manipulation

C. Experimental Manipulation Design

Based on the experimental factorial design, this method requires four groups. One group will be the control group, and the other will be the manipulation group. The subjects of the manipulation group were divided into three groups to anticipate the possibility of the threat of mortality or maturation disturbance factors. The mortality disturbance will occur when the subject resigns before the experimental process complete. The maturation disorder factor will happen when the subject experiences natural changes as long as the passage of the experiment.

Manipulation is an action in a specific pattern on experimental subjects to control the confounding factors that influence the causal relationship between the dependent and independent variables.

This experiment set up three different treatments in three groups. The first group (XAlBlCh) represents manipulation test one. The second group XAlBhCh) carried out the second manipulation experimental test. The third group (XAhBlCh) carried out the third

manipulation experiment. The last group carried out the test without manipulation as a control group.

Experimental subjects act as leaders or managers of SME companies. The manager's task is deciding the innovation investment decisions. This research examines the role of organizational decision-making ability in making investment decisions. The study observes the control decision. The study will look at the changes in innovation investment decisions. For example, the manager will adopt the innovation at one time, but will not adopt the-innovation at another time. This phenomenon will appear when decision-makers are faced with more than one independent factor and simultaneously influence together. The experiment manipulates the actions to have high ecological validity. The manipulation has to represent real-life [17]. The study design manipulation through compiling the scenario using storytelling whose was describing of the everyday events and structured as follows:

- Experimental 1st group manipulation.
  Initial treatment: the experiment treated the respondents facing a new technology offering situation in the form of EDC with low expected benefits and low organizational readiness without any external pressure.
  Final treatment: Respondents face a new technology offering in the form of EDC with low expected benefits, low organizational readiness, and external pressure.
- Experimental 2nd group manipulation.
  Initial treatment: the experiment treated the respondents facing a new technology offering in EDC with high expected benefits and low organizational readiness without any external pressure.
  Final treatment: Respondents face a new technology offer in the form of EDC with high expected benefits, low organizational readiness, and external pressure.
- Experimental 3rd group manipulation.
  Initial treatment: the experiment treated the respondents facing the new technology offers in the form of EDC with low expected benefits and high organizational readiness without any external pressure.
  Final treatment: Respondents face new technology offerings in the form of EDC with low expected benefits, high organizational readiness, and external pressure.
- Experimental 4th group (control group):
  In the 4th group, the experiment treated the respondents to face a new technology offering in EDC. This technology has a relative advantage and expected benefit. The managers can feel it. People tend to adopt technology that has a comparative advantage and can provide expected benefits than does not. This research asked the respondents to perceive the perceived relative advantages and benefits scheduled of EDC, and to think about the possible costs and efforts required to use EDC. Then the study asked the respondent about his/her willingness for adopting the EDC.

D. Research Subject

The research subjects were SMEs actors in the Purwokerto area. The number of experimental research subjects required at least 30 samples in each treatment. The study takes 216 people as subjects, in the age range of 21-55 years. Male and female respondents were 130 and 86 people, respectively. Respondents were randomly divided into three treatment groups and one control group as follows:

1st group	62 (M= 41;F=21)
2nd group	66 (M= 39;F=27)
3rd group	66 (M= 40;F=26)
4th group (control group)	22 (M= 9;F=13)

E. Randomization

To reduce or eliminate the bias that occurs due to differences in gender, age, status, randomization is necessary[17]. Randomization randomly spread subjects into four groups. The thing to note in randomization is that the respondents were not informed about different treatments or manipulations of every group. The purpose is to avoid manipulation bias.

F. Data Analysis Techniques

This research intended to reveal a rational calculation process in decision-making by SMEs business actors. The rational-calculation process will rise in form of the presence or absence of changes in decisions. A numerical table will show the difference in the number of those who make decisions in the column 'without external pressure' and column 'no external pressure' in each type of manipulation.

Data analysis uses descriptive statistical data analysis [19] by descriptively presenting the reasons for changes in innovation investment decisions.

III. RESULT

Table 2 and Table 3 present the results of the experimental data processing of innovation investment decisions. Table 2 presents the result of the experiment 4th group. Table 3 presents the result of the experiment 1th , 2th and 3th group.

Table 2. Innovation investment decisions in the Control Group

Group	Decision	
	Adoption	No adoption
Control	22 (100%)	0 (0%)

Table 3. Innovation investment decisions in the Experimental Manipulation Group

Group	Reason	External pressure				No External pressure			
		Adoption		No-adoption		adoption		No-adoption	
1	2	3	4	5	6	7	8	9	10
	PB	49	74,24%	-	-	59	89,39%	-	-
	OR	-	-	5	7,58%	-	-	1	1,52%
PB.h.-OR.l	Irrasional	8	12,12%	4	6,06%	6	9,09%	0	0%
	Total	**57**	**86,36%**	**9**	**13,64%**	**65**	**98,48%**	**1**	**1,52%**
	PB	42	63,63%	11	16,67%	56	84,85%	0	0%
	OR			0	0%	3	4,54%	0	0%
PB.l.-OR.h	Irrasional	9	13,64%	4	6,16%	6	9,09%	1	1,52%
	Total	**51**	**77,27%**	**15**	**22,73%**	**65**	**98,48%**	**1**	**1,52%**
	PB	27	43,54%	26	41,94%	58	93,54%	2	3,23%
	OR	-	-	4	6,45%	-	-	0	0%
PB.l-OR.l	Irrasional	2	3,23%	3	4,84%	2	3,23%		
	Total	**29**	**46,77%**	**33**	**53,23%**	**60**	**96,77%**	**2**	**3,23%**

The Control-group data analysis.

Table 2 provides an overview of how respondents take EDC adoption decisions based on no manipulated respondents' perceptions. The results showed that all respondents (100% of total) stated adopting EDC for their business. They decide to adopt EDC based on their perceptions and assumptions about the technology advantage. Respondents see EDC as a payment device for non-cash transactions. EDC was no complicated device, easy to learn, and had no particular knowledge requirement. The process for having EDC is simple, not require much cost. The use of EDC will provide convenience for consumers.

The Manipulation-groups Data analysis

Table 3 presents three reasons for innovation adoption decisions. They are perceived benefit (PB), organization readiness (OR), and irrational reason. The innovation adoption decision that has no explained reason or no reason at all will be an irrational reason decision.

The data analyzing carry out by comparing the number of respondents in the table between the no-externally pressure column and with-externally pressure column. The comparison of the number of adoptions in each treatment group showed an increase (the change column of 4 to column of 8) of 12.12% (86,36% to 98,48%), 22.21% (77,27% to 98,48%), and 50% (46,77% to 96,77%). The number of adoptions in the presence of external pressure on all manipulation treatments (column 8) was close to 100% (98.48%, 98.48%, and 96.77%). Changes in adoption rates illustrate a shift in decisions. Initially, users do not decide to adopt when they have not faced external pressure. Users drift the decision to adopt when they get external pressure. External pressure causes a shift in EDC adoption decisions. External pressure can be in consumer needs like a non-cash payment need. Business actors who face the demands of consumer needs are encouraged to fulfil them. Because of the limited resources or low organizational readiness, most SME business actors do not adopt innovation. On the other hand, business actors adopt it because they feel the benefits of using EDC.

IV. DISCUSSION

Lacovou put forward three determinant factors, namely Technology, Organization, and Environment, which influence innovation adoption decisions. External pressure is a factor in the business environment that SME actors cannot control. The only effort by SME actors to run their business is to adapt to environmental conditions. Therefore, external pressure is the most dominant factor in influencing the innovation decisions of SME actors.

The benefit factor using technology and organizational readiness are factors that are why SME actors encourage and reject innovation decisions. Some of the reasons the SME actors adopted EDC were due to the benefits of technology, including EDC helping the work process be efficient. Indirectly EDC provides business benefits to survive because EDC can help create consumer satisfaction, adaptive to the environment.

The organizational readiness factor is the subject premise of adopting EDC. Organizations that feel ready with resources tend to have fewer barriers to adopting new technologies. Ironically, the main characteristic of SMEs is an organization that has limited resources. Most SME actors reject to embrace technology because of their limited resources. Resource availability is a critical factor in the innovation decisions of SME actors, while EDC offers many benefits. EDC can be a payment device for non-cash transactions; the technology is not complicated, easy to learn, does not require a knowledge base, the requirement for its use is simple, does not require many capitals to procure. The use of EDC will provide convenience for consumers. Ease of conditions in EDC use does not require the availability and readiness of many resources. So for SME actors, the organizational readiness factor is not a critical factor in adopting EDC.

The changing influence of the three determinants on innovation adoption will shift the decisions. The changing in the existence of the determinant perceived by SME actors illustrates that a rational calculation process in decision-making exists. This study identified irrational choices. It showed the decisions with no

apparent reasons by the SME actors. The numerous irrational decisions in the presence of external pressure is not more than 2%.

V. CONCLUSSION

This EDC adoption by SMEs study needs to reveal the rational calculation process in decision-making. Therefore, it must choose the appropriate method. The chosen method must uncover the process moment, has high internal validity, has ecological validity under the issues studied, can control irrelevant factors. The appropriate research method is a field experiment.

The study run field experiment method through the stages of preparing an experimental matrix design, developing an experimental factorial design, developing an experimental manipulation design, determining research subjects, carrying out randomization, carrying out data analysis techniques according to matrix design, factorial design, and experimental manipulation design. This study using the field experiment method to represent the human calculating-decision process.

The results of data analysis show the factors influencing of the SME actors in making EDC adoption decisions are the presence or absence of external pressure factors, organizational readiness, and perceived benefits. For example, one of the reasons MSMEs adopt EDC is that MSMEs want and need to be able to compete and maintain their business. Therefore, MSME actors will take decisions that support these reasons.

To achieve the business goal, SMEs perform rational calculations in their decisions. SME actors tend to adopt EDC when they feel perceiving external pressure. Meanwhile, in a situation where there is no external pressure, SME actors will consider the benefits of using EDC rather than organizational readiness. These are because using EDC does not require a specific knowledge base. The requirements for its use are uncomplicated and do not require significant capital to procure.

The yields of this field experiment- research were confirming Lacovou framework. Moreover, the study illustrates the simulation of the effect of a combination of perceived benefits, organizational readiness, and environmental factors simultaneously.

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