Technology Adoption: an Interaction Perspective

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Abstract. The success of a new technology depends on how well it is accepted by its intended users. Many technologies face the problem of low adoption rate, despite the benefits. An understanding of what makes people accept or reject a new technology can help speed up the adoption rate. This paper presents a framework for technology adoption based on an interactive perspective, resulting from a literature study on technology adoption. In studying technology adoption, it is necessary to consider the interactions among elements involved in the system, for these interactions may generate new characteristics or new relationships. The interactions among elements in a system adoption have not received sufficient consideration in previous studies of technology adoption. Based on the proposed interaction perspective, technology adoption is elaborated by examining interactions among the individual (i.e. the user or prospective user), the technology, the task and the environment. The framework is formulated by adopting several theories, including Perceived Characteristics of Innovating, Diffusion of Innovation Theory, Technology Acceptance Model, Task-Technology Fit and usability theory. The proposed framework is illustrated in the context of mobile banking adoption. It is aimed to offer a better understanding of determinants of technology adoption in various contexts, including technology in manufacturing systems.

1. Introduction

In a competitive world, innovation has become a key survival factor. New technologies have enabled industries to increase their performances and create better relationships with customers. Organizations must always create new technologies to satisfy customer needs and serve customers better.

The success of a new technology depends on how well it is accepted by its intended users. Many technologies faced the problem of low adoption rate, despite of the benefits. Many innovations require a lengthy period of many years from the time when they become available to the time when they are widely adopted [1].

An understanding of what makes people accept or reject a new technology can help speed up the adoption rate. Many scholars have studied the acceptance of a new technology. From acceptance models in farming industry context, this stream of research had evolved to more general contexts. Rogers [2] introduced Diffusion of Innovation (DOI) theory in 1962. Since then many research had

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been conducted to build and apply adoption models in various contexts, including Theory of Reasoned Action [3], Technology Acceptance Model [4] and its extension [5], Theory of Planned Behavior [6], Personal Characteristics of Innovating [7], Task–Technology Fit [8], Unified Theory of Acceptance and Use of Technology [9] and its extension [10] and Value-based Adoption Model [11]. These models had been used to explain adoption of various technologies in various countries. Some studies confirmed those models while other studies found conflicting results. Technology adoption behavior is a complex phenomenon and no single model is comprehensive enough to cover all aspects of the behavior [12].

This paper presents a framework for technology adoption based on an interaction perspective, resulted from a literature study on technology adoption. In studying technology adoption, it is necessary to consider the interactions among elements involved in the system. Interactions among elements in a system may generate new characteristics or new relationships [13]. This paper aims to broaden the perspective in studying new technology adoption.

The interactions among elements in a system adoption have not received sufficient consideration in previous studies of technology adoption. Based on the proposed interaction perspective, technology adoption is elaborated by examining interactions among the individual (i.e. the user or prospective user), the technology, the task and the environment.

The remainder of this paper is organized as follows. First a literature study on technology adoption is presented. It is followed by an explanation of the interaction perspective and the proposed framework for technology adoption. Finally, the proposed framework is illustrated in the context of mobile banking adoption. This paper ends with conclusion and suggestions for future research.

2. Technology Adoption

Technology adoption has been studied in various contexts. Originating from technology adoption in farming industry, the research area has evolved to the development of more generic models. One of the earliest researches on technology adoption was conducted in 1903 by Gabriel Tarde, a sociologist from France that proposed the S-shaped diffusion curve [14]. However, the revolutionary paradigm for adoption research proposed by Ryan and Gross in 1943 in a study on adoption of hybrid seed corn by Iowa farmers [2]. This study established the customary research methodology: adopters are asked when they adopted, where they obtained information about the innovation and the consequences of adoption [2].

Rogers [2] introduced Diffusion of Innovations (DOI) model in 1962, which later became one of the most frequently used technology adoption models. According to DOI, the adoption of a new technology (or innovation) is affected by 5 characteristics of the innovation itself, i.e. the relative advantage, compatibility, complexity, trialability, and observability. The more an innovation is useful, compatible, trialable and observable, and the less complex it is, the higher is the adoption rate. DOI had been applied in various contexts of technology but only relative advantage, compatibility and complexity are found to consistently predict adoption [15].

Theory of Reasoned Action (TRA) was developed by Fishbein & Ajzen [3], aimed to explain what makes an individual perform certain behavior. TRA has been used to predict behavior in various contexts, including predicting technology adoption behavior. According to TRA, the performance of a certain behavior depends on the intention to perform that behavior. The behavioral intention is based on two determinants, i.e. the attitude toward the behavior and the subjective norm concerning the behavior. The attitude depends on the individual's belief about the outcome of the behavior, while the subjective norm depends on the individual's belief whether the behavior should or should not be performed.

Technology Acceptance Model (TAM) is a modification of TRA, aimed to explain the acceptance of computer technology in workplace context [4]. Adopting TRA, TAM believes that actual use is based on the behavioral intention to use, but this intention is solely affected by the attitude toward using the technology. The attitude is formed by two beliefs: perceived usefulness and perceived ease of use. The parsimony of TAM makes it very popular in technology adoption study. Despite its

popularity, of two main determinants of TAM, only perceived usefulness is consistently found to affect technology adoption intention in many empiric studies. TAM2 was developed to improve TAM, by studying the determinants of perceived usefulness and intention to use [5]. TAM2 employed seven additional constructs covering social influence processes and cognitive instrumental processes. This addition omits TAM2 from parsimonious nature, which makes previous TAM popular. Some of the new constructs are specific for workplace context, which may limit the applicability of the model to other context.

Theory of Planned Behavior (TPB) [6] was developed as a modification of TRA. Similar to TRA, TPB was aimed to explain why an individual perform a certain behavior. TPB argues that behavioral intention can find expression in behavior only if the individual can decide at will to perform or not perform the behavior [6].

Personal Characteristics of Innovating (PCI) was developed based on the notion that attitude toward an object often differ from the attitude toward using the object [7]. PCI employs and modifies six constructs adopted from DOI and TAM, and added two original constructs. PCI introduces new perspective to innovation adoption literatures, which changes the focus from studying the characteristics of an innovation to the characteristics of using the innovation.

Task-Technology Fit studies how information systems affect individual performance in an organizational context [8]. TTF theorizes that technology utilization depends on the degree to which a technology assists an individual in performing the individual's tasks, i.e. the task-technology fit. The TTF framework adds new insight in technology adoption literatures by incorporating the element of task and also the fitness of the task and the technology.

Venkatesh et al. [9] reviewed and integrated 8 acceptance models into a unified model called Unified Theory of Acceptance and Use of Technology (UTAUT). The model comprises of four main constructs, i.e. performance expectancy, effort expectancy, social influence and facilitating conditions. UTAUT argues that these constructs are the determinants of behavioral intention and behavioral intention is the single determinant of use behavior. UTAUT also includes four variables that moderate the effects of the main constructs to behavioral intention. While UTAUT studied technology adoption in workplace context, UTAUT2 was developed for consumer use context [10]. UTAUT2 revises several UTAUT constructs and adds new relationships between constructs. For the purpose of studying adoption in consumer context, the model also incorporates three additional constructs, i.e. hedonic motivation, price value and habit.

Value-based Adoption Model (VAM) also studies technology adoption in consumer use context [11]. VAM adopts the principles of value maximization from consumer behavior studies. Based on the consumer choice perspective, consumer estimates the value of the choice object by considering all relevant benefits and sacrifice factors [11]. VAM argues that perceived value determines adoption intention. The model comprises four main constructs, i.e. usefulness and enjoyment (represent the benefits), and the technicality and perceived fee (represent the sacrifices).

3. Interaction Perspective in Technology Adoption

In studying technology adoption, it is necessary to consider the interactions among elements involved in the system. Interactions among elements in a system may generate new characteristics or new relationships [13]. It is for this reason, this paper studies technology adoption based on interaction perspective. By studying the elements and the interactions among the elements, a clearer picture emerges [17].

The interactions among elements in a system adoption have not received sufficient consideration in previous studies of technology adoption. Several previous studies employed independent variables explaining the characteristics of the individual in their model, i.e. what kind of individual characteristics can affect the decision to adopt. Examples of variables categorized as characteristics of individual are beliefs about consequences of behavior (in TRA model), attitude (in TRA, TAM and TPB), and gender (in UTAUT and UTAUT2).

Several previous studies employed independent variables explaining the characteristics of the technology, e.g. relative advantage and complexity (in DOI model) and perceived fee (in VAM). This variables attempt to explain what characteristics of technology affect the decision to adopt. There are also variables explaining characteristics of the environment, i.e. studying what condition of environment surrounding the individual can affect adoption decision. Subjective norm (in TRA and TPB) and facilitating conditions (in UTAUT and UTAUT2) are two examples of variables categorized as characteristics of environment.

Interactions among the elements are moderately considered in previous studies. Perceived usefulness and perceived ease of use (in TAM) are examples of variables explaining the interaction of individual and technology. Compatibility, trialability and observability in DOI can also be categorized as elaboration of interaction of individual and technology, although DOI is primarily focused on the characteristics of technology. Task-technology fit (TTF) explains interaction of task and technology, and social influence (in UTAUT and UTAUT2) explains interaction of individual and environment.

From the previous studies can be identified four elements involved in system adoption: individual, technology, task and environment. The aspects considered in previous studies can be grouped into two categories: (1) the characteristics of elements, and (2) the interactions among elements. The first category can further be refined to characteristics of: technology, characteristics of individual and characteristics of environment. None of the previous studies elaborate the characteristics of task. The second category can further be refined to interactions of individual-technology, interactions of individual-environment and interactions of technology-task. None of the previous studies elaborates the interactions of individual-task. Table 1 summarizes all aspects considered in previous studies.

Table 1. Aspects considered in previous technology adoption studies

No	Model	Aspects	
		Characteristics of elements	Interactions among elements
1	Diffusion of Innovations [1]	1	A
2	Theory of Reasoned Action [3]	2	B
3	Technology Acceptance Model [4]	-	A
4	Theory of Planned Behavior [6]	2,4	-
5	Personal Characteristics of Innovating [7]	-	A, B
6	Task–Technology Fit [8]	-	A, D
7	Extended TAM/TAM2 [5]		A, B
8	Unified Theory of Acceptance and Use of Technology [9]	2,4	A, B
9	Value-based Adoption Model/VAM [11]	1	A
10	Extended UTAUT/UTAUT2 [10]	2,4	A, B

(Note: 1: technology, 2: individual, 3: task, 4: environment, A: individual-technology interaction, B: individual-environment interaction, C: individual-task interaction, D: technology-task interaction)

The main idea to study the interaction among elements, instead of the characteristics of those elements so as to better understand adoption comes from the study of Moore & Benbasat [7]. Moore & Benbasat developed Perceived Characteristics of Innovating (PCI) based on the notion that attitudes toward an object can frequently differ from the attitudes toward a particular behavior concerning the object. PCI was developed by altering characteristics of innovations in Diffusion of Innovation (DOI) model to characteristics of using the innovation. Later Gounaris & Koritos [18] employed both models in their study on internet banking adoption and found that PCI was superior to DOI. This finding

shows that focusing on the interaction among elements instead of the characteristics of the elements brings better result.

4. A Framework for Technology Adoption

Based on the interaction perspective, the proposed framework elaborates technology adoption by examining interactions among the individual (i.e. the users or prospective users), the technology, the task and the environment. The framework comprises of the interactions between individual and technology, individual and task, individual and environment, and technology and task, as depicted in figure 1.
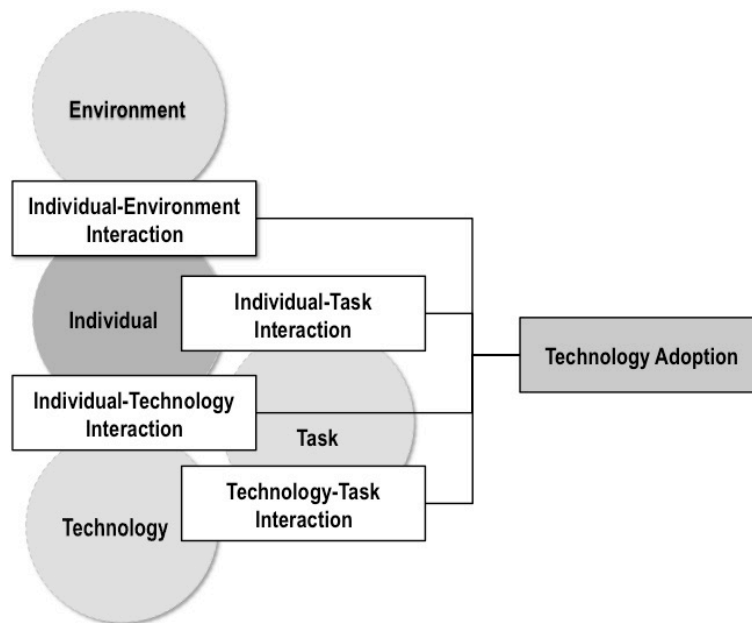

Figure 1. A framework of technology adoption: Interaction perspective

4.1. Individual-Technology Interaction

In adopting technology, the user or prospective user must interact with the technology. This makes the interaction between individual and technology the central interaction in technology adoption. An elaboration of this individual-technology interaction may bring better understanding of the adoption.

A technology must be usable for it to be used by the intended user. A system is usable when the user can do what they want to do the way they expect to be able to do it, without hindrance, hesitation, or questions [19]. Usability is a part of system acceptability, basically aimed to study how well a system satisfies the needs of users and other potential stakeholders [20]. To be usable, a system should be useful, efficient, effective, satisfying, learnable and accessible [19]. These usability attributes should be considered when studying technology adoption. The more usable a technology, the more will the individual adopt the technology.

To be used by the intended user, a technology must also be compatible. Compatibility is the degree to which an innovation is perceives as consistent with the existing values, past experience, and needs of potential adopters [1], which is also a part of interaction between individual and technology. A technology incompatibility with the individual may disturb its adoption.

In the context of mobile banking adoption, the interaction occurs between the individual and the mobile banking application. For this reason, the usability of the mobile banking application should be studied to understand the adoption of mobile banking. In other context, the technology involved in the system should be identified to accurately study its usability.

4.2. Individual-Environment Interaction

Every individual interacts with his or her environment, and this can affect his or her decision to adopt a technology. For example, the interaction between individual and his or her social environment can cause him or her to receive a recommendation to use a certain technology. People can decide to adopt a new technology because of the influence of other people. Venkatesh et al. [9] defines social influence as the degree to which an individual perceives that important others believe he or she should use the new system.

The interaction between individual and environment is not always favorable to a decision to adopt. In the context of new technology that replaces human personnel (e.g. ATM replaces bank teller, parking ticket machine replaces parking personnel), the need to have personal interaction can inhibit the adoption. Many customers value this personal interaction [21], therefore this can influence their decision to adopt. A good examination of the interaction between individual and environment can help explain technology adoption.

In the context of mobile banking, a customer can be encouraged to adopt mobile banking because of many people close to them (e.g. friends, family members, business partners) are using mobile banking. However, bank customers who need personal interaction from bank clerks can refuse to adopt mobile banking, where transactions must be done through mobile applications.

4.3. Individual-Task Interaction

Individuals use technology to accomplish certain task(s), therefore the interaction between individual and task should also be considered in studying technology adoption. The individual's need and motivation to perform the tasks can influence the decision to adopt the technology. If a person doesn't have the need or willingness to do the task, the person will unlikely adopt the technology.

Enjoyment in performing the tasks can also influence the decision to adopt technology. Flow is defined as a holistic sensation that people feel when they act with total involvement; reflects a balance between users' skills and challenges [22]. Flow is commonly measured as the level of intrinsic enjoyment of an activity [23], and has been used to explain adoption in e-commerce and mobile technology contexts [22].

In the context of mobile banking, people use mobile banking to perform banking and/or e-commerce activities. People without the need or motivation to perform those activities will unlikely adopt mobile banking. In addition, the more enjoyment an individual experiences in mobile banking activities, the more he or she will adopt the technology.

4.4. Task-Technology Interaction

For individuals to use a certain technology, the technology must support the task(s) that the individuals need to accomplish. This interaction between task and technology needs also be considered in studying technology adoption. The more its functionality matches the task needed by individuals, the more likely individuals will use a technology.

Task-Technology Fit (TTF) argues that user will adopt technology when the technology fits his or her tasks and improves their performance [8]. Task-technology fit is defined as the degree to which a technology assists an individual in performing his or her tasks [8]. TTF has been used to study technology adoption, especially in information technology contexts.

In the context of mobile banking, for bank customers to adopt it, the mobile banking application must support the tasks needed by bank customers. Either they are banking activities (balance check, fund transfer, etc.), or e-commerce activities (credit card bill payment, top-up purchase, etc.), or both, the mobile banking application should support these features.

5. Conclusion

Technology adoption behavior is a complex phenomenon and no single model is comprehensive enough to cover all aspects of the behavior. This paper aims to broaden the perspective in studying new technology adoption. A framework for technology adoption was developed based on an

interaction perspective, resulted from a literature study on technology adoption. The interactions among elements in a system adoption have not received sufficient consideration in previous studies of technology adoption. Based on the proposed interaction perspective, technology adoption is elaborated by examining interactions among the individual (i.e. the users or prospective users), the technology, the task and the environment. The framework is formulated by adopting several theories, including Perceived Characteristics of Innovating, Diffusion of Innovation Theory, Technology Acceptance Model, Task-Technology Fit, flow and usability theory. This study is a part of a research in progress on mobile banking adoption in Indonesia. Future work will be to develop hypotheses based on the proposed framework and empirically validate the proposed model.

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