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PREFACE

This proceeding contains sorted papers from the International Conference on Information & Communication Technology and Systems (ICTS) 2009. ICTS 2009 is the fifth annual international event organized by Informatics Department, Faculty of Information Technology, ITS Surabaya Indonesia.

The 5th ICTS 2009 proceeding is divided into three sections based on a research interest. Section 1 contains all about Computer & Communication Networks, Computer Education, Society and Management. Section 2 covers Software Engineering, while Section 3 includes topics on Intelligent and Visual Computing.

This event is a forum for computer science, information and communication technology community for discussing and exchanging the information and knowledge in their areas of interest. It aims to promote activities in research, development and application on computer science, information and communication technology.

We would like to express our gratitude to all of keynote speakers: Professor Abdul Hanan Abdullah and Professor Sampei Mitsuji.

We would like to express our gratitude to all technical committee members who have given their efforts to support this conference.

We also would like to express our sincere gratitude to our sponsors: Faculty of Engineering Kumamoto University Japan, JICA PREDICT - ITS, IEEE Indonesia Section, HMTC and Computer Society for great support and contribution to this event.

We would like to thank you to all the authors and the participants of ICTS 2009. This year the authors and the participants come from England, Germany, Indonesia, Iran, Malaysia, New Zealand, Oman, Poland, Switzerland and Taiwan. We hope next year you will participate again in the ICTS 2010.

Finally, we also would like to thank to all parties for the success of ICTS 2009.

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INFORMATION TECHNOLOGY ADOPTION RESEARCH: A PROPOSED THEORETICAL GUIDE

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ABSTRACT

Research within the adoption of information technology has been existing for quite sometimes. The theoretical framework used for such research have been from the area of Diffusion of Innovation by Rogers [1], technology acceptance [2-5] which is based on Theory of Reasoned Action [6], and also recently Actor Network Theory [7-9]. This paper try to map the existing theories in order to give a better view on how that theory should fit into adoption of IT research.

Keywords: theoretical framework, information technology, adoption, individual, organization, interactive process.

1 INTRODUCTION

Adoption of innovation, in this case the innovation is Information Technology (IT), has long been studied and covered extensively in the literature. Although these studies are strong in identifying theoretical foundations, factors, players, organisational structure, and how these factors influence adoption of innovation in an organisation, and provide a comprehensive coverage of the topic, there is still a need to take a fresh, systematic look at the literature to map and structure the vast amount of information it provides. A few studies have proposed frameworks to analyse the literature such as the dichotomy of variance research and process research [10], the distinction between diffusion, determinants, and process research [11], and roles and the interaction between individual and organisation [12]. Rogers [1] stated that diffusion of innovation involved a social system, where the elements within that system interact in the adoption process.

This article used Slappendel's perspective [12] to map the various theory into three main classifications. The classification is based on the point of view taken by the theory. Slappendel proposed three different perspectives, namely individualist, structuralist, and interactive process. The next sections will discuss each perspective.

2 PERSPECTIVES ON INNOVATION RESEARCH

2.1 Individualist

Individualist perspectives assume that the major sources for innovation and changes within organizations are individuals. Such individuals act with their own agenda and make rational decisions to maximize value or utility. Within the literature of adoption of innovation, individualist perspectives are apparent in the Innovation–Decision Process Model (IDPM) [1], Theory of Reasoned Action (TRA) [6], which was later modified and evolved into the Theory of Planned Behavior (TPB) [13], and the Technology Acceptance Model (TAM) [2]. Within those theories, the focus was on how individuals accept new ideas (as a predictable behavior in TRA and its derivatives) and factors influencing the acceptance. The following sections will discuss these theories further.

2.1.1 Innovation Diffusion and Innovation Decision Process Model (IDPM)

Innovation diffusion uses an approach in which the decision to adopt new technology is mainly based on perceptions of the technology within the decision-making unit [1, 14]. IDPM was based on communication theory, where the innovation was communicated to the audience (potential adopters). IDPM could be viewed as the adoption part of the Diffusion of Innovation model by Rogers [15]. The IDPM stages as depicted in Figure 1, defined by Rogers [1] are:

- ***Knowledge***. The decision-making unit is exposed to the existence of innovation. In this case the innovation could be new hardware, software, methodology, or tools. The main activity in this stage is cognitive (knowing). The knowledge about innovation might come through different communication channels.

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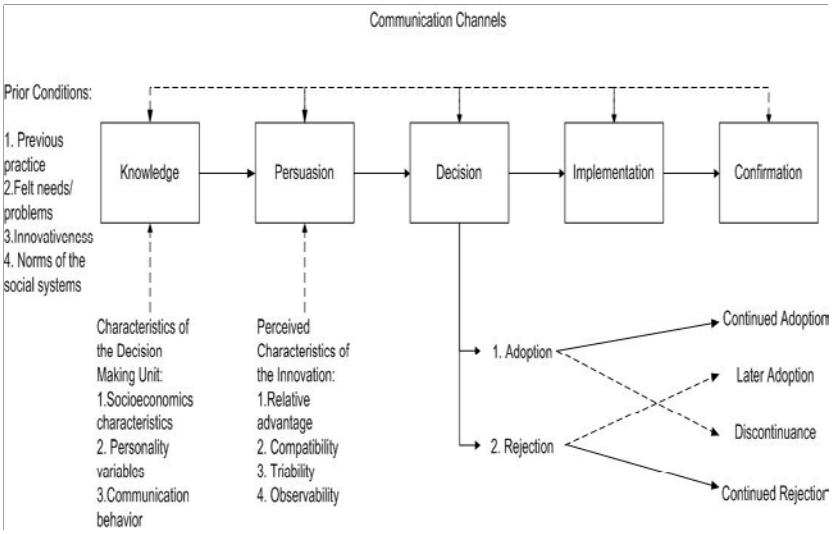

Figure 1. Innovation–Decision Process Model [adopted from 1]

It could be in the form of advertising, word of mouth, formal education or training. Hassinger argues that the knowledge-finding activity is not a passive exercise [cited in 1]. The knowledge-finding activity would be initiated when the need for innovation exists.

- ***Persuasion***. The decision-making unit forms an opinion toward the innovation. This opinion could be favourable or unfavourable. The main activity in this stage is affective (feeling). The decision-making unit would actively seek information about the innovation of concern before developing an opinion.
- ***Decision***. The decision-making unit decides either to reject (rejection) or accept (adoption) the innovation. Usually, the decision to adopt or reject would be made based on a trial period. The result would determine either to adopt or reject the innovation. External parties might be involved by providing an opportunity to demonstrate the innovation.
- ***Implementation***. The decision-making unit actually uses the innovation. This is where the activities shift from strictly mental to real action. It would involve behaviour change due to the implementation. In this stage, the decision-making unit would discover whether the initial knowledge and perception of innovation were true or not. The implementation stage would end when innovation becomes an integrated part of the adopter's life or the innovation perceived as useless.
- ***Confirmation.*** The decision-making unit confirms or reverses the decision to reject or adopt the innovation made in the previous stage. The reason for this change is that information received about innovation may have conflicted with the previous beliefs.

IDPM also incorporates the conditions prior to the knowledge stage that influence the knowledge stage. These conditions are previous practices, the need to be fulfilled or the problem to be solved, innovativeness of the decision-making unit, and the norms of the social systems. IDPM assumes that the adoption process is continuous [1]. A decision to adopt or reject an innovation could be changed in the future if more knowledge and persuasion become available to the decision-making unit. It also could change due to the realities faced during the implementation process.

IDPM has been used to study IT adoption. IDPM has been used to find factors affecting IT adoption in general [16-19], EDI adoption [20, 21], computer technology adoption in less developed countries [22, 23], senior IS managers' adoption of new computing architectures [24], and adoption of web service standards [25]. Others have studied the relationship between the level of internet adoption and competitive advantage [26], general IT diffusion patterns [27], and the role of change agents in IT adoption [28]. The research in IT adoption uses Rogers's IDPM stages to find factors influencing the whole adoption process within a particular context or to explain the role of a particular factor in a particular adoption process [22, 29-32].

In IDPM, it is assumed that every innovation is desirable and therefore rejection of innovation would be considered as resistance to change [33, 34]. The reality is that not every innovation is embraced by the community, as Rogers himself [1]

pointed out in the Persuasion stage. The innovation characteristics of relative advantage, compatibility, triability, and observability would influence the opinions of the decision-making unit toward the innovation.

Within the IDPM model depicted in Figure 1, Rogers portrayed the implementation stage when the decision to adopt was made; however, the real action of implementation was not the focus of this theory. Instead, the focus is more on the communication of information regarding the innovation to the adopter that might change the perception toward innovation. The emphasis on the communication process implies that the adoption is achieved when the decision to accept the innovation is made.

IDPM explains the adoption of innovation on an individual level very well, but not at the organizational level. Most studies using IDPM assume that organizations are at the same level of granularity as an individual level. The consequence of this assumption is that the interaction among individuals within an organization as an integrated unit has been ignored.

2.1.2 Theory of Reasoned Action (TRA), Theory of Planned Behavior (TPB), and Technology Acceptance Model (TAM)

TPB and TAM were both derived from TRA, which originated from the psychology discipline. Basically, TRA is concerned with the prediction of behavior based on psychological variables of an individual. TPB was designed as an improvement to TRA, while TAM was designed specifically for technology acceptance. These two theories will be explained in the following two sections.

Theory of Reasoned Action (TRA) and Theory of Planned Behavior (TPB)

TRA was formulated in 1967 in an attempt to provide consistency in studies of the relationship between behavior and attitudes [6, 35]. TPB [13] is considered as an extension of TRA [35]. The main assumption of TRA and TPB is that individuals are rational in considering their actions and the implications of their actions (decision-making). Rational decision-making assumes that the decision is made under uncertainty [36, 37]. Rational decision-making implies that either optimum results were expected or the decision-making unit was aware of all the impacts and consequences [37, 38].

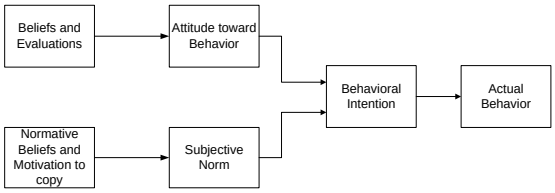

Figure 2. Theory of Reasoned Action [adopted from 6]

TRA was developed to examine the relationship between attitudes and behavior [6, 39]. There are two main concepts in TRA: ”principles of compatibility” and the concept of ”behavioral intention” [6, 39]. Principles of compatibility specify that in order to predict a specific behavior directed to a specific target in a given context and time, specific attitudes that correspond to the specific target, time and context should be assessed [6, 39]. The concept of behavior intention states that an individual’s motivation to engage in a behavior is defined by the attitudes that influence the behavior [6]. Behavior intention indicates how much effort an individual would like to commit to perform such behavior. Higher commitment is more likely to mean that behavior would be performed.

Behavior intention is determined by attitudes and subjective norms [6, 39]. An attitude refers to an individual’s perception (either favorable or unfavorable) toward specific behavior [35]. ‘Subjective norm‘ refers to the individual’s subjective judgment regarding others’ preference and support for a behavior [35].

TRA was criticized for neglecting the importance of social factors that in real life could be a determinant for individual behavior [35, 40]. Social factors mean all the influences of the environment surrounding the individual (such as norms) which may influence the individual behavior [13]. To overcome TRA’s weakness, Ajzen [13] proposed an additional factor in determining individual behavior in TPB, which is Perceived Behavioral Control. Perceived behavioral control is an individual perception on how easily a specific behavior will be performed [13]. Perceived behavioral control might indirectly influence behavior.

TRA and TPB have some limitations in predicting behavior [35]. The first limitation is that intention determinants are not limited to attitudes, subjective norms, and perceived behavioral control [13]. There may be other factors that influence behavior. Empirical studies showed that only 40% of the variance of behavior could be explained using TRA or TPB [13, 35]. The second limitation is that there may be a substantial gap of time between assessment of behavior intention and the

actual behavior being assessed [35]. In that time gap, the intention of an individual might change. The third limitation is that both TRA and TPB are predictive models that predict an individual's action based on certain criteria. However, individuals do not always behave as predicted by those criteria [35].

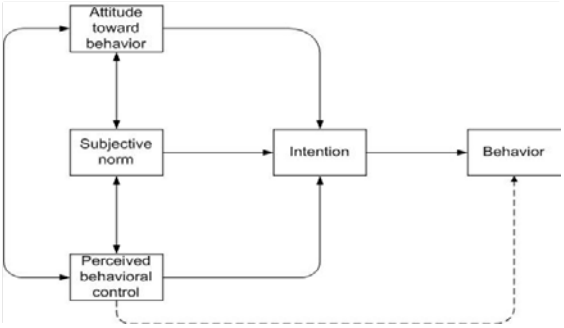

Figure 3. Theory of Planned Behavior [adopted from 13]

In terms of IT adoption, TRA and TPB have been used to explain the adoption process from individual perspectives. TRA was modified into TAM to predict user acceptance of new computer technology [41, 42]. TAM uses the same principles as TRA in predicting acceptance of IT (behavior) from an individual's intention to accept IT. The similarity has been assessed in a study involving 107 MBA students at the University of Michigan [4].

TPB has also been used to explain the adoption of IT. For example, TPB has been used to explain the adoption of voice-mail technology [43] and WAP service [44]. TPB is also comparable with TAM in explaining web presence in SMEs [45].

Technology Acceptance Model (TAM)

TAM was formulated by Fred D. Davis to provide a valid measurement scale for assessing user acceptance of computers [2, 3]. TAM is focused more on technology, and is claimed to be different from previous measurements as it provides a valid measurement scale to predict user acceptance of IT. These measurements were derived from TRA. To measure user acceptance, TAM uses two variables, "perceived usefulness" and "perceived ease" of use [2, 3]. Perceived usefulness (PU) refers to the degree to which the user believes the new technology would enhance job performance [2-4]. Perceived ease of use (PEU) refers to the user's belief that using the new technology would require minimum effort [2-4]. TAM suggested that the user's intention to use new technology is jointly determined by attitudes toward using and perceived usefulness [2-4] as shown in Figure 4:

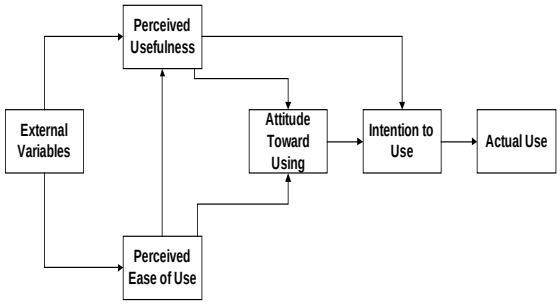

Figure 4. Technology Acceptance Model [adopted from 2]

PEU may be influenced by two factors: the "availability of training and support" and "perceived accessibility" of the new technology [46]. PEU is also influenced by computer self-efficacy, objective usability, and direct experience [47]. PU may be influenced by three factors: the availability of training and support; the social presence of the technology through communication channels; and the social influence to use the new technology [46]. However, in TAM the main focus to measure user acceptance is PU and PEU. TAM seems to ignore *subjective norms* found in both TRA and TPB. Probably TAM assumes that *subjective norms* are included within external variables.

As a model of measuring and predicting user acceptance of new technology, TAM has been tested in various contexts. It has been tested on IT adoption in North America, Switzerland, and Japan [48]. It has also been tested with government employees [49], web systems and e-commerce [50-53], electronic supermarkets [54], and even in agricultural sectors [55]. TAM is widely used and has been perceived as valid in different contexts.

Although TAM has been widely used, it has been found that it could not explain the IT adoption experience in Japan [48]. Straub et.al. [48] believe that this is due to cultural differences. Although it is not clear whether culture is the cause of differences in that study result and what the specific cultural characteristics are that cause the differences, TAM still could not explain the Japanese experience in IT adoption. Furthermore, TAM measurement tools (questionnaires for PEU and PU) could be biased if the researcher changes the order of questions asked. Changing the order or even the wording of questions is common practice when adapting TAM for investigations in different contexts [56]. The order of questions and the translations of TAM's questionnaire might be responsible for the Japanese result. Other research has found that although TAM is useful for predicting user acceptance of new technology, it is better in explaining technology adoption if the researcher takes into account human

and social change processes and also the adoption of innovation model [42]. TAM's focus on PU and PEU did not cover whether there is the need for applicability of a technology (IT) or whether it is "objectively" useful.

Finally, TAM has been extended and evolved into TAM2. TAM2 extends the original TAM to include factors such as subjective norms, image, job relevance, output quality, result demonstrability, experience, and voluntariness [5]. TAM2 has also incorporated some aspects that are similar to the innovation adoption model: observability, triability, and compatibility [1] as suggested by Legris et.al [42].

Even with the modification, TAM is used to explain behavior based on specific stimuli given to individuals as is the case with TRA and TPB. It does not take into account the interactions between individuals within an organization. TRA, TPB, and TAM usually predict the acceptance (or behavior) of innovations as a statistical aggregate from respondents' responses.

2.2 Structuralist Perspectives

Unlike individualist perspectives, a structuralist perspective argues that diffusion of innovation is determined by organizational characteristics (such as technology, strategy, differentiation, etc) and organizational variables (such as size, complexity, professionalism, formalization, and governance) [12]. Structuralist perspectives are not only concerned with the organization itself but also its environment. Within structuralist perspectives, the environment influences the adoption of innovation for an organization and at the same time innovations are facilitated by communication between the organization and its environment [57, 58]. Typical environmental factors are customers, suppliers, competitors, and government [57]. Customers could be a source of innovation information or may demand new products or services that push the organization to adopt innovations, while suppliers might make organizations aware of innovations. On the other hand, the competitive pressure from competitors might initiate adoption, although with limited effect. Finally, governments with their policies also influence the adoption of innovation within organizations, although many structuralist perspectives articles do not discuss this [12].

Typical examples of structuralist perspectives on adoption innovation can be seen in the literature on inter-organizational information systems or any systems which would involve third parties outside the organization. The following are examples:

- Teo and Pian [26] investigated the strategy, size, and competitive advantage influence toward web adoption.
- Soliman and Janz [59] found that inter-organisational information systems were affected by the systems characteristics, pressure from competition, and trading partners' influence.
- Utomo and Dodgson [60] argued that for IT diffusion to be successful, the support of government and research institutions were important as well as the organisation's strategy.
- Yao, Xu, Liu, and Lu [61] found that organisational characteristics, especially size, influenced the adoption of Automatic Teller Machines (ATMs) at a university.

It can be seen that the focus is really on the organization's characteristics and its environment affecting adoption of innovation. It is also noted that the processes within organizations were not a focus in structuralist perspectives [12]. Internal organizational processes such as the development of structure, pattern, and interaction were important factors to explain organization characteristics. Organization characteristics can explain why semiformal organizations such as SMEs can be more flexible than larger enterprises, so may explain why an SME can adopt innovation more quickly than larger enterprises.

2.3 Interactive process perspectives

It can be said that interactive processes offer more comprehensive perspectives of innovation within organizations. Individuals' actions and the structure of an organization would determine the adoption of innovation. The interactive process acknowledges that individuals might act within the organization and its structure, yet at the same time organizational characteristics and its environment would influence the individual's actions. Adoption of innovation is a process which involves the individual, the organization, the environment, and the interactions between them [12]. Research using interactive processes is also found in the Computer Supported Cooperative Work (CSCW) area. One example is the work of Palen and Grudin [62]. They investigated the adoption and deployment of calendaring application within organization. The organization deployed the calendar application and the process of individuals using the calendar began. Palen and Grudin called this discretionary adoption. Within interactive process perspectives, Actor

Network Theory (ANT) is one of the emerging theories that attempts to explain adoption of innovation as a result of interaction process.

Actor Network Theory (ANT)

ANT is often accredited as the work of Michel Callon, Bruno Latour, and John Law [8, 14, 63-67]. ANT deals with [68]:

> *"… progressive constitution of a network in which both human and non-human actors assume identities according to prevailing strategies of interaction. Actors' identities and qualities are defined during negotiations between representatives of human and non-human actors. The most important of these negotiations is 'translation', a multi faced interaction in which actors Construct common definitions and meanings, Define representatives, Co-opt each other in the pursuit of individual and collective objectives."*

The translation process consist of four stages [65]:

1. ***Problematisation***. Key actors attempt to define the problem and roles of other actors to fit the proposed solution, which was made by the key actors.
2. ***Interresment***. Processes that attempt to impose the identities and roles defined in problematisation on other actors.
3. ***Enrolment***. A process where one set of actors (key actors) imposes their will on others. The other actors will be persuaded to follow the identities and roles defined by the key actors. This will then lead to the establishment of a stable network of alliances.
4. ***Mobilisation***. This is where the proposed solutions gain wider acceptance. The network would grow larger with the involvement of other parties that were not involved previously. This growth is due to the influence of actors.

When using ANT to investigate IT adoption, a researcher would focus on issues such as network formation, human and non-human actors, alliance, and network build up [14, 69]. Stronger alliances would be likely to influence the decision to adopt or reject IT. In conclusion, ANT recognizes that adoption of innovation is initiated by individuals who build a network of individuals (in the form of an organization) and nonhumans (machine, tools, etc.) to adopt innovations. ANT is different from DOI in several ways:

- It breaks the communication into stages (of translation).
- It considers the details of "resistance" (anti-program).
- It treats non-humans as actors.
- It explains success and failure with the same model.

ANT was originally developed to explain the diffusion of science into society [for example the idea of pasteurisation in 8]. It is similar to Rogers's DOI. The difference is that Rogers's DOI viewed the diffusion as merely a communication process; while ANT viewed diffusion of innovation as involving a political game where an actor (who wants to spread the innovation) builds a network that will use the innovation.

The use of ANT in explaining the adoption of innovation is still in its early stage. Some examples are the works of McMaster [70, 71] and Tatnall [14, 64]. In those studies, the process of translation was believed to be richer and deeper in that it acknowledged the intertwining and inseparability of technical and social issues. Ciborra has also used ANT to study the management of IT infrastructure and knowledge management [72, 73]. Development of knowledge management and management of IT infrastructure are considered to be political processes, where different stakeholders try to win power and spread their "ideology".

ANT is an example of a theory to explain how different stakeholders in an organization try to spread their ideas to the other stakeholders and influence them to accept the ideas. From the ANT perspective, an actor would build a network of power to overcome other networks of power so he or she could win and impose their ideas. At the end, the actors would use the network to achieve their own goals. In the context of adoption of innovation, the ANT perspective could be used to show how different actors spread their ideas (innovation) to be adopted by others through the development of a network. When their ideas (innovation) are accepted by the other stakeholders (the development of a network), the actor could use the network to achieve his or her own goals.

3 DISCUSSIONS AND CONCLUDING REMARKS

We have discussed the relevant literature on IT adoption, using the perspectives of the

innovation framework from Slappendel [12]. Rogers's IDPM [1] has informed us about the adoption process. However, Rogers's IDPM is mostly concerned with the acceptance of innovation and not the actual use of the innovation. We believe that adoption of innovation should include the use of the innovation. Slappendel's [12] framework has informed us that there are many factors involved within the interactive process of adoption of innovation. Individualist perspectives theory such as TAM [2, 3], TRA [6], and TPB [13] have shown us how an individual might decide to act on something based on certain variables. The action concerned might be the adoption of innovation (for example in TAM). Structuralist perspective research has informed us that the process of adoption of innovation involves not only an individual action but also other individuals and non-individuals (organization and environment).

From each perspective, numerous studies have been made to explore the adoption of innovation. Research in the individualist framework tends to focus on the acts of the individual who initiates the adoption process, while the structuralists believe adoption of innovation is determined by the organization's characteristics and its environment. The interactive process school believes that adoption of innovation is a result of interactions between individuals, the organization, and the environment. The views of the different perspectives are supported by the contingency theory of organizational behavior, which recognizes that an organization is situated in an environment and consists of individuals who interact with each other within groups.

The intention of each individual to use IT can be seen as resulting from efforts to spread the IT (diffusion) by other parties [1]. At the individual level, as suggested by Davis [2] through TAM, decisions to accept new technology were determined by individual perceptions of ease of use and usefulness. As described by Karahanna and Straub [46] perception of ease of use was influenced by training and support availability and accessibility. Usefulness is influenced by availability of training and support, the social presence of the technology through communication channels, and social influence to use the technology [46]. Availability of training and support and awareness of technology have been covered by vendors and also government initiatives.

In conclusion, both IDPM [1] and TAM [2] have been able to provide theoretical foundation for analyzing individual adoption of IT. However, as Slappendel [12] pointed out, adoption of innovation is not only an individual decision but also involves other elements within the individual environment (e.g. organizations). To some extent, IDPM and TAM have already shown that individual decisions were influenced by the environment. Organizations adopting IT have gone through interactions between individuals within the organization and between the organization and its environment. Therefore such interaction is covered in the IDPM and TAM.

In light of such complexity, a combination of perspectives is needed to give a more comprehensive view of adoption of innovation. We used Slappendel's framework [12] as the basis of our analysis of research literature on adoption of innovation. In Slappendel's original framework [12] we did not find a specific model which could be used to explore and explain IT adoption. What we found was that Slappendel classified the theory of adoption of innovation into three categories. We believed that an interactive process model is the most appropriate approach to be used in this thesis. However, we did not find a model of such an interactive process in Slappendel's framework. Slappendel's framework only provides a perspective to look at adoption of innovation as an interaction between different stakeholders. Therefore we need to build an initial model that could guide us in exploring the adoption of IT from the interactive process perspective.

What we proposed is the combination of factors influencing IT adoption and how those factors interact during the process of IT adoption. Our proposed model has the following assumptions: as each organization consists of individuals who interact with each other (Robbins, 2003), therefore it is necessary to acknowledge that individual characteristics and their actions influence the adoption of innovation. Organizations are situated and interact within their environment [57, 74], therefore it is also important to acknowledge that environment and organizational characteristics influence the adoption of innovation.

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