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Understanding the Acceptance of Modeling Methods by IS Developers: A Theoretical Model and an Empirical Test

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UNDERSTANDING THE ACCEPTANCE OF MODELING METHOD BY IS DEVELOPERS: A THEORETICAL MODEL AND AN EMPIRICAL TEST

Alternative Approaches to Information Systems Development

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Abstract

Modeling is an essential aspect of information systems (IS) development. A modeling method defines the constructs and syntax that modelers can use to develop information models. Despite the proliferation of modeling methods, only a few have been widely accepted by the IS development community. IS developers are ultimately the ones who use these modeling methods and evaluate their acceptability. Therefore, the long-term viability of a modeling method and its eventual success depend on its extensive and continued use by IS developers. This study examines IS developers' modeling method acceptance by identifying factors that influence their intention to continue using a modeling method. The theory of planned behavior (TPB) is used as the primary theoretical foundation for this research. Based on a comprehensive literature review, a research model to explain IS developers' modeling method continuance was developed. A cross-sectional survey study was conducted to test the research model.

Key words: information systems development, modeling method, acceptance

Introduction

Modeling is an essential aspect of information systems (IS) development (Olle et al. 1991). A modeling method defines the constructs and syntax for modelers to develop various models and for readers to understand existing models. Some modeling methods are also called modeling languages (e.g. the Unified Modeling Language) or modeling techniques. In essence, components of a modeling method – constructs and syntax – are similar to the vocabulary and grammar in a natural language. As a result, the outcome of applying a modeling method, like a sentence or paragraph using a natural language, conveys information for communication.

Recognizing the critical role of modeling in IS development, researchers and practitioners have designed many modeling methods. Despite the proliferation of modeling methods, only a few have been widely accepted by IS development community (Siau and Rossi 1998). A recent and promising modeling method is the Unified Modeling Language (UML). Promoted as a standard by the Object Management Group (OMG), UML is thought to be a viable and popular method for object-oriented modeling (Booch et al. 1999; Kobryn 1999; Maciaszek 2001). Nonetheless, a recent study indicates that UML has also met with relatively slow acceptance among IS developers (Grossman et al. 2005): only 27.5% of the sample use UML consistently on all projects while over 44% use it only sporadically.

The slow acceptance of most modeling methods has raised research interests among IS researchers. Some researchers have conducted studies to investigate the strengths and weaknesses of specific modeling methods. However, findings from these studies with technical focus provide only partial explanation of the actual acceptance and usage pattern. To move forward the research and practice in this area, we also need to examine the phenomenon from the behavioral perspective.

While the initial adoption of a modeling method is often an organizational decision, IS developers are ultimately the ones who use modeling methods and evaluate their acceptability. Prior studies (e.g. Brown et al. 2002; Khalifa and Verner 2000; Orlikowski 1993) have suggested that individual developers can decide not to use a modeling method

even if there has been an organizational decision to adopt it organization-wide. In other words, the long-term viability of a modeling method and its eventual success depend on its continued and extensive use by individual developers.

Therefore, it is imperative to have a good understanding of the continued use of a modeling method by individual developers. This study focuses on the reasons why individual developers are willing to continue using a modeling method, after its initial adoption, in different degrees. In other words, the goal of this study is to identify the independent variables and evaluate their impact on the dependent variable, which is the individual developers' intention to continue using a modeling method.

To address this research question, this study developed a research model to explain the individual developers' continuance intention to use a modeling method. The development of the research model was mainly based on a comprehensive review of relevant literature in social psychology, behavioral science, and information systems. The theory of planned behavior (TPB) (Ajzen, 1985, 1991), one of the most prominent theories of behavioral intention, was chosen as the theoretical foundation in view of its widespread applicability in social sciences. A cross-sectional survey study was used to empirically test the research model.

The rest of the paper is organized as follows. First, the research background of this study is introduced. Second, the theoretical foundation is described. This is followed by the development of the research model. Third, the details about the survey study are provided. Finally, the potential limitations and contributions of this study are discussed.

Research Background

In information systems development, modeling has been defined as "the activity of formally describing some aspects of the physical and social world around us for purposes of understanding and communication" (Mylopoulos 1992 p.51). In other words, modeling is the process of presenting knowledge held by various stakeholders in the development process for the purpose of understanding and communication. Many researchers and practitioners have articulated on the importance of modeling in IS development. For instance, Kung and Solvberg (1986) suggest four functions of modeling: provide a way for developers and users to communicate, increase analysts' understanding, serve as the basis for design, and serve as documentation of the original requirements of the system for maintenance purposes. Similarly, Booch et al. (1999) summarize the four important aims of modeling as: (1) visualize a system as it is or as user and developer community want it to be, (2) specify the structure or behavior of a system, (3) give developers a template that guides them in constructing a system, and (4) document the decisions that the user and developer communities have made.

Modeling Methods

Regardless of specific purposes, modeling activities are conducted using certain modeling methods. A modeling method can be defined as an approach to perform modeling, based on a specific way of thinking, consisting of directions and rules, and structured in a systematic way (Brinkkemper 1996). A modeling method is similar in nature to a natural language, including a notation and a deductive mechanism for drawing inferences from a body of statements represented in that notation (Mylopoulos et al. 1990). Therefore, some modeling methods are called modeling languages or modeling techniques.

Depending on the purpose of a specific modeling activity, a modeling method must have a clear focus. Modeling methods with different focuses have been designed and proposed by both researchers and practitioners. For example, the current version of the Unified Modeling Language (UML 2.0) defines 13 different modeling methods for object-oriented modeling activities in software-intensive systems.

There is no shortage of modeling methods in the field of IS development. In the early 1980s, there were hundreds of different modeling methods (Bubenko 1986; Olle et al. 1982). During the period between 1989 and 1994, the number of object-oriented modeling methods increased from fewer than 10 to more than 50 (Booch et al. 1999). The quest to develop the next modeling method has been wittily termed the YAMA (Yet Another Modeling Approach) syndrome (Oei et al. 1992) and NAMA (Not Another Modeling Approach) (Siau 1999; Siau et al. 1996).

The proliferation of modeling methods has kept plaguing IS development organizations as well as individual developers, who have tried desperately to find a modeling language that meets their needs. The slow acceptance of most modeling methods creates much concern among developers, software companies, CASE tool venders, and certainly the designers of modeling methods.

Literature Review

IS researchers have primarily taken two approaches to examining the issues related to modeling method. Some studies have technical focus. These studies usually treat modeling method as the subject of research. Other studies investigate the behavioral issues related to modeling method, and treat the users of modeling method (i.e., development organization and developers) as the subject of research.

Prior Studies with Technical Focus

There are two streams of studies in this category. One stream is focused on the design and application of specific modeling methods (e.g. Krogstie et al. 2005; Loucopoulos and Zicari 1992; Olle et al. 1986; Siau and Halpin 2001). The other stream is primarily concerned about evaluating or comparing various modeling methods. Technical focus is common among these studies (e.g. Loucopoulos 1992; Moody et al. 2003; Siau and Rossi 1998).

Prior Studies with Behavioral Focus

While extensive studies have been conducted on the technical issues related to modeling method (i.e., the design, application, and evaluation of modeling methods), few empirical studies have investigated the actual adoption and use of modeling methods by the IS development community. There is limited coverage in the actual usage of UML. For instance, Dawson and Swatman (1999) conducted a research project to investigate how object-oriented modeling methods were used by practicing professionals in requirements engineering. Agarwal and Sinha (2003) carried out an empirical study to assess the usability of UML from a developer's perspective. Finally, Grossman et al. (2005) investigated UML's usage among developers.

These studies have provided some insights into the acceptance and actual use of UML, as an example of modeling method, in IS development. However, it is still unclear what factors influence the acceptance of modeling methods by individual developer.

Since the actual acceptance of modeling methods is largely neglected in the IS research, there are many possible research topics. To further narrow down the research focus of this study, existing literature on technology acceptance is reviewed. In particular, this review focuses on the acceptance of development methodology and Computer-Aided Software Engineering (CASE) tool, two development artifacts closely related to modeling method.

Prior Studies on Acceptance of Development Methodology and CASE Tool

The majority of these studies (e.g. Hardgrave and Johnson 2003; Iivari 1996; Orlikowski 1993; Riemenschneider et al. 2002) examine the acceptance of either development methodology or CASE tool at the individual developer level. As pointed out by Hardgrave and Johnson (2003), an organization's decision to adopt will not automatically translate into individual acceptance without resistance. "There would naturally be some mutual influence between the organizational and individual decision to adopt an [development methodology]" (p.323). The review of prior studies on the acceptance of development methodology and CASE tool also indicate that many factors, including technological, personal, and organizational issues, have great influence on developers' acceptance, which is often expressed by developers' intention to adopt or use.

Focus of the Present Study

Firstly, this study focuses on the acceptance of modeling methods by individual developers. We concur with the viewpoint of some researchers (e.g. Hardgrave and Johnson 2003; Khalifa and Verner 2000) that there is mutual influence between the organizational and individual decision to adopt and use a development artifact, such as a modeling method, a development methodology, or a CASE tool. In this study, we take the stance that individual developers are the ones who actually use a modeling method and evaluate its usability and acceptability. Thus, the long-term viability of a modeling method is largely dependent on individual developers' acceptance.

Secondly, as in the case of IS development methodologies (Hardgrave and Johnson, 2003; Khalifa and Verner, 2000) and CASE tools (Iivari, 1996; Orlikowski, 1993), the adoption of a development artifact is often an organizational decision. As a result, individual developers may not have the choice whether to "accept" a new modeling method or not during the initial adoption period. Therefore, it is appropriate to investigate individual

developers' usage pattern in the post-adoption stage. In this study, we focus on examining factors that influence the continued use (continuance) of a modeling method by individual developers.

Thirdly, even though the actual level of modeling method usage would be an ideal indicator of modeling method continuance, there are two problems of using usage behavior as the surrogate of continuance in the present study. First, the actual level of usage would be greatly influenced by the characteristics of specific IS development projects and not necessarily by the issues related to a modeling method. This problem may have a profound impact on cross-sectional studies when subjects are from different organizations. Second, when modeling method use is strictly optional, the actual level of usage would sufficiently represent continuance of a modeling method. But it would not be the case when the level of use is mandated within organizations. In the IS literature, acceptance is often expressed by one's intention to perform a specific behavior (Davis 1989; Taylor and Todd 1995; Venkatesh and Davis 2000; Venkatesh et al. 2003). Following this norm, modeling method continuance is measured by individual developers' intention to continue using it in the present study.

In summary, this study examines individual developers' modeling method continuance through evaluating their continuance intention to use it in the post-adoption stage. With this research focus clarified, we turn to the introduction of related theories to explore the potential influence of the organizational, social, and technological factors.

Theoretical Foundation and Development of Research Model

Continuance intention is a type of behavioral intention. One of the most prominent theories of behavioral intention is the theory of planned behavior (TPB).

Theory of Planned Behavior

The subject of behavioral intention in the workplace has a long history within the field of social/organizational psychology. The TPB (Ajzen 1985; Ajzen 1991) is a prime example of a social psychology theory that has found widespread applicability in social sciences, including IS (Hardgrave and Johnson 2003; Mathieson 1991; Taylor and Todd 1995). According to the TPB, behavioral intention is directly determined by attitude toward the behavior, subjective norm, and perceived behavioral control (PBC). Actual performance of the behavior is predicted by behavioral intention and by the degree of actual control one has over performing the behavior. The TPB has been extensively applied in the IS research as a theory to explain IS/IT adoption behaviors.

Other theoretical perspectives, such as Technology Acceptance Model (TAM) (Davis 1989), Diffusion of Innovation (DOI) (Rogers 1995) and Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al. 2003), were also reviewed. There is extensive similarity among what the TPB and other established theoretical perspectives (TAM, DOI, and UTAUT) explain regarding factors influencing behavioral intention. In view of the widespread applicability of the TPB in social sciences, this study employs the TPB as its theoretical foundation for developing the research model.

Development of Research Model

The TPB lays out a general framework of behavioral intention's determinants (Attitude, Subjective Norm, and PBC). However, it does not specify the factors that influence these intention determinants in the current research context. Some IS researchers (e.g. Lewis et al. 2003; Venkatesh and Davis, 1996, 2000) have studied the antecedents of attitude, subjective norm and PBC in the context of IS acceptance. To our best knowledge, no study has taken this approach to investigating IS developer's continuance intention to use a modeling method. Therefore, this study follows the precedents of prior acceptance research (e.g. Hardgrave and Johnson, 2003; Iivari 1996; Lewis et al. 2003; Riemenschneider et al. 2002) to identify the context-specific antecedents of attitude, subjective norm and perceived behavioral control.

As discussed in the previous section, the TPB is chosen as the theoretical foundation for the development of the research model. Other theoretical perspectives and empirical studies in IS research are used to extend the general framework to include antecedents of high-level constructs (attitude, subjective norm, and PBC). In doing so, we aim to not only assure high explanatory validity, but also select managerially amenable factors. This approach has been suggested and employed by many researchers (e.g. Ajzen 1991; Karahanna et al. 1999; Lewis et al. 2003; Taylor and Todd 1995) in IS research.

Research Model

Figure 1 presents the model of developer's modeling method continuance. The right-side of the research model is an adaptation of the TPB in the context of modeling method use. In other words, developers' intention to continue using a modeling method is determined by attitude, subjective norms, and PBC. The left side of the figure depicts antecedent factors that influence developers' continuance intention through the three main determinants.

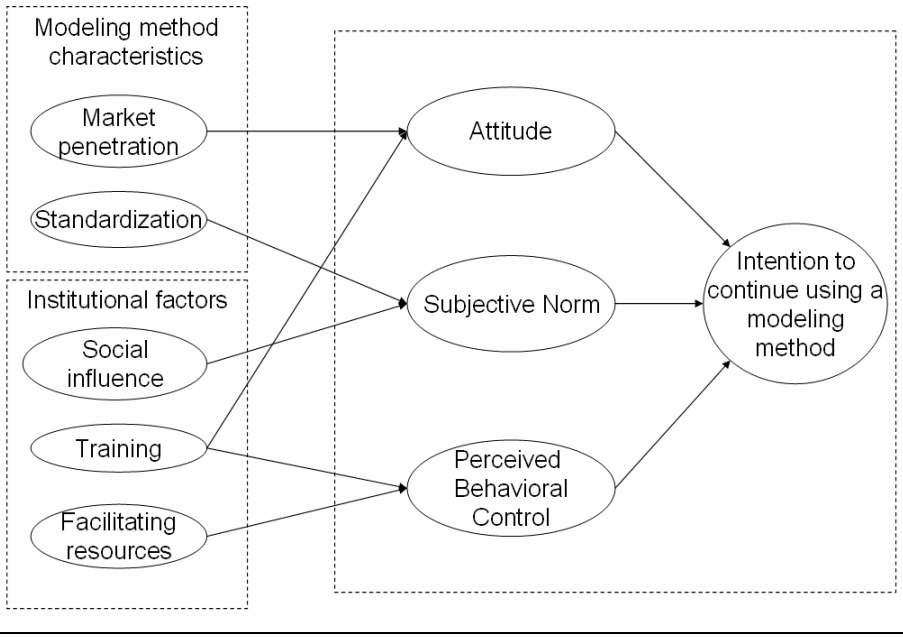

Figure 1. Research Model

According to the TPB (Ajzen 1985, 1991), all external factors exert their influence on behavioral intention through attitude, subjective norm, and PBC. To identify the antecedent factors that shape a developer's perceptions about modeling method continuance, we reviewed related theoretical models and prior empirical studies. In particular, the existing literature on the acceptance of development methodology and CASE tool was extensively referred to for the identification of antecedent factors. In this study, we focus on the factors that are reasonably controllable during the initial adoption and post-adoption continuance. Thus, we examined the factors that are classified into two categories: modeling method's characteristics and institutional factors (see the left-panel of research model). This approach to developing research model has been employed in many IS studies (e.g. Iivari 1996; Khalifa and Verner 2000).

Modeling Method's Characteristics

There are many modeling methods in the market. The methods that have high market penetration will be more likely to be regarded as having relative advantage. This is due to (1) internalization effect, a process by which, when one perceives that an important referent thinks one should use a modeling method, one incorporates the referent's belief into one's own belief structure (Rice et al. 1991), and (2) valuing modeling skills when individual developers view an industry-standard modeling method as improving their skills and therefore enhancing their knowledge portfolio and marketability (Orlikowski 1993). Thus, market penetration is proposed as a direct determinant of attitude.

Standardization is found to be able to promote wide recognition and facilitate acceptance (Kobryn, 1999). Therefore, standardized modeling methods are more likely to be perceived as being the mainstream, resulting in higher levels of subjective norm. In other words, if a modeling method has a high level of standardization, the developer's social network (development community) is more likely to use it for modeling activities. In the research model, standardization is proposed as a direct determinant of subjective norm.

Institutional Factors

Antecedent factors in this category deal with the factors within an organization in which individual developers work with modeling methods. Prior studies have primarily examined the effect of social influence (Hardgrave and Johnson 2003; Iivari 1996; Riemenschneider et al. 2002), training (Amoako-Gyampah and Salam, 2004; Igbaria et al. 1997; Venkatesh and Davis 1996), and facilitating resources (Taylor and Todd 1995) on an individual developer's formulation of salient beliefs. In the same vein, these factors are proposed to affect intention's determinants in the research model.

Social influence will play an important role in shaping the subjective norm. Social influence refers to the normative beliefs that the developer attributes to what relevant others expect him or her to do with respect to using the modeling method. Social influence is closely related to the communication network aspects of modeling activities. In other words, developers often use information models to help communicate with other developers or clients (Booch et al. 1999). Therefore, social influence is proposed as a direct determinant of subjective norm.

Organizations often provide formal and informal training to developers when a new modeling method is adopted. Training has been found to influence perceived ease of use and perceived usefulness (Amoako-Gyampah and Salam 2004; Igbaria et al. 1997; Venkatesh and Davis 1996). In addition, training is often used as means of improving self-efficacy (Bernardin and Buckley, 1981; Gist et al. 1989). These constructs are similar to attitude and PBC, two determinants of continuance intention. In the research model, hence, training is proposed as a direct determinant of both attitude and PBC.

Facilitating resources refer to the external resources provided by organizations to use a modeling method, such as CASE tools, software templates, computers, and networks. Taylor and Todd (1995) investigated the impact of facilitating conditions on users' system use intention in organizations. In the context of the present study, an abundance of facilitating resources will provide a supportive environment for developers to use a modeling method. Therefore, it is proposed as a direct determinant of PBC.

Research Design

The research model outlined above was empirically tested through a cross-sectional survey research. Survey research is a typical method for testing models in social science studies (Babbie 1990), including IS (Grover et al. 1993; Pinsonneault et al. 1993).

The population of interest for this study includes IS developers who have knowledge of certain modeling methods. The data collection was through a Web-based survey. Eighteen survey questions were developed to measure the constructs in the research model. Due to the space constraints for research-in-progress paper, details of the research design as well as data analysis, are available upon request and can be found in Tan (2006). The findings will be reported in the paper presentation in ICIS 2006.

Conclusion

In this study, we developed a theoretical model to identify the factors that influence individual developers' continuance intention to use a modeling method. A cross-sectional survey study was conducted to test the research model.

From a theoretical perspective, this study extends existing knowledge of modeling method continuance in two important ways. Firstly, by building on the TPB and integrating other theoretical perspectives, we have made a significant step toward a more comprehensive understanding of the complexity that relates to developer's continuance intention to use a modeling method. Secondly, we have extended the general framework of the TPB to account for specific antecedent factors that indirectly affect intention. This extension provides a greater and deeper understanding of why individual developers continue using a modeling method in different degrees.

From a managerial perspective, the model of IS developer's modeling method continuance enables managers of software development organizations to make necessary improvements and design effective interventions to maximize the benefits of using a modeling method in their development efforts. In addition, such understanding enables the designers and vendors of modeling methods and supporting tools to improve the usability and acceptability of their products.

This study is not without limitations. First, only a limited number of antecedent factors are examined in this study. Following a positivist research approach, we aimed to not only assure high explanatory validity, but also select managerially amenable factors. The five antecedent factors were selected because they are reasonably controllable by development organizations. A full-scale empirical study following interpretive research approach, such as grounded theory research and qualitative case studies, can be applied in the future to probe other relevant situational factors. Second, there are theories or theoretical perspectives that may be also valuable in explaining the adoption and use of modeling method by IS development community. For instance, adaptive structuration theory (DeSanctis and Poole 1994) provides a viable foundation for exploring the "evolution-in-use" as well as the organizational impacts of technological artifacts (modeling methods in this case). Future research may employ alternative theories to investigate the adoption and use of modeling method by IS development community.

References

Agarwal, R., and Sinha, A.P. "Object-oriented modeling with UML: A study of developers' perceptions," *Communications of the ACM* (46:9) 2003, pp 248-256.

Ajzen, I. "From Intentions to Actions: A Theory of Planned Behavior," in: *Action-Control: From Cognition to Behavior*, J. Kuhl and J. Beckmann (eds.), Springer-Verlag, Berlin, 1985, pp. 11-39.

Ajzen, I. "The Theory of Planned Behavior," *Organizational Behavior & Human Decision Processes* (50:2) 1991, pp 179-211.

Amoako-Gyampah, K., and Salam, A.F. "An extension of the technology acceptance model in an ERP implementation environment," *Information & Management* (41:6) 2004, pp 731-745.

Babbie, E.R. *Survey Research Methods* Wadsworth, Belmont, CA, 1990.

Bernardin, H. J., and Buckley, M. R. "Strategies in rater training," *Academy of Management Review* (6:2) 1981, pp 205-212.

Booch, G., Rumbaugh, J., and Jacobson, I. *The Unified Modeling Language User Guide* Addison-Wesley, Reading, Mass., 1999.

Brinkkemper, S. "Method engineering: Engineering of information systems development methods and tools," *Information and Software Technology* (38:4) 1996, pp 275-280.

Brown, S. A., Massey, A. P., Montoya-Weiss, M. M., and Burkman, J. R. "Do I really have to? User acceptance of mandated technology," *European Journal of Information Systems* (11:4) 2002, pp 283-295.

Bubenko, J.A. "Information systems methodologies: a research view," in: *Information Systems Design Methodologies: Improving the Practice*, T.W. Olle, H.G. Sol and A.A. Verrijn-Stuart (eds.), North Holland, Amsterdam, 1986.

Davis, F.D. "Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology," *MIS Quarterly* (13:3) 1989, pp 318-340.

Dawson, L., and Swatman, P. "The use of object-oriented models in requirements engineering: a field study," *20th international conference on Information Systems* (ICIS'99), Charlotte, NC, 1999, pp. 260-273.

DeSanctis, G., and Poole, M. S. "Capturing the complexity in advanced technology use: Adaptive structuration theory," *Organization Science* (5:2) 1994, pp 121-147.

Gist, M. E., Schwoerer, C., and Rosen, B. "Effects of alternative training methods on self-efficacy and performance in computer software training," *Journal of Applied Psychology* (74:6) 1989, pp 884-891.

Grossman, M., Aronson, J.E., and McCarthy, R.V. "Does UML make the grade? Insights from the software development community," *Information and Software Technology* (47) 2005, pp 383-397.

Grover, V., Lee, C.C., and Durand, D. "Analyzing Methodological Rigor of MIS Survey Research from 1980-1989," *Information and Management* (24) 1993, pp 305-318.

Hardgrave, B.C., and Johnson, R.A. "Toward an information systems development acceptance model: The case of object-oriented systems development," *IEEE Transactions on Engineering Management* (50:3) 2003, pp 322-336.

Igbaria, M., Zinatelli, N., Cragg, P., and Cavaye, A.M. "Personal computing acceptance factors in small firms: a structural equation model," *MIS Quarterly* (21:3) 1997, pp 279-305.

Iivari, J. "Why are CASE tools not used?" *Communications of the ACM* (39:10) 1996, pp 94-103.

Karahanna, E., Straub, D. W., and Chervany, N. "Information technology adoption across time: A cross-sectional comparison of pre-adoption and post-adoption beliefs," *MIS Quarterly* (23:2) 1999, pp 183-213.

Khalifa, M., and Verner, J. "Drivers for software development method usage," *IEEE Transactions on Engineering Management* (47:3) 2000, pp 360-369.

Kobryn, C. "UML 2001: A standardization odyssey," *Communications of the ACM* (42:10) 1999, pp 29-37.

Krogstie, J., Halpin, T., and Siau, K. *Information Modeling Methods and Methodologies* Idea Group Publishing, Hershey, PA, 2005.

Kung, C.H., and Solvberg, A. "Activity modeling and behavior modeling," in: *Information Systems Design Methodologies: Improving the Practice*, T.W. Olle, H.G. Sol and A.A. Verrijn-Stuart (eds.), North-Holland, Amsterdam, 1986, pp. 145-171.

Lewis, W., Agarwal, R., and Sambamurthy, V. "Sources of influence on beliefs about information technology use: An empirical study of knowledge workers," *MIS Quarterly* (27:4) 2003, pp 657-678.

Loucopoulos, P. "Conceptual Modeling," in: *Conceptual Modeling, Databases, and CASE: An Integrated View of Information Systems Development*, P. Loucopoulos and R. Zicari (eds.), John Wiley & Sons, New York, 1992, pp. 1-26.

Loucopoulos, P., and Zicari, R. *Conceptual Modeling, Databases, and CASE: An Integrated View of Information Systems Development* John Wiley & Sons, New York, 1992.

Maciaszek, L.A. *Requirements Analysis and System Design: Developing Information Systems with UML* Addison Wesley, New York, 2001.

Mathieson, K. "Predicting User Intentions: Comparing the Technology Acceptance Model with the Theory of Planned Behavior," *Information Systems Research* (2:3) 1991, pp 173-191.

Moody, D.L., Sindre, G., Brasethvik, T., and Solvberg, A. "Evaluating the Quality of Information Models: Empirical Testing of a Conceptual Model Quality Framework," *25th International Conference on Software Engineering*, Portland, OR, 2003, pp. 295-305.

Mylopoulos, J. "Conceptual Modeling and Telos," in: *Conceptual Modeling, Databases, and CASE: An Integrated View of Information Systems Development*, P. Loucopoulos and R. Zicari (eds.), John Wiley and Sons, New York, 1992, pp. 49-68.

Mylopoulos, J., Borgida, A., Jarke, M., and Koubarakis, M. "Telos: Representing Knowledge about Information Systems," *ACM Transactions on Information Systems* (8:4) 1990, pp 325-362.

Oei, J.L.H., van Hemmen, E.D.F., and Brinkkemper, S. "The Meta Model Hierarchy: A Framework for Information System Concepts and Techniques," Technical Report 92-17, Department of Information Systems, University of Nijmegen, Nijmegen, The Netherlands.

Olle, T.W., Sol, H.G., MacDonald, I.G., Rolland, C., Sol, H.G., Van Assche, F.J.M., and Verrijn-Stuart, A.A. *Information Systems Methodologies; A Framework for Understanding*, (2nd ed.) Addison-Wesley, Boston, MA, 1991.

Olle, T.W., Sol, H.G., and Verrigin-Stuart, A.A. *Information Systems Design Methodologies: A Comparative Review* North Holland, Amsterdam, 1982.

Olle, T.W., Sol, H.G., and Verrigin-Stuart, A.A. *Information Systems Design Methodologies: Improving the Practice* North-Holland, Amsterdam, 1986.

Orlikowski, W.J. "CASE tools are organizational change: Investigating Incremental and Radical Changes in Systems Development," *MIS Quarterly* (17:3) 1993, pp 309-340.

Pinsonneault, A., and Kraemer, K. "Survey research methodology in management information systems: An assessment," *Journal of Management Information Systems* (10:1) 1993, pp 75-106.

Rice, R.E., and Aydin, C. "Attitudes towards using new organizational technology: Network proximity as a mechanism for social information processing," *Administrative Science Quarterly* (36) 1991, pp 219-244.

Riemenschneider, C. K., Hardgrave, B. C., and Davis, F. D. "Explaining software developer acceptance of methodologies: A comparison of five theoretical models," *IEEE Transactions on Software Engineering* (28:12) 2002, pp 1135-1145.

Rogers, E. M. *Diffusion of innovations* (4th ed.) Free Press, New York, 1995.

Siau, K. "Information modeling and method engineering: A psychological perspective," *Journal of Database Management* (10:4) 1999, pp 44-50.

Siau, K., and Halpin, T. *Unified Modeling Language: Systems Analysis, Design and Development Issues* Idea Group Publishing, Hershey, PA, 2001.

Siau, K., and Rossi, M. "Evaluation of Information Modeling Methods - A Review," *Thirty-first Hawaii International Conference on System Sciences (HICSS-31*), Big Island of Hawaii, 1998, pp. 312-314.

Siau, K., Wand, Y., and Benbasat, I. "Evaluating Information Modeling Methods-A Cognitive Perspective," *Workshop on Evaluation of Modeling Methods in Systems Analysis and Design (EMMSAD '96*), Crete, Greece, 1996, pp. 1-13.

Tan, X. "Understanding Information Systems Developers' Modeling Method Continuance: A Theoretical Model and An Empirical Test," Doctoral Dissertation, University of Nebraska – Lincoln, 2006

Taylor, S., and Todd, P.A. "Understanding Information Technology Usage: A Test of Competing Models," *Information Systems Research* (6:2) 1995, pp 144-176.

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

Venkatesh, V., and Davis, F.D. "A Theoretical Extension of the Technology Acceptance Model: Four Longitudinal Field Studies," *Management Science* (46:2) 2000, pp 186-204.

Venkatesh, V., Morris, M.G., Davis, G.B., and Davis, F.D. "User acceptance of information technology: toward a unified view," *MIS Quarterly* (27:3) 2003, pp 425-478.