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Keng Siau

University of Nebraska-Lincoln, siauk@mst.edu

Xin Tan

University of Nebraska - Lincoln, xintan@unlserve.unl.edu

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An Investigation into the Continued Use of Unified Modeling Language (UML) in Information Systems Development

Keng Siau

Department of Management
University of Nebraska – Lincoln
Email: ksiau@unl.edu

Xin Tan

Department of Management
University of Nebraska – Lincoln
Email: xintan@unlserve.unl.edu

ABSTRACT

As the *de facto* standard for object-oriented modeling language, UML is expected to play an increasingly important role in information systems development. The long-term viability and eventual success of UML depend, to a great extent, on the continued use by UML users such as developers and analysts. Systematic investigations on UML's continued use have been missing from contemporary discussions. Our study attempts to fill this gap in the literature. We developed a research model, which is primarily based on the Expectation Disconfirmation Theory (EDT). According to this model, UML users' perceived discrepancy between pre-adoption expectation and post-adoption perceived performance, which is conceptualized as *performance disconfirmation* and *effort disconfirmation*, is the determinant of *satisfaction*. UML users' post-adoption expectation, in terms of *perceived usefulness* and *perceived ease of use*, is the determinant of *attitude*. Both satisfaction and attitude are posited as determinants of users' *intention to continue using UML*.

Keywords

UML, Information systems development, continuance, disconfirmation, expectation.

INTRODUCTION

The Unified Modeling Language (UML) 2.0 specification defines twelve types of diagrams, which can be applied for specifying, visualizing, and documenting models of software systems in various development phases (OMG, 2005). Since UML has emerged as the computer industry's *de facto* standard for object-oriented modeling language (Kobryn, 1999), it is expected that UML will play an increasingly important role in information systems development.

Object Management Group (OMG) has taken great effort to standardize UML. The major benefits of UML's standardization include wide recognition and acceptance (Kobryn, 1999). Modeling tool vendors are including UML support in their products. Some emerging information systems development methodologies, such as Unified Process (UP) and Agile Development, have adopted UML as their primary modeling language. As a result, more and more software development organizations have started adopting UML for various systems development activities.

Like other standards, the long-term viability of UML and its eventual success depend on its continued use by its end-users such as system developers and analysts. To date, systematic investigations on the continued use by UML users have been missing from contemporary discussions. The objective of our study is to understand the continued use of UML in information systems development. More specifically, we are interested in (1) what are the salient motivations underlying individual analysts' intention to continue using UML, and (2) to what extent do these motivations influence continuance intention?

Based on an expectation disconfirmation theory (Oliver 1980) and related IS studies (Bhattacharjee 2001; Bhattacharjee and Premkumar, 2004), we developed a research model, which describes the relationships among performance disconfirmation, effort disconfirmation, satisfaction, perceived usefulness, perceived ease of use, attitude, and continuance intention. A survey is planned to collect data from IS professionals who have used UML in various systems development activities. In view of the latent variables in the research model, structured equation model (SEM) will be used as the statistical technique for model testing.

THEORETICAL BACKGROUND

The Use of UML in Information Systems Development

The original designers of UML have suggested that UML as a graphical modeling language can be used for modeling system requirements, describing design artifacts, and specifying implementation details in information systems development (Booch, Rumbaugh, and Jacobson, 1999; Rumbaugh, Booch, and Jacobson, 1999). Some researchers have proposed ways to applying UML diagrams in various information systems development activities (*e.g.*, Jackson 1998; Dennis, Wixom, and Tegarden, 2001; Maciaszek 2001).

Much effort, such as the standardization of UML as well as embedding UML in systems development methodologies and CASE tools, has been taken to facilitate software development organizations to adopt UML. Despite of the vast adoption of UML by software development organizations, the pattern of using UML in a continued way is mixed among developers and analysts (Wieringa, 1998; Dawson and Swatman, 1999; Glinz, 2000). Some researchers have focused on the technical issues to identify the deficiencies and problems of UML that hinder the adoption as well as continued use (Glinz 2000; Siau and Cao, 2001; Shen and Siau, 2003). However, the social and cognitive issues surrounding developers and analysts' continued use of UML are largely absent in the extant literature.

IS Studies in Continuance Behavior

In contrast to initial adoption or acceptance, continuance refers to a post-acceptance stage when the use transcends conscious behavior and becomes part of normal routine activity (Bhattacharjee, 2001). IS researchers have taken different approaches to examining post-adoption behaviors.

Some researchers take the stand that continuance is an extension of initial acceptance behavior. For instance, some longitudinal studies (Karahanna and Straub, 1999; Venkatesh and Davis, 2000; Venkatesh, Morris, Davis, and Davis, 2003) use the same variables to explain both acceptance and continuance decisions. The name of a latest model, the Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh *et al.* 2003), reveals the implicit assumption of this approach: continuance behavior (continued use) covaries with initial adoption behavior (acceptance).

Bhattacharjee (2001) pointed out that the above approach is unable to explain why some users discontinue IS use after accepting it initially. Furthermore, the above approach does not take into account users' psychological motivations emerging after their initial acceptance. In other words, these emergent motivations potentially influence users' subsequent continuance decisions but not their prior acceptance decisions (Bhattacharjee, 2001). Drawing upon the expectation disconfirmation theory (EDT), Bhattacharjee and his colleagues (Bhattacharjee, 2001; Bhattacharjee and Premkumar, 2004) empirically assessed the impact of some emergent motivations on users' continuance intention.

Expectation Disconfirmation Theory (EDT)

EDT is widely used in the area of consumer behavior to study consumer satisfaction and post-purchase behavior, such as repurchase and complaining (Anderson and Sullivan, 1993; Oliver, 1980, 1993; Tse and Wilton, 1988). Oliver (1980) proposes a model (Figure 1) expressing consumer satisfaction as a function of expectation and expectancy disconfirmation, and as an influencing factor of attitude and repurchase intention.

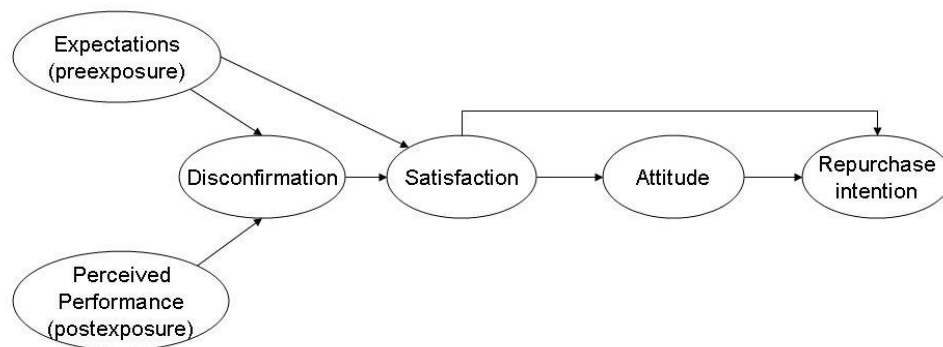


Figure 1. Key constructs and relationships of Oliver's EDT model

According to this model, consumers form an initial expectation of a specific product prior to purchase, then they form perceptions about its performance after a period of initial consumption. Following that, the perceived discrepancy (disconfirmation) between prior expectations and the actual performance of the product will be evaluated. The evaluation of disconfirmation and expectations are two antecedents of consumers' satisfaction with the product, which will affect repurchase intention directly and indirectly through attitude.

Similar to (Bhattacharjee, 2001), we contend that analysts' decision to continue using UML is akin to consumers' repurchase decision. This is because, like repurchase decision, the continuance decision (1) follows an initial acceptance decision, (2) is influenced by the initial use experience, and (3) can potentially lead to ex post reversal of the initial decision. Our study is similar in spirit to the approach taken by (Bhattacharjee 2001; Bhattacharjee and Premkumar, 2004). We adapt EDT from the consumer behavior literature to propose a model of continued use of UML in information systems development.

RESEARCH MODEL

In order to adapt EDT to our research context, several theoretical extensions are required. First, we concur with Bhattacharjee (2001) that the effects of any pre-adoption variables are already captured within the disconfirmation and satisfaction constructs. So, the proposed continuance model focuses only on post-adoption variables. Second, as post expectation is especially important for products where expectation may change over time, the proposed continuance model extends EDT to including ex post expectations, which are represented by perceived usefulness and perceived ease of use (Davis, 1989). Figure 2 shows the proposed research model.

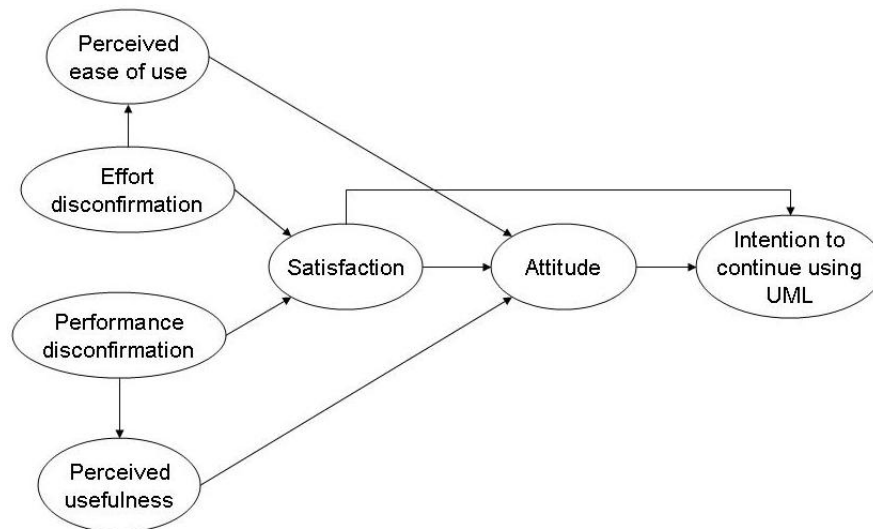


Figure 2: A model of the continued use of UML in information systems development

According to EDT and its adapted models, UML users' intention to continue using UML is determined by their satisfaction with prior UML use, both directly and mediated by attitude. Therefore, the following hypotheses are formulated:

- H1. UML users' level of satisfaction with UML use is positively associated with their intention to continue using UML.
- H2. UML users' level of satisfaction with UML use is positively associated with their attitude toward using UML.
- H3. UML users' attitude toward using UML is positively associated with their intention to continue using UML.

EDT posits that satisfaction is determined by the perceived discrepancy between prior expectations and perceived performance. In our research model, the perceived discrepancy is represented by effort disconfirmation and performance disconfirmation. These two constructs corresponds to two related concepts in UTAUT (Venkatesh *et al.* 2003): effort

expectancy and performance expectancy.

H4. UML users' degree of performance disconfirmation is positively associated with their satisfaction with UML use.

H5. UML users' degree of effort disconfirmation is positively associated with their satisfaction with UML use.

Disconfirmation in EDT is related to a concept of cognitive dissonance (Festinger, 1957). When UML users' pre-adoption expectancies are disconfirmed during actual use, psychological tension may be evoked. Rational users may try to remedy this dissonance by distorting or modifying their post-adoption expectancies in order to be more consistent with reality. Bhattacharjee (Bhattacharjee, 2001) argues that disconfirmation will tend to elevate users' post-adoption performance expectancy. In the same vein, we propose the following hypotheses:

H6. UML users' degree of performance disconfirmation is positively associated with their perceived usefulness of UML.

H7. UML users' degree of effort disconfirmation is positively associated with their perceived ease of using UML.

Finally, TAM (Davis, 1989) literature has established that perceived usefulness and perceived ease of use are the predominant predictors of attitude and information technology usage intention. Therefore, we include perceived usefulness and perceived ease of use in our model to be determinants of attitude.

H8. UML users' degree of perceived usefulness of UML is positively associated with their attitude toward using UML.

H9. UML users' degree of perceived ease of using UML is positively associated with their attitude toward using UML.

RESEARCH METHOD

Initial Instrument Development

Since no empirical study has examined the continued use of UML in information systems development, we must design a survey with questionnaires to measure the conceptual constructs in our research model. The questionnaires (available upon request) are developed based on prior studies, especially that of (Bhattacharjee, 2001; Bhattacharjee and Premkumar, 2004; Davis, 1989). The instruments within these studies have been proved to be valid and reliable in the IS research context.

Pilot study

The next step in our research is to conduct a pilot study to assess the relevance and content validity of our survey questionnaires. Since the unit of analysis is individual UML users such as developers, project managers, and analysts, we will recruit some practitioners for the pilot study. Necessary changes will be made to the survey questionnaires based on the feedback of our pilot study participants.

Data collection

With relatively valid and reliable questionnaire items, we will administer the survey to random selected systems development professionals (system analysts, developers, and project managers), who have used UML in various information systems development tasks. As the patterns of continued use of UML are assumed to be different among developers and analysts, this variance is suited well for statistical analysis.

Data analysis

For model testing, the data will be first evaluated for validity and reliability using confirmatory factor analysis. Cronbach alphas will be used to evaluate the reliability of the questionnaire items. With validity and reliability established, we will test the research model using structured equation model (SEM). Common model fit indices will be used to evaluate overall model fit. Statistically significant relationships among constructs will be identified by the model test procedure.

CONCLUSION

Based on the review of relevant consumer behavior and IS literature, we developed a research model, which identifies the factors that affect the continued use of UML by developers and analysts in information systems development. The research model, as a plausible nomological network, incorporates the constructs derived from the expectation disconfirmation theory (EDT) (Oliver, 1980) and its adapted model (Bhattacharjee, 2001). Our domain specific research model provides an in-depth understanding of the continued use of UML in organizational context. Upon the completion of the study, the tested research model can make both academic and practical contributions.

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