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Abstract

Systems development methodologies are not widely used (less than 50% actually use a methodology to guide systems development). With the importance placed on information systems and the current problems in developing systems, why are methodologies not used? The objective of the study proposed herein is to develop a model to assist organizations in assessing the determinants of actual use of systems development methodologies. The authors are currently in the midst of a multi-phase research project designed to build and test the model.

Introduction

The importance of information systems in today's complex and dynamic environment only heightens the challenge of how to successfully develop information systems. Unfortunately, evidence suggests that systems development is not improving as it should. In addition to a growing two to four year application backlog (Parker and Case, 1993), research indicates that only about 25% of all developments are successful (Whiting, 1998). These factors have contributed to the so-called "software crisis" (Pressman, 1997). Innovations ranging from CASE tools to prototyping to object-oriented development have been introduced in the recent past. However, subsequent research on these areas indicate that many of the tools such as CASE, techniques such as prototyping, and methodologies in general are not widely utilized (Kemerer, 1992; Hardgrave, 1995; Glass, 1996). If these innovations are meant to improve software development, why are they not being used?

With the exception of a series of articles appearing in the early 1980s (Zmud 1982, 1983, 1984), research has largely ignored the study of factors influencing the adoption or use of systems development methodologies. Overall, there has not been a comprehensive study of methodology use. The purpose of the study is to develop a theoretical model to assist organizations in assessing the determinants of actual use of development methodologies.

Perspectives on Systems Development

A methodology is a comprehensive guide to developing a system. It is, to use an analogy, a "how-to book" for building a system. A technique is the detail for one or more phases of the methodology (i.e., a chapter in the how-to book). A tool is used to support one or more techniques. Examples of methodology, technique, and tool are SSADM (Structured Systems Analysis and Design Methodology), structured programming, and CASE tools, respectively. Without a methodology, tools and techniques provide relatively little (if any) benefit.

Research has indicated that only about 43% of the companies actually follow any type of methodology (Glass, 1996). The Software Engineering Institute, using the Capability Maturity Model as a framework, categorizes the systems development practices of 58% of organizations as chaotic indicating the lack of a consistent (either formal or informal) development process (Software Engineering Institute, 1998). Why are methodologies not used more? No one knows for sure and research has failed to satisfactorily answer this question (Wynekoop and Russo, 1995). Overall, the literature has not addressed such questions as (Wynekoop and Russo, 1995): (1) Are methodologies used? If not, why not? (2) How are methodologies selected? (3) Do methodologies work? and (4) Are methodologies obsolete?

Perspectives on Use

Actual 'use' of an innovation is the end result of the adoption process: parties become aware of the innovation, the innovation is introduced, affected parties decide to adopt or reject the innovation, the innovation (if adopted) is used and on-going decisions are made regarding the continued use of the innovation. The entire process of awareness through use is often called the innovation process (Rogers, 1994); some call it assimilation (Fichman and Kemerer, 1997). In this study, 'use' is used broadly to indicate the full spectrum of adoption – from awareness to actual use.

There are several streams of innovation research, including research about the innovation process and perceptions of using the innovation primarily based on the Diffusion of Innovations (DOI) by Rogers (1994), and intention-based models which use behavioral intention to predict usage based mainly on the Theory of Planned Behavior (TPB) by Ajzen (1988). In the area of information technology, innovation research has addressed topics such as IT adoption in small businesses (Harrison, et al., 1997), adoption of personal computers (Igbaria, et al., 1997), use and adoption of executive information systems (Rai and Bajwa, 1997), and adoption of outsourcing practices (Hu, et al., 1997). In the specific area of systems development methodologies (or closely

related areas), innovation research is generally lacking. Zmud (1982, 1983, 1984) published a series of studies that looked at influences, such as communication and organizational structure, on the innovation process. Leonard-Barton (1987) looked at the adoption of structured analysis techniques. Recently, Johnson (1998) looked at an individual's propensity to adopt object-oriented technology. Overall, there is no published evidence of a comprehensive look at the innovation process, and use, in particular, for development methodologies.

As no theory of methodology use exists, this research proposes a theoretical model that borrows heavily from existing innovation research. The result is a comprehensive, integrated model of methodology use (see Figure 1) based largely on Rogers' DOI and Ajzen's TPB. The major components of the model are innovation characteristics, organizational structure, internal factors, organizational goals, voluntariness, and use, as explained in the following sections.

Innovation Characteristics

Perhaps the most well known set of constructs studied in innovations is that proposed by Rogers (1994). The constructs are compatibility (degree of consistency with existing state), trialability (degree of experimentation possible), observability (degree of visibility), relative advantage (degree of advantage over existing state), and complexity (degree of difficulty of innovation) (Rogers, 1994). In IT studies, the concepts of usefulness and ease of use have replaced relative advantage and complexity, respectively (Davis, 1989). Studies by Agarwal and Prasad (1997), Moore and Benbasat (1991), Taylor and Todd (1995), Chau (1996), Davis (1989), and Igbaria et al. (1997) have investigated at least a subset of these constructs. This set of constructs can be used for examining the intention to use and the affects on actual use.

Organizational Structure

Zmud (1982) first proposed the use of organizational structure characteristics (formalization and centralization) in the study of systems development methodologies. This is one of the few sets of constructs that have actually been used in previous systems development research. Ruppel and Harrington (1995) later used formalization and centralization as independent variables in their study of the adoption of telework.

Internal (intraorganizational) Factors

Chau (1996), in a study of the adoption of CASE tools by systems developers, found management support and internal support (e.g., training) influenced the innovation characteristics of relative advantage (usefulness) and complexity (ease of use). Similarly, Igbaria et al. (1997) found the same relationships in a study of small business adoption of personal computers. Training and management support appear to influence the adoption and use of an innovation.

Organizational Goals

Hollenbeck and Klein's (1987) goal-setting theory and Naylor, Pritchard, and Ilgen's (1980) theory of organizational behavior suggest that the goals of the organization influence the intention and actual use of an innovation. Johnson (1998) found positive influences between organizational goals and a software developer's intention to adopt object-oriented technology. Organizational goals, therefore, are germane to the study of methodology acceptance.

Voluntariness

Most innovation studies assume the acceptance and use of an innovation is voluntary. However, this is not always the case. Moore and Benbasat (1991) introduced voluntariness to the study of IT innovations and found significant relationships. Voluntariness has subsequently been used in other studies (e.g., Agarwal and Prasad, 1997).

Use

The ultimate outcome of the study of the innovation adoption process is the actual use of an innovation. However, actual use is only one phase in the overall process of adoption. The five stages of adoption, according to Rogers (1993), are (1) awareness and understanding, (2) attitude forming, (3) decision to adopt or reject an innovation, (4) use of the innovation, and (5) reinforcement of the decision, with possible rejection if unfavorable. Fichman and Kemerer (1997) refer to the process as assimilation. This study is concerned with the entire adoption process. 'Use' generically refers to the entire process.

Summary

Overall, the model in Figure 1 is a theoretical model of methodology use. From this theoretical model, an instrument was developed to examine determinants of use. The authors are currently in the process of pre-testing the instrument. A Fortune 100 company has agreed to allow the authors to administer the questionnaire to software developers in their organization. This sample will allow for validation of the instrument and a preliminary indication of the accuracy of the model in determining use.

Research Methods

The research methodology employed allows for the building and testing of theory. It has been suggested that multiple research methods are necessary to adequately build and test a new theory (Eisenhardt, 1989). The proposed research, designed to allow the building and testing of theory, will be conducted in four phases: (1) build the theoretical model and associated instrument; (2) validate the instrument; (3) test the model; and (4) conduct an industry survey.

Phase 1: Build Theoretical Model and Associated Instrument

Phase 1 represents the theory building phase of the research project. Using existing theory and prior studies, a theoretical model was constructed. After the literature-based model was complete, action research was used to further define the model. With action research, also known as participative research, the researcher becomes part of the organizational process under study (Jenkins, 1985). Action research is crudely equivalent to a case study with researcher intervention. In this case, the researchers spent time studying the methodology innovation process in the participating organization. The purpose of the action research was to identify modifications to the literature-based model. At this phase, it is possible to determine if a single model sufficiently covers both use and determinants of use. This portion of the project is completed, as evidenced by the model shown in Figure 1.

After the theoretical model is established, the associated instrument(s) (in the form of a survey) was constructed. Instrument items were adopted from prior studies when possible. For new constructs, new items were generated.

Phase 2: Validate Instrument

Once the initial instrument is established, it is necessary to assess the validity and reliability of the instrument. To gather the data necessary to determine validity and reliability, the instrument will be administered to a sufficient sample of developers at a Fortune 100 participating organization. The instrument will be modified according to the validity and reliability (i.e., areas of poor validity or reliability will be omitted).

Phase 3: Test the Model

After assessing the validity and reliability and making necessary adjustments, the resulting model can be tested. Overall, we are looking at how well the model explains use. Since the model in Figure 1 is a causal model, the causal relationships are, by theory, assumed to exist until disconfirmed or falsified through testing. Through the analysis of the data collected in Phase 2, parts of the model may be rejected on statistical grounds, resulting in a more accurate model. For example, if a relationship cannot be supported by analysis, it will be removed and the model re-analyzed. This process is continued until the overall fit of the model is acceptable and individual relationships are significant.

The final model may be very similar to the model created in Phase 1, or it may be very different (or somewhere in between). Once the model is finalized, theory construction is complete.

Phase 4: Conduct Industry Survey

After theory construction, the theory must be tested in a broader population. This is necessary to truly test the theory and ensure that the model is not an artifact of the participating organization. In this case, an industry survey can be used to collect the necessary data. A broad cross-section of firms from a variety of industries should provide a sufficient quantity and quality of data. The validity, reliability, and fit of the model (as explained in Phases 2 and 3) will be assessed. Modifications to the model will be made as needed.

Summary and Current Status of Research Process

The phases are described sequentially, but they are not meant to be sequential. At any phase (1-4), it may be necessary to return to a previous phase. This iteration will be necessary until a sufficient model is constructed.

References and figure available upon request from Bill C. Hardgrave.