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Factors Affecting the Adoption of Web Services Technology

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ABSTRACT

This study aims to finding the factors that affect the adoption of web services technology. The study proposes a web service technology adoption model in which three contexts from Tornatzky and Fleischer's (1990) framework, namely, external environmental context, technological context and organizational context, and two constructs from the TAM (Davis, 1989) model, perceived usefulness and perceived ease of use, are studied to determine their influence on web services adoption. Exploratory factor analysis is used to explore the factors affecting the adoption of web services technology. Structural Equation modeling is used to validate and analyze the research model.

INTRODUCTION

To cope with an increasingly competitive market, enterprises need to improve the mechanisms of doing business over the Web. This need is certainly why Cagnon and Toulouse (1996) stated that using technology today is no longer a matter of choice, but rather one of survival, and one of the essential features of most successful firms. Web Services technology is increasingly used in business-to-business (B2B) and enterprise application integration (EAI) architectures (Kreger, 2003; Stal, 2002). The technology has the potential to deliver significant return on investment (ROI) by reducing the time and cost to launch an application. Still, if web services have so much potential, why isn't everyone using it currently? The decision to adopt the technology still

remains a challenge for many enterprises. Research has yet to address important questions, such as what are the primary factors for enterprise application developers to adopt Web Services technology? What factors have positive/negative impact on the technology adoption? Until these questions are addressed satisfactorily, the reasons why enterprise application developers decide to adopt or not adopt this new technology will remain a mystery.

To address these complex questions, this paper proposes and tests a Web Services technology adoption model in which three contexts - external environmental context, technological context, and organizational context are adopted from Tornatzky and Fleischer's (1990) framework; and two constructs - perceived usefulness and perceived ease of use are adopted from the TAM (Davis, 1989) model. The study provides insight into the decision making process of enterprise application developers when deciding whether and how to adopt the technology.

The paper is outlined as follows. First, the Web services technology and the different technology characteristics found to be crucial for technology adoption in the previous studies are discussed in the literature review. A research model derived from the Tornatzky and Fleischer framework and TAM is then presented. This presentation is followed by discussions of the research method and an interpretation of the findings. Finally, the paper finishes with applicable conclusions and their implications.

LITERATURE REVIEW OF WEB SERVICES TECHNOLOGY

To Web services have gained a lot of attention, primarily because their underlying technologies are based on industry-standard protocols like XML and HTTP. Among the key success factors of web services are flexibility (Elfwing, Paulsson, & Lundberg, 2002), scalability (Litoiu, 2002), and the ability to meet changing requirements (Kirda, 2001). Adding to those strengths, Abiteboul, Benjelloun & Milo (2002) argue that Web services provide the proper infrastructure for data integration. Its framework provides the appropriate solution for many agility requirements (Stal, 2002). Web services deployment leads to lower operational costs, increased reliability and minimal time-to-market (Gergic et.al., 2002) scenarios. These advantages are characterized by "loose coupling" for service exchange (Bielski, 2003). Deployment of this new technology has shown that existing assets used within a company can readily become revenue-generating assets. However Farrell and Kreger (2002) do warn that reliability must be a first-rank consideration in deploying Web services as any permanent solution in an organization.

The service-oriented architecture of web services makes it possible to reuse existing services, eliminating the need to build new applications from scratch. One of the most important features of web services is ease-of-use (Larsen & Bloniarz, 2000) and use of Web standards. Standardization allows for cross-vendor compatibility and provides a forum for open-market tools and products (Hunter & Hohpe, 2002). The beauty of web services lies in the accessibility of the services via standard protocols (HTTP, SMTP) that are language- independent, platform-independent, and location-independent, thus providing an efficient way of integrating existing systems and adding new functionalities (Hunter & Hohpe, 2002, Lea & Vinoski, 2003). Web services provide solutions to many platform interoperability problems faced by system integrators (Ran, 2003; Elfwing, Paulsson, & Lundberg, 2002).

All the above factors seem to create positive recommendation for web service adoption; however, lack of security still remains a crucial issue for adoption of the technology (Kraft, 2002; DuWaldt & Trees 2002; Hung & Qiu 2003). Various issues remain, such as use of existing infrastructure, levels of security in a system, quality of service, cost, agility, etc., and remain a concern for any web services adoption. Supporting this issue and anlysis, Lea & Vinoski (2003) recommend that web service complexity should be reduced, and simultaneously, web service reliability should be improved. Perhaps these issues explain that although the technology has a lot of potential, the adoption rate has to date been very slow (Ran, 2003).

According to Meehan (2002), many enterprises want to "experiment" with Web services rather than be an early adopter. Contradictorily, Hunter and Hohpe (2002) claim that major vendors are investing heavily in the technology to drive the adoption of Web Services higher. Lea and Vinoski (2003) also mention that many application developers are considering using Web services because of its remote-invocation and document-passing standards mechanism. Thus, the most commonly investigated Web services characteristics that can affect its adoption include the following: Relative advantage, complexity, security, interoperability, reuse of legacy systems, ease-of-use, standardization, loose coupling, flexibility, and cost.

Previously Identified Factors Affecting Adoption of the Technology

Tornatzky and Fleischer (1990) suggested that there are three elements of a firm's context that influence the process by which it adopts and implements technological innovations: Organizational context, technological context, and environmental context. Organization context is defined in terms of several descriptive measures: Firm size, centralization, formalization, complexity of managerial structure, quality of human resources, and the amount of slack resources available internally. To communicate with the external environment firms, it is important to set up "boundary-spanning mechanisms" (Tornatzky and Fleischer, 1990, p.153). Technological context describes both the internal and external technologies relevant to the firm (Tornatzky and Fleischer, 1990, p.153). This context may include current practices and equipment internal to the firm, as well as the pool of external technologies outside the firm. External environmental context is the arena in which a firm conducts its business—interacts within its industry, competes in the marketplace, accesses resources supplied by others, and deals with government (p.154). The authors suggest that all these factors can influence the degree to which a firm sees the need for, seeks out, and brings in new technology. They also suggest that the environment presents both constraints and opportunities for the technological innovation.

Davis (1989) proposed the technology acceptance model for empirical testing of user acceptance on information technology. Two main constructs included in the TAM model are perceived usefulness and ease of use. Perceived usefulness is "the degree to which a person believes that using a particular system would enhance his or her job performance", and ease of use is a person believes that using a particular system would be free of effort (Plouffe, Hulland & Vandenbosch, 2001). TAM thus suggests that two specific beliefs - perceived ease of use and perceived usefulness - determine one's behavioral intension to use a technology (Venkatesh, 2000).

RESEARCH MODEL

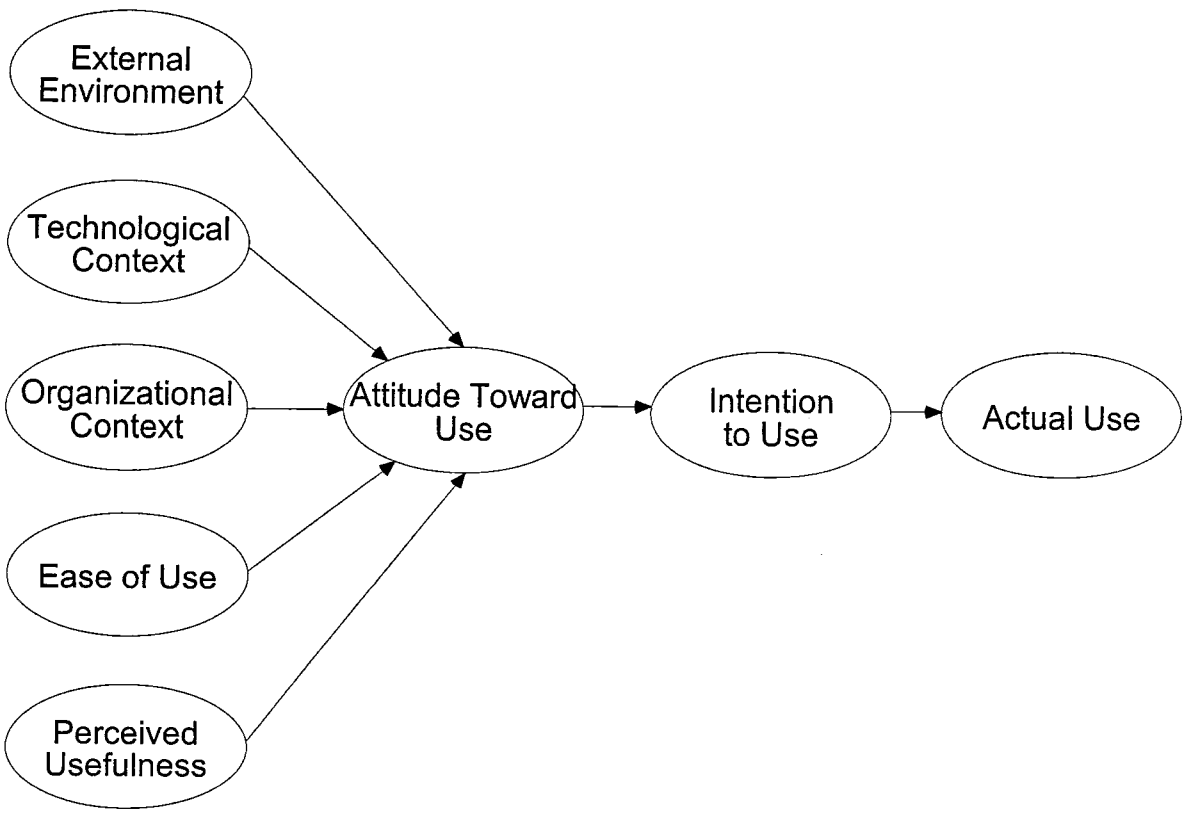

Figure 1 Research Model for Web Services Technology Adoption

The research model is developed by combining the TAM (Davis, 1989) model, which is mainly used for adoption of single-user applications, with the Tornatzky and Fleischer (1990) framework, which considers the environmental, technological and organizational aspects of technology adoption. Five important dimensions used in the new research model are (1) External environmental context, (2) Technological context, and (3) Organizational context (4) Perceived usefulness (5) Ease of use. Based on the literature review, an adoption model tailored for web services is developed and depicted in Figure 1. The purpose of the study is to test the research model and identify the factors that are indeed responsible for current Web services technology adoption.

METHODS

A quantitative approach has been employed to conduct the research. Since the research requires studying current conditions and the results required are in the form of statistics and numbers, a

quantitative approach is well suited. A survey method as a means to quantify results determines and describes the way things are (Gay & Airasian, 2002). It can be used to assess the perception and preferences of people about a particular issue or topic (Gay & Airasian, 2002). Survey research is suitable for this study as the answers to the posed research questions/problems are most appropriately based on opinions of Web service users about that technology.

Population and Sample

The target population for the study consisted of people having knowledge of or experience with Web services technology. A purposive sampling technique has been used to select a non-random sample because the identified target population is not easily accessible The participants are selected mainly from online Web services technology forums, information technology professionals from software companies, and graduate students with knowledge or experience of the technology in various parts of the United States and India. An online questionnaire was used to collect the data.

Instrumentation

All the seventy questions were developed in such a way that the respondents reported on a Likert scale, the extent to which they selected the agreement of factors affecting the adoption of web services technology. Our items were modified to reflect the nature of this study by using the constructs from Davis (1989), and Tornatzky and Fleischer (1990). To make the desired comparisons, demographic information about the respondents was also collected through questionnaire.

Pilot Study

A pilot study was conducted to make sure that there were no ambiguities in the questions and that all questions were understandable by the participants. A total of 62 graduate and undergraduate students who had knowledge and/or experience with Web services technology volunteered to read the cover letter and fill out the questionnaire before the actual study was conducted. Based on feedback from the pilot study, some questions were rephrased for more clarity.

Data Collection

An e-mail was sent to approximately 300 selected subjects. The electronic email had a cover letter and a hyperlink, which took the participants to the online questionnaire. After one week, a friendly reminder was sent to the participants. Of the 300 personalized e-mails sent out, 10 were returned by servers because the intended recipient was either no longer a user of the particular Internet Service Provider or the recipient's mailbox had exceeded its quota. Therefore, only 290 personalized e-mails were effectively sent and received. A total of 211 data sets were collected. Out of this number, 7 were found to have missing data. Therefore, data were collected from a total of 204 successful survey sets.

RESULTS AND FINDINGS

The sample had 79.4% males, and 16.2% females. The majority of the sample were between 21 and 25 (39.7%), and 26 and 30 years (33.8%) in age. Of the participants, 39.7% had 1 to 3 years of experience, 22.1% had 3 to 6 years of experience, and 10.3% had 6 to 9 years of experience while only 1.5% had over 10 years of experience in software development. The majority of respondents (39.7%) had average of 3 years of experience working in a software firm. About 28.9% of the users were employed in firms with more than 1000 employees. Also, the majority of the users were employed in firms that belong to the computer-related services sector.

Reliability Assessment

Exploratory factor analysis was carried out to evaluate the contributing factors for adoption of web services technology. Factor analysis can be used to determine what items or scales must be included on and excluded from a measure. We used values greater than 0.5 as the cutoff value of the factors loading to retain items within scale (Hair et. al., 1992). Factors that failed to show reliable factor loading were eliminated from the study. Cronbach's coefficient alpha was computed for each construct to test for reliability. A minimum alpha of 0.6 sufficed for early stages of research (Nunnally, 1967). Our constructs are deemed to have adequate reliability for the next stage of analysis with Cronbach's alphas range of 0.617 to 0.921.

Structural Equation Modeling

The overall fit was assessed using multiple fit criteria. Specifically, three goodness-of-fit indices were used, including chi-square/degree of freedom=3.058, normalized fit index (NFI)=.940, and comparative fit index (CFI)=.959. All the fit statistics moderately supported the research model. The explanatory power of the model for the individual constructs was examined using the resulting R^2 for each dependent construct. Together, the exogenous variables, i.e., external environmental, technological, organizational, ease of use, and perceived usefulness, were able to explain 88 percent of the variances observed in attitudes towards adopting the Web services technology (see Figure 2). Perceived usefulness appeared to have the strongest determinant of attitude toward use, followed by external environmental and technological constructs. At the same time, attitude toward use contributed significantly to intension rather than the contribution of intension to actual use.

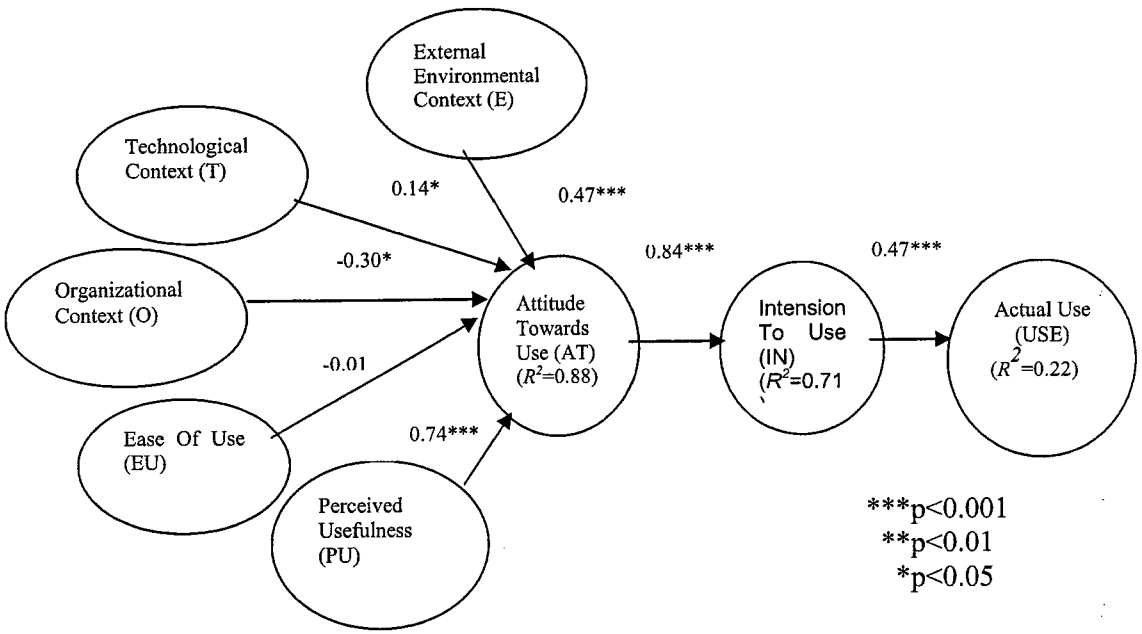

Figure 2: Research Model Testing Results

The external environmental and the technological factors showed positive effect on the attitude toward use of Web services technology with path coefficients of 0.47 ($p < .001$) and 0.14 ($p < .05$), respectively. Contrary to our expectation, the organizational factor showed a negative effect on attitude toward use of Web services technology. The data supported the perceived usefulness casual paths postulated by TAM with the exception of ease of use. Ease of use showed a negative direct effect on the user attitude and was insignificant. Perceived usefulness had a significant direct positive effect on the user's attitude to use web services technology with a path coefficient of 0.74 ($p < .001$). This coefficient suggested that every unit increment in external environmental factors, technological factors, and perceived usefulness would strengthen an individual's (positive) attitude by 0.47, 0.14, and 0.74 units, respectively. The effects of attitude on intention were also significant (.84, $p < .001$). The findings from the structural equation modeling show that intention to adopt Web services technology can be positively influenced by external environmental, technological, and perceived usefulness and negatively influenced by organizational factors and ease of use.

The external environmental construct has a direct effect on the attitude towards use of web services technology. The survey results reveal that popularity, competition, and market uncertainty are the contributing factors for the external environmental context. The support for popularity was in accordance with Nambisan & Wang (1999). Because of high popularity, many organizations desire to adopt Web services technology. The support for competition is expected, as organizations need to survive their competitors with respect to time, money, and quality. The intensity of the competition in the products or services the firm provides can influence the degree to which a firm sees the need to bring in new technology. Market uncertainty was one of the

factors affecting the web services technology adoption. This result can be explained as "cyclic instability" (Tornatzky and Fleischer, 1990). Many companies rise and fall dramatically, as the economy moves through growth and recession periods. Thus market uncertainty tends to change the decision-making ability of companies with respect to innovations.

Technological construct has a direct effect on the attitude toward use of Web services technology. The construct includes extensibility, scalability, quality of service, and flexibility. are the most important. Quality of service is found to have an influence on intention to adopt Web services technology. This result implies that when selecting a technology, quality of service plays the most important role in influencing the adoption decision. The support for flexibility, scalability and extensibility is expected. Previous studies have shown that flexibility, scalability, and extensibility of an innovation play an important role in the adoption of the Web services technology. Most companies do not want to adopt a technology that is not flexible for future changes. To the contrary, they prefer a technology that can be integrated in a time and cost effective manner. In other words, users who feel that Web services technology is flexible, scalable, and extensible are more inclined to adopt the technology.

The negative support for the organization factor was unexpected. According to Nambisan & Wang (1999), one of the reasons organizations want to adopt Web services technology is the low investment requirement. One plausible explanation could also be that perceived usefulness is preferred to lower costs when selecting one technology over the other. Another possible explanation for lack of administrative support can be that Web services technology is relatively new. Hence, administrative support can be difficult to achieve because of the risks involved with the technology. For the same reason, there exists knowledge barrier among the software staff. Exact roles, implementation issues, and the resources required to launch Web services may not be clear to many software developers and managers. The knowledge barriers could also be the result of user populations not having actually used Web services technology. Hence, a knowledge barrier could play an important role in accepting or rejecting the technology. For Web services technology to be more acceptable, managers in software firms must provide informative ways to communicate the technology, like making training available to businesses. More information availability about the technology will bridge the gap between the technology and the users, increasing the chances of adoption of the Web services.

Contrary to what TAM hypothesizes, ease of use was found to have a negative effect on a user attitude toward use of the Web services technology. This result may suggest that users might not want to spend time learning a new technology, even if the technology is relatively easy to use. This view is especially true when the adoption and use of the technology may interfere with a traditional style of working (Hu et.al., 1999). Therefore, for Web services technology to be accepted by users, it will be necessary to demonstrate its capability to fill the needs of individual users, who tend to treat technologies as tools that are acceptable only when desired utilities in that practice has been proven over time. Another reason could be that Web services are relatively new in the business arena. Many users might not have had time or opportunity to use the technology and hence might feel the technology is too difficult to use. New terminology related to Web services technology may also lead users to believe that the technology is difficult to use.

In agreement with what TAM postulates, perceived usefulness was found to have a significant effect on user intent to use Web services technology. This view is consistent with the results

found in IS literature. Hu et al. (1999) suggested that users are more practical and tend to focus most on the usefulness of the technology itself. Also, users want to spend time learning a new technology that is useful in doing their day-to-day work more efficiently. Moreover, since the majority of the sample were male, the findings are in accordance with Venkatesh & Morris (2000), who state that men consider perceived usefulness to a greater extent than do women, when making decisions regarding the use of new technology.

IMPLICATIONS

The data analysis led to the conclusion that the intention to adopt Web services technology can be influenced by the external environmental, technological, organizational factors, perceived usefulness, and ease of use. The data analysis also led to the conclusion that perceived usefulness had a positive significant influence on attitude regarding the use of Web services technology contrary to the results regarding ease of use.

From a managerial point of view, the findings of this study reveal that certain technological factors, i.e., competition, popularity of Web services, and market uncertainty, play an important role in the decision process to adopt Web services technology. The findings also disclose that technological factors, like quality of service, flexibility, extensibility and scalability, are important players and affect the user's intentions to adopt Web services technology. To the contrary of what TAM postulates, the TAM construct, i.e., ease of use, was insignificant in terms of the user's attitude toward using the Web services technology. This view could be because the study was more technology-oriented than it was application or system oriented. Generally for applications or systems users want a technology that is as easy to use as possible and with a minimum learning curve. However, for specific technology like Web services, users don't feel ease of use is as significant as usefulness of the technology.

The important findings of this study reveal that to foster individual intentions to use a technology, it is important to encourage and cultivate a positive attitude toward using the technology. In this connection, positive perception of the usefulness of Web services technology is very important, whereas its ease of use may not be equally important to the users. One logical implication is that the vendors of Web services technology want to sell their product and have the management of an organization interested in adopting the Web services technology. This implication results in strongly emphasizing the most effective means to communicate the utility of the Web services technology to its target users.

LIMITATIONS

This study had four main limitations. First, the use of an online survey limited us to a pool of restricted users. Hence, the results may not be as generalizable to non-Internet users. Second, the study was based on a self-reported survey. Third, time and cost are the two major constraints to any proposed research study. A direct consequence of time and cost constraints is the lack of access to experienced project managers involved with web services technology who could provide the desired information. Due to lack of IT managers who were involved in the study, managerial perception to better evaluate organizational factors could not be achieved. Fourth, web service technology is relatively new in the software industry, and as a result, the research

literature related to web service technology is scarce and the pool of adopters may be at this point of time quite small.

CONCLUSION AND FUTURE RESEARCH

Theory testing has become increasingly important for IS research, in particular when different technologies and user populations are involved (Hu, Chau, Liu, Sheng & Tam, 1999). This study presents research in findings regarding the factors affecting the adoption of Web services technology. The research model was developed from the Tornatzky and Fleischer (1990) technological innovation framework, along with the TAM (Davis et. al, 1989). The model was evaluated by using data collected from more than 200 participants in the software development field who have experience and/or knowledge of Web services technology. The research tested the research model, and several implications can be drawn from the study results.

There is still room for further investigation into the process of adoption of Web services technology. The following are recommendations for future studies. First, future study should be carried out on more experienced users. Conducting the same study on various groups of experienced participants in a Web services field, like project managers, developers, students, etc., would further strengthen the results of this study. Second, as Web services technology is still in its early stages, this study was unable to measure the actual perception toward this technology. Currently, few implementations are available. In the future as the number of users grows, more reliable information can be gathered from a larger pool of participants. In that way a more comprehensive investigation of Web services adoption intensions can be conducted. Third, the generalized study on adoption intentions of Web services technology should be extended to specific industries like insurance, supply chain management, information services, since factors crucial for one industry may be unimportant for another. A comparison can then be made between individual industries in terms of business specific factors influencing adoption decisions. Additionally, the criteria for selecting a Web services technology over legacy technologies, and the type of technological, organizational, external environmental factors perceived to be useful will be able to be determined more easily and precisely.

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