

Technological, Organizational, and Environmental Antecedents to Web Services Adoption

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ABSTRACT

The proliferation of web services within the last two years enables organizations to assimilate software and services from different companies and locations into an integrated service capable of streamlining important processes. Widespread adoption of web services has not yet occurred across all industries. To better understand the key determinants of web services adoption at the firm level, a conceptual model of factors impacting web services adoption was developed. The conceptual model was grounded in the technology–organization–environment (TOE) framework (Tornatzky and Fleischer, 1990) to support the formulation of eleven propositions that may affect adoption and continued utilization of web services. Specifically, factors for each of the contexts within the TOE framework were formulated and supported including: (1) technological factors (security concerns; reliability; deployability); (2) organizational factors (firm size; firm scope; technological knowledge; perceived benefits); and, (3) environmental factors (competitive pressure; regulatory influence; dependent partner readiness; trust in the web service provider). A summary of the relationships between the key constructs in the model and recommendations for future research are provided.

Key words: Web services; TOE framework; technological context; organizational context; environmental context; intention to adopt; adoption behaviour

INTRODUCTION

In a 2002 survey of 779 corporate and information technology (IT) professionals, over 77% reported that web services are critical to their organizations' future successes and 74% indicated that web services can provide their firms with immediate business value (Systinet, 2002). Web services are Internet-based enterprise applications that use open, extensible mark-up language (XML)-based standards and transport protocols to exchange data with clients (Java, 2006). In essence, a web service is a standardized way for applications to communicate with each other over standard Internet protocols based on XML, a non-proprietary, simple, and flexible text format for exchanging data. Using XML, enterprise applications such as credit card verification services, email and phone number verifiers, and electronic payment services (Cdyne, 2006) can communicate using web services even if they are written in different programming languages and run on dissimilar platforms. Web services are characterized by extensive interoperability, extensibility, machine-processable descriptions, and can be loosely coupled in order to achieve complex operations (W3C, 2006). In other words, web services are characterized by: (1) application-to-application integration at a lower cost than a costly enterprise resource planning (ERP) application alternative; (2) open standards as opposed to proprietary electronic data interchange (EDI) technologies of the past; and, (3) platform independence. Even EDI proponents such as Wal-Mart are moving away from traditional EDI and VANs (value-added networks) in favour of IP-based Internet communications for conducting business with suppliers. A recent survey (Accenture, 2003) reported that over 80% of executives indicated that web services are used for both internal and external applications. According to the Accenture study (2003), the primary web services applications are employee benefits (53%), eCommerce (42%), customer relationship management including customer relationship management (CRM) (34%) and supply chain management (33%). Web services provide various benefits to

organizations including: (1) interoperability between various software applications running on disparate platforms; (2) accelerated application development; (3) increased worker productivity; and, (4) improved employee and customer satisfaction (IBM, 2002).

Interest in web services has expanded in recent years as evidenced by the increased volume of research. There are several reasons that might be attributed to the increased research activity. First, web services are seen, by many, as modern day EDI. Web service open standards combined with the proliferation of the Internet offer a low cost alternative to proprietary EDI and associated value-added networks. Hence, integrating disparate applications on various platforms along the supply chain is no longer available only to large organizations such as Wal-Mart. Rather, the existence and use of web services offers greater flexibility for small organizations seeking services to accomplish specialized tasks. Second, one of the primary reasons for the interest and growth in ERP solutions such as SAP is due to the difficulty in integrating diverse information systems. With open standards such as XML web services, it is possible for these systems to communicate with each other at a low cost, greatly diminishing the need to invest in costly ERP solutions that would commit firms to a single vendor. Third, since VANs are not required to offer and consume web services, any small business that has a niche service to offer can do so without high infrastructure costs.

The various elements that makeup a web service include: (a) hypertext transfer protocol (HTTP); (b) extensible mark-up language (XML); (c) XML schema definition (XSD); (d) simple object access protocol (SOAP); (e) web services definition language (WSDL); and, (f) universal description, discovery, and integration (UDDI). HTTP is the standard protocol of the World Wide Web. Since most firewalls allow communications through TCP port 80, clients and web service providers can communicate without any hindrance. XML, a derivative of Standard Generalized Mark-up Language (SGML), provides a standard way of representing data. Each platform may provide different type structures which presents a problem in communication between the client and service provider. Although XML provides a way to represent data, this standard does not include conventional data types and ways to extend them. The XML schema standard is the type system used by web services which allows both simple and complex data types to be converted into standard XML Schema Definition (XSD) typologies. The data are serialized and deserialized to text and transmitted using HTTP. When web services are available for use, clients should be able to send requests to and receive responses from the web service. While XML provides a means to represent the data and the associated structures, SOAP specifications provide the formats for the requests and the responses containing Remote Procedure Calls (RPCs). The specifications also provide standard rules for encoding data as XML so that data can be transferred across heterogeneous platforms. The offerings of a web service are outlined in a document using the Web Service Description Language (WSDL). This is important since a client must first understand what a service has to offer before adopting it. Thus, XML-based WSDL provide a formal machine-readable (human-readable too) description of the web service that includes methods exposed, parameter inputs required, and data types of return values. The UDDI specification is a centralized registry for web services and enables businesses to dynamically find and transact with one another. In particular, the UDDI specification enables a firm to: (1) describe its business and services; (2) discover other businesses that offer desired web services; and, (3) integrate business operations (UDDI, 2004).

Web services offer several advantages over IP-based services. Interoperability is an important benefit, since services can be used with many different technologies and the development of web services is more cost-effective than developing single-technology based applications. A second advantage is deployability. Dissemination over standard Internet technologies such as HTTP enables web services to be deployed even across a firewall. Finally, the usability of web services permits businesses to deploy standardized functionality which gives applications and environments the opportunity to use web services as they are needed.

Therefore, the basis for this research is to examine the relationships between web services as a technology, the organization in a specific context, and the environment. To conduct this examination, this paper proposes eleven directional propositions that permit the exploration of technological, organizational, and environmental antecedents to the intention to adopt and the adoption of web services. This work is meant to extend the knowledge base of technology adoption through a proposed relational model for technology adoption and acceptance that can be tested for confirmation and strength.

THEORETICAL BASIS FOR THIS RESEARCH

An organizational innovation is defined as a process, system, or service that is either internally developed or purchased from an external source, where the innovation is new to the firm (Damanpour and Evan, 1984). Innovation is a concept that has been extensively studied at the individual-level with less emphasis placed, to date, on understanding organizational-level effects. Organizations support the introduction of innovations when the existing process or service is replaced with one expected to be an improvement over the current system (Gallivan, 2001). Additionally, firms may seek innovations due to pressures associated with maintaining a competitive advantage or gaining recognition within an industry.

A range of models and theories are used to evaluate and test individual-level acceptance of technologies. One of the most commonly employed models is the Technology Acceptance Model (TAM) developed by Davis (1989) to explain and predict an individual's acceptance behaviour toward a new technology, independent of the user population and the technology being introduced. While this theory is useful for understanding why individuals accept particular technologies across a range of populations, the model is not suited for investigation of organizational-level acceptance of technologies since the adoption decision for web services is generated as a strategic firm-level initiative. Therefore, there is a need to employ an organizational-level theory to explain and predict a firm's acceptance behaviour of web services.

Many of the studies that investigate firm-level adoption employ Innovation Diffusion Theory (IDT) (Rogers, 1995), which suggests that diffusion of an innovation is principally based on the: (1) characteristics of the technology; and (2) users' perceptions of the system. Research based on the Innovation Diffusion Theory (Rogers, 1995) assumes that the adoption decision is undertaken to improve operational efficiency (Teo et al., 2003). However, the organizational decision to adopt web services may also be influenced by the environment of the organization – customers, suppliers, other trading partners, competitors, and government regulations – that provide barriers and incentives to technology adoption. Since widespread adoption of web services across industries has not yet occurred, it is plausible that the institutional environment of the firm will play a large role in the organizational adoption decision along with the characteristics of the technology. As such, it is appropriate to ground this study in a framework that considers the influence of the technology, the organization, and the environment to account for broader environmental factors likely to influence the scope and degree of web services use. Therefore, the use of Tornatzky and Fleischer's (1990) technology-organization-environment (TOE) framework enables the consideration and proposed investigation of specialized factors likely to influence web services adoption.

Technology-Organization-Environment (TOE) Framework

To study the adoption of technological innovations in general, Tornatzky and Fleischer (1990) developed the technology-organization-environment (TOE) framework to describe the organizational components that affect the firm's adoption decisions. Tornatzky and Fleischer's (1990) TOE framework asserts that three principle contexts – technological, organizational, and environmental – influence the process by which an organization adopts and accepts a new technology. The technological context considers the available technologies important to the firm, both internal and external, that might be useful in improving organizational productivity. The organizational context is defined in terms of resources available to support the acceptance of the innovation. These criteria include firm size and scope; the centralization, formalization, interconnectedness, and complexity of the managerial structure; and the quality and availability of the firm's human resources. The environmental context represents the setting in which the firm conducts business, and influenced by the industry itself, its competitors, the firm's ability to access resources supplied by others, and interactions with the government.

A plethora of empirical studies (e.g., Chau and Tam, 1997; Gibbs and Kraemer, 2004; Iacovou et al., 1995; Kuan and Chau, 2001; Thong, 1999; Zhu et al., 2004; Zhu et al., 2003; Zhu and Kraemer, 2005) have used the TOE framework as a theoretical foundation for investigating organizational acceptance of new technologies. Zhu and Kraemer (2005) used the TOE framework to investigate antecedent influences on e-business use and business value in a multinational study of 624 organizations. Zhu et al. (2004) developed a research model based on the TOE framework to evaluate and test the influence of technological, organizational, and environmental factors on e-business value. Additionally, Zhu et al. (2003) studied data from 3,100 firms to understand influences of technology competence, organizational factors of firm scope and size, and environmental context influences of consumer readiness, trading partner readiness, and competitive pressure on e-business adoption. All three studies were interested in understanding antecedents to e-business adoption.

The TOE framework has also been used to empirically validate the antecedent factors that influence EDI adoption (e.g., Iacovou et al., 1995; Kuan and Chau, 2001; Ramamurthy et al., 1999). Using the case study methodology,

Iacovou et al. (1995) investigated EDI adoption influences of seven firms that were suppliers to the provincial government of British Columbia (BC) and specifically investigated perceived benefits (technological context), organizational readiness (organizational context) and external pressures (environmental context) as drivers of EDI adoption. Kuan and Chau (2001) investigated different antecedents of EDI adoption within the three contexts (perceived direct benefits – technological context; perceived financial cost and perceived technical competence – organizational context; perceived industry pressure and perceived government pressure – environmental context) and demonstrated similar support for the utility of the TOE framework to investigate factors impacting acceptance and adoption of technologies. Ramamurthy et al. (1999) investigated the impact of EDI on firm performance as a consequence of technological, organizational, and environmental contexts. Their empirical results indicated that the effect of EDI on operational and market-oriented performance was significantly linked to these factors. Although specific elements identified within the three contexts may vary across different studies, the TOE framework has shown consistent empirical support. Drawing upon the empirical evidence of other scholars, the current study uses the TOE framework as theoretical foundation for investigating adoption of web services.

A PROPOSED MODEL OF WEB SERVICES ADOPTION

An examination of prior research on the adoption of web services reveals limited identification and investigation of factors likely to influence the adoption decision. In a review of the most recent literature, a number of key themes emerge (Table 1).

First, several papers have identified the need to address security concerns in different forms, including the addition of mechanisms that restrict access to the service (Coetzee and Eloff, 2005a; Yagüe et al., 2005), maintain corporate privacy (Pearson, 2002), and ensure that any data or information calculated or generated are protected (Coetzee and Eloff, 2005b; Joshi et al., 2004; Shah and Murtaza, 2005). Second, consistency of reliable operations was also identified as important to effective web service usage (Shah and Murtaza, 2005). Third, the issues around deployability were noted as relevant (Baghdadi, 2005) within the existing literature. These first three categories align with the research model proposed by this paper under the technological context within the TOE framework

	Baghdadi, 2005	Coetzee and Eloff, 2005a	Coetzee and Eloff, 2005b	Janssen et al., 2006	Kim and Segev, 2005	Shah and Murtaza, 2005	Joshi et al., 2004	Pearson, 2002	Yagüe et al., 2005
Research Model	Deploying Web Services	Autonomous Trust for Web Services Security Mechanisms	Information Security Access Control	Public-Sector Orchestration	Perceived Benefits	Competitive Advantage Security Reliability	Security	Privacy Trustworthiness of Client	Security / Authentication
Security Concerns		√	√	√			√	√	√
Reliability							√		
Deployability	√								
Firm Size									
Firm Scope									
Technological Knowledge									
Perceived Benefits					√				
Competitive Pressure						√			
Regulatory Influence				√					
Dependent Partner Readiness									
Trust in Web Service Provider		√						√	

Table 1: Comparison of research model to other studies

Firm size and firm scope have been investigated in a variety of adoption scenarios but not in the context of web services. Firm size has been investigated in the scope of e-commerce use (e.g., Gibbs and Kraemer, 2004), the extent of IS adoption (e.g., Thong, 1999), e-business value (e.g., Zhu et al., 2004; Zhu et al., 2003), and e-business use (e.g., Zhu and Kraemer, 2005). The influence of firm scope of various forms of technology adoptions has also been considered by scholars: firm scope (e.g., Zhu et al., 2003) and global scope (e.g., Zhu et al., 2004; Zhu and Kraemer, 2005). As part of the organizational component of the Tornatzky and Fleischer’s (1990) TOE framework, the concepts of firm size and scope are included in the current study as determinants of web services adoption.

Technological knowledge is another component of the organizational context within this research. Technological knowledge represents the totality of institutional knowledge resident within a specific firm. As a quality of the firm’s human resources, this construct provides a mechanism for evaluating whether an organization can adequately address the technological necessities of web services.

Kim and Segev (2005) explain the benefit of using web services to manage negotiation processes and demonstrate how these services can be applied to implement a marketplace-based architecture. The inclusion of perceived benefits, as a determinant of web services adoption, is introduced within the organizational context of the current model. Perceived benefits of the technology have been shown to be important in EDI adoption research (e.g., Iacovou et al., 2005; Kuan and Chau, 2001; Ramamurthy et al., 1999).

Competitive pressure, regulatory influence, dependent partner readiness, and trust in the web service provider are environmental context elements under consideration in this study. Zhu et al. (2003) found that consumer readiness is an important predictor of e-business adoption as did Zhu and Kraemer (2005). Shah and Murtaza (2005) proposed that competitive advantage is important in web services activities but did not provide empirical support for this assertion.

Zhu et al. (2004) investigated the effect of regulatory influence on e-business value. However, regulatory influence and dependent partner readiness have not been investigated for web services adoption. Trust in the web service provider is also considered in the current paper. Pearson (2002) indicated that the trustworthiness of the client is an important consideration when selecting web services. Coetzee and Eloff (2005a) assert that providers can develop trust in the requestors of web services.

The proposed research model, Figure 1 (see appendix 1), organizes the potential adoption determinants into Tornatzky and Fleischer's (1990) TOE framework to establish the three principle contexts – technological, organizational, and environmental.

Technological Context

Technological context, in general, refers to the application or object of new technology adoption. Numerous scholars have studied and confirmed the importance of a variety of first- and second- order constructs that affect the technological context. Kwon and Zmud (1987) asserted the importance of the internal technology resources (infrastructure, technical skills, developer, and user time) for successful IT adoption. Their theoretical assertions were supported by a number of empirical studies (e.g., Cragg and King, 1993; Crook and Kumar, 1998; Grover, 1993; Kuan and Chau, 2001). Zhu et al. (2003) conceptualized and studied the technological context by identifying and operationalizing technology competence through three second-order constructs: IT infrastructure, Internet skills, and e-business awareness.

In the current paper's proposed model, the technological context is refined into three first-order variables: (1) security concerns; (2) reliability; and, (3) deployability. The basis for each of these technological context variables is grounded in existing research. Nambisan and Wang (1999) identified the issue of security, both real and perceived, as a factor affecting the intention to adopt and actual adoption behaviour. Security is defined as both the perception, or judgment, and fear of safeguarding mechanisms for the movement and storage of information through electronic databases and transmission media.

Organizations are dependent upon their information systems for day-to-day operations. Information system databases hold crucial data about customers, suppliers, processes, and business transactions. Compromising the security of these systems can be very costly to the organization in terms of dissatisfied customers resulting in a loss of goodwill, potential litigation, and a likely reduction in business. Since web services are relatively new technologies, their use poses new security problems to organizations (Coetzee and Eloff, 2005b). Because of the importance to both the provider and consumer of the service, security has received considerable attention in recent literature (e.g., Coetzee and Eloff 2005a; Joshi et al., 2004; Birman, 2004; Shah and Murtaza, 2005; Yagüe et al., 2005; Zhao and Cheng, 2005). Coetzee and Eloff (2005a) stress the importance of security in building trust between the provider and consumer of web services. Joshi et al. (2004) noted security as a major obstacle to the adoption of web service technologies.

Another concern that is closely associated with security is web service reliability. Lai and Guynes (1997) and Lippert (2001) suggested that the perceived reliability of a technological innovation has a profound effect on its adoption. Shah and Murtaza (2005) also argue that resolving security and reliability issues are critical in the widespread adoption of web services. According to Zhao and Cheng (2005), security and reliability issues, with respect to web services, are yet to be resolved. Realizing the importance of security, Yagüe et al. (2005) proposed an access control model for web services to address the security issue. Birman (2004) contends that web services, today, miss the functional reliability because the current models do not consider 'real world' issues likely to influence organizational acceptance of these technologies. These studies stress the importance of web service security and reliability. Hence, in this research, the following propositions are presented:

Proposition 1: The higher the perceived security concerns of the service, the less likely web services will be adopted and used.

Proposition 2: The higher the perceived reliability of the service, the greater the potential for adoption and use of web services.

Web services are fast becoming the de facto integration standard for applications. However, web services are still experiencing technical issues related to security, availability, and performance (Baghdadi, 2005). Due to the use of

existing specifications and standards based on the WS-I standards organization (WS-I, 2006), most of the functionality surrounding security, reliable messaging and transactions of the web services are integrated. While some web services standards such as SOAP and UDDI have matured on several criteria (e.g., interoperability and usability), others such as WS-Transfer and WS-Business Activity are still evolving (Levinson and O'Brien, 2006). Such lack of mature standards may be an issue in the deployability of web services, leading to the following proposition:

Proposition 3: The higher the perceived deployability of the service, the greater the potential for adoption and use of web services.

Organizational Context

Organizational context refers to the affect of organizational characteristics on the decision to adopt web services. A variety of authors have examined organizational parameters as independent variables to technology adoption. Thong (1999) recognized the importance of considering organizational characteristics in information systems adoption and acceptance. Specifically, the adoption literature proposed that firm scope and size are important organizational factors for technology adoption (Rogers, 1995; Tornatzky and Fleischer, 1990). This was also confirmed in the information systems literature. For example, Dewan et al. (1998) and Hitt (1999) found that the greater the scope of the firm, the greater the demand for IT investment. Likewise, Brynjolfsson et al. (1994) found that firm size is strongly associated with investments in information technology.

Firm size has been consistently shown to be a good predictor of IT adoption in organizations (Damanpour, 1992). Large firms have more resources, greater economies of scale, and can take greater risks associated with innovation adoptions (Thong, 1999; Kuan and Chau, 2001; Zhu et al., 2003; Gibbs and Kraemer, 2004). Small firms, because of their resource constraints, do not readily adopt newer technologies. However, small firms are more agile and flexible than large firms. When controlled for technological and financial resources, larger firms use technology to a lesser degree (Zhu and Kraemer, 2005). While this may be true for a mature technology, small firms cannot risk resources to adopt unknown or immature innovations. Since web services standards are still evolving, this research proposes the notion that large firms can easily absorb the risks of web services adoption leading to the following proposition:

Proposition 4: The larger the size of the firm, the greater the potential for adoption and use of web services.

Firm scope, another common organizational factor, is defined as the geographical extent of the organization's operations. Prior research has shown a positive relationship between firm scope, IT use and value added (Zhu et al., 2003, Zhu et al., 2004, Zhu and Kraemer, 2005). In the context of web services, an organization that has operations in several geographic areas with numerous business partners will achieve more benefits through the use of a standardized technology than an organization with narrow scope. This leads to the following proposition:

Proposition 5: The greater the scope of the firm, the greater the potential for adoption and use of web services.

In the present research model, two additional variables are recognized under the organizational context: (1) technological knowledge, which in general, represents the totality of institutional technological knowledge resident within an organization; and, (2) perceived benefits. This institutional knowledge is comprised of the sum of technological expertise by all members of an organization and is reflected in the technological sophistication of their operations. Technological knowledge has been identified and validated as a measurable factor in understanding and describing the organizational context (Cooper and Zmud, 1990; McEvily and Chakravarthy, 2002). Therefore, it is proposed that:

Proposition 6: The greater the technological knowledge of an organization, the greater the potential for adoption and use of web services.

Perceived benefits are the judgments of members within an organization, (generally users and managers of users), that the adoption of new technology and the retirement of a legacy system will have a notable benefit on individual- and organizational-level performance. Perceived benefits have been studied by Iacovou et al. (1995) and have been

confirmed as an important organizational context variable. In this study, perceived benefits represent managers' perceptions regarding the overall benefits of adopting web services. Hence, the following is proposed:

Proposition 7: The greater the perceived benefits by the organization, the greater the potential for adoption and use of web services.

Environmental Context

Competitive pressure has long been recognized as an adoption motivator in the innovation adoption literature (e.g., Grover, 1993; Iacovou et al., 1995; Premkumar et al., 1997; Crook and Kumar, 1998). Porter and Millar (1985) analyzed the strategic rationale underlying competitive pressure as an IT adoption driver. They suggested that, by adopting information systems, firms might be able to alter rules of competition, affect the structure of the industry, and leverage new ways to outperform their competitors, thereby changing the competitive environment. This analysis of the relationship between competitive pressure and technology adoption can be extended to web services. As an outcome, the model proposes that:

Proposition 8: The greater the competitive pressure, the more likely the organization will adopt and use web services technology.

Delmas (2002) suggested that if regulatory agencies require the adoption of specialized standards, that firms may experience higher transaction costs in order to meet the necessary objective. In addition, Delmas (2002) noted that organizational non-compliance with environmental regulations may produce additional transaction costs and potential legal outcomes resulting from these activities. While Delmas (2002) was directing her focus to the adoption of the ISO 14001 standard, the associated logic also holds in the context of web services. Xu et al. (2004) assert that governments can encourage adoption, specifically e-business adoption, by developing business and tax laws that are beneficial to the organization. Therefore, in the context of web services, the following is proposed:

Proposition 9: Organizations that experience high levels of regulatory influence are more likely to adopt and use web services technology.

Trading partner readiness was identified and recognized by Zhu et al. (2003) and others as a factor in technology adoption. While Zhu et al. (2003) explore the absence of trading partner readiness, this study proposes that an index of trading partner readiness, modified and labeled as dependent partner readiness can be developed and measured against the degree of intention to adopt and use web services. Web services and organizational partnerships go well beyond the individual organization. Oftentimes, the decision to use web services is influenced by the technology already adopted or rejected and by those related partnerships that permit the manufacture, distribution and use of products and services. Zhu et al. (2003) note that during data collection and analysis of the reasons that a technology is not adopted, oftentimes partner organizations in the extended operation were 'blamed' for not being ready to adopt and accept a new technology. Therefore, this study proposes the following:

Proposition 10: The greater the degree of dependent partner readiness, the more likely the firm will adopt and use web services.

This study proposes two modifications to the Zhu et al. (2003) configuration of the environmental context: (1) the application is a web service which is an organizational-level consumer; and, (2) an additional variable is added that reflects the degree and perception of predictability, reliability and usefulness of the vendor/provider of the web service. In this study, that measure is identified as trust in the web service provider. Trust in the provider operationalizes as meeting a minimum threshold level of belief that the web services will be predictable – perform as intended, reliable – perform consistently, and useful – make a contribution to overall performance improvement. Thus, the following is proposed:

Proposition 11: The greater the trust in the provider, the more likely the firm will adopt and use web services.

CONCLUSION

The model presented in this paper offers eleven propositions based on the Tornatzky and Fleischer (1990) technology-organization-environment (TOE) framework to explain the principle organizational contexts in which the firm adopts and implements an innovation. Ten positive relationships and one negative relationship were proposed addressing technological, organizational, and environmental issues related to web services adoption. The model enables further investigations through empirical testing to confirm both the direction and intensity of the proposed relationships.

The testable propositions set forth in this research offer an opportunity for further investigation into the relationship between the technological, organizational, and environmental factors and web services adoption through a variety of research designs. These designs may include the use of survey techniques and analytical protocols such as structural equation modelling (SEM). A typical SEM analysis for the propositions outlined in this manuscript might be to employ independent analyses for each classification of relationships (technological, organizational and environmental) and an aggregated SEM analysis to investigate all the relationships simultaneously. The fundamental basis for structural equation modelling is the ability to simultaneously examine multiple regression statements. Applied research settings within various organizations should be used to validate this model and permit the identification of alternative intervening or moderating variables on the relationship between these variables and web services adoption. Once organizational adoption has occurred, the investigation can progress to individual-level adoption using models and theories to ground that research.

The use of this model in applied settings including research, education, commerce and government is warranted. In a research setting, the application is to further validate, enhance and support understanding of factors affecting web services adoption through use of testable propositions. The ability to use the model as a tool for teaching web services with an emphasis on acceptance of new technologies provides an educational benefit for academics. Businesses can apply the model's concepts to achieve greater efficiencies in support of their web services initiatives. Additionally, government agencies can use this model as a tool for understanding factors affecting acceptance of web services technologies.

As a consequence of this theory development effort, a number of recommendations emerge. First, the linkage between these technological, organizational, and environmental determinants and web services adoption is a conceptualization worthy of exploration. Second, through the understanding of the influence of these determinants, organizations may gain an increased return-on-investment (ROI) from their web services investments. Third, the establishment of an effective metric will enable organizations to include an additional quantifiable assessment to measure performance and usage. And fourth, since adoption behaviour is a significant component of organizational effectiveness, a better understanding of its determinants will improve overall organizational performance.

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APPENDIX 1

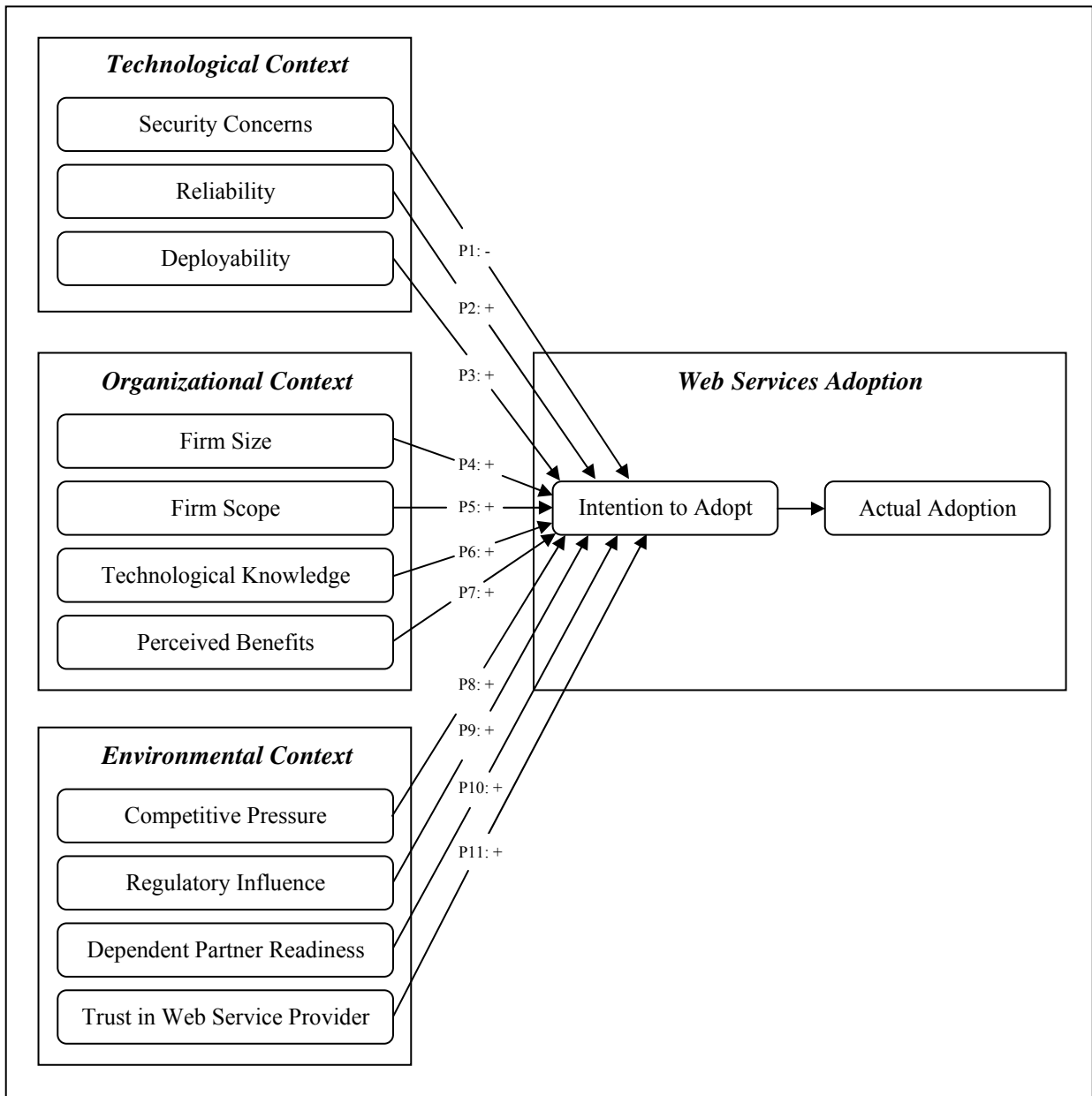


Figure 1: Conceptual model for web services adoption