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ENTERPRISE RESOURCE PLANNING ADOPTION: STRUCTURAL EQUATION MODELING ANALYSIS OF ANTECDANTS

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ABSTRACT

This study identifies the key antecedent factors for accomplishing the adoption stage of enterprise resource planning (ERP) systems. Five potential antecedent factors of adoption were derived from the literature, including that on innovation theories, and data were obtained from a sample of 217 organizations across Australia. A structural equation modeling (SEM) technique was used to examine the complex relationships between antecedents and the adoption decision. We found that there were three positive drivers of a successful outcome of the ERP adoption stage. Prior findings have shown that system quality is a key enabler for innovation adoption by individuals, and we found that system quality is also an important driver for organizational adoption of ERP. It was also indicated that organizations consider adopting ERP when the market and customer patterns are relatively stable rather than in turbulent environments.

Keywords: adoption, enterprise resource planning (ERP), structural equation modeling (SEM), partial least square (PLS), implementation

INTRODUCTION

An important source of improved competitiveness is technological process innovation, and enterprise resource planning (ERP) systems are one source of such innovation—one that can bring about a fundamental shift in the way a business functions, moving it from a functional to a process-oriented way of operating. ERP promises to incorporate best business practices, improve coordination and control and link “back-office and front-office operations” [1]. Researchers have concluded that ERP improves coordination, enhances order management, information visibility, and customer responsiveness, and boosts accountability and discipline [2, 3].

Therefore, the potential of ERP to deliver value seems to be well recognized, yet its introduction into organizations continues to be a daunting task, encountering failures and difficulties [4]. The risks, challenges, and high failure rates of ERP projects have been documented in the literature since the mid-1990s [4, 5, 6, see Appendix A for ERP failure examples]. The significantly high costs, the broad scope of the projects, and the associated changes it brings to people, processes, culture, and organizational structure make ERP projects a complex endeavor that leave little room for error. The continued failures may be due to the lack of a holistic and structured understanding of the organizational innovation process involved in ERP projects, particularly, the organizational approach at the adoption stage [7]. Esteves and Bohorquez [8] observed that the number of ERP studies with theoretical foundations remains limited.

Much of the research in the ERP context focuses on the implementation stage, while very few studies have examined the stages of its introduction and use [9, 63]. Some researchers [10, 11] attribute this focus to the high risks and failure rates of ERP projects. It may well be that some researchers consider implementation a term that *includes* initiation, adoption, implementation, and use [63], whereas these are identified as separate terms by innovation adoption scholars [e.g., 12]. Van Stijn and Wensley [13] explain that the focus on the implementation stage is due to researchers considering the implementation stage an “obstacle” that needs to be overcome first.

We suggest that the research focus on the implementation stage alone is counterproductive, as it has led to the generation of fragmented, unsystematic knowledge output. While each stage of the innovation adoption process has its set goals, priorities, focus, stakeholders, and strategies, the successful accomplishment of one stage serves as an input to the next stage [14]. Therefore, to improve the chances of achieving success in ERP projects, the issues related to a successful outcome at each stage of the innovation process should be investigated separately [7, 63]. Thus, the way in which problems at one stage may cause related problems at another can be more easily exposed. Similarly, antecedent success factors at one stage can be examined to see if they are also factors of success at another and whether they are independent of each other, as an understanding of the possible synergies can be important managerially [15]. By focusing on one specific stage of the overall process, a greater understanding of the entire innovation management process can be reached and can help to improve the chance of successful outcomes for ERP projects. Accordingly, the research described here focuses on one stage of innovation: the adoption stage of an ERP system.

As we have argued above, achieving the adoption of an ERP system is critical to the overall subsequent successful outcome; however, little research has been done on the issues, problems, and antecedent factors of this stage in the process. ERP adoption differs from the adoption of a typical IT system because ERP systems are inherently complex, integrated in nature, capital intensive, more risk prone, and generally not tailor made, and they require different organizational capabilities to operate and maintain [16]. Therefore, the research findings on the adoption process of traditional IT systems may have limited ability to provide direct indications of the complexities of the ERP adoption decision-making process and antecedent influencing factors. An understanding of the antecedents critical to the success of the adoption process of ERP can help organizations to achieve savings in cost and time and reduce the risk of failures [15]. Therefore, this topic merits research attention. In the context of the foregoing arguments, the aim of our study is to identify the antecedents that influence the adoption decision stage of an ERP project.

ADOPTION OF ERP

The initial adoption of an innovation is a key stage of any project seeking to install and use it, as the adoption will lead to substantial monetary and resource commitments and this applies to ERP projects as they can be considered innovations [17]. A lack of understanding of what is required at this primary stage can lead to serious difficulties later on and a drain on critical organizational resources. The adoption stage has been recognized as one of most critical stages in the innovation process [15, p.423]. We use Rogers's definition of adoption: "the decision of any individual or organization to make full use of an innovation as the best course of action available" [12, p.177].

The identification of the antecedents of the organizational adoption of ERP is important for the successful achievement of an ERP project. We summarize below some of the main findings from the literature relevant to our study and, in this selective review, we examine adoption from an organizational perspective. While the adoption stage has been considerably researched in the innovation diffusion literature [e.g., 18, 19], it seems to have attracted little attention in the ERP literature, where the prime focus has tended to be on the implementation process of ERP [8].

For IT projects, in general, the following have often been found to be significant predictors of the adoption behavior of organizations: organization size, business complexity, availability of resources, control mechanisms, and staff skills and expertise [12]. We briefly examine below the degree to which these antecedents, and related items, have been found to apply to the adoption of ERP.

A formalized and centralized organization structure has been found to help smooth implementation [19] because ERP entails increasing the control and centralization of information and processes within an organization. However, Kostopoulos et al. [20] found that centralization is negatively related to ERP adoption.

Organization size, structure, knowledge, and management capabilities have been found to be antecedents of ERP adoption [21], whereas business complexity appears to have less of an influence on ERP adoption [22].

The system development processes involved in ERP differ from those in traditional systems; hence, organizational readiness (OGRD) is crucial for ERP adoption success [23], and the components of this, such as technological readiness, information technology (IT) and information systems (IS) competence of staff, internal capabilities, and financial and human resources, have been examined by a range of authors [16, 19, 20, 24].

The marketing activities of resellers and providers can also play a role in shaping organizational behaviors relating to the adoption of ERP. Therefore, environmental uncertainties, which can manifest themselves in many ways, for example, in partner readiness, regulatory compliance requirements, need for product/service differentiation, require careful consideration at the adoption stage of ERP. Related to this, a major strategic concern for organizations considering the adoption of ERP is to assess the benefits and risks. The perceived benefits of organizations adopting ERP have been found to be positively associated with the adoption decision [25], the benefits typically being to gain operational speed and business profitability [2, 3]. The perceived value of adopting ERP also affects the decision by an individual in an organization to adopt and use the system [26].

The quality characteristics of an ERP system, such as stability, performance, reliability, format, and ease of use, have been found to be crucial indicators of successful system adoption [27, 28]. The literature reviewed above indicates that ERP adoption has been mostly considered part of the implementation stage, and insufficient distinction has been made between the two in most studies. We believe that the antecedents of each stage should be investigated separately, which will aid in reducing the problems of achieving full ERP implementation.

THEORETICAL UNDERPINNING

Scholars have produced several innovation process models [63]. These models describe organizational and individual behaviors related to the adoption and use of innovations, with a view to improving the uptake and acceptance of innovations. As we investigate the antecedents of the adoption stage of ERP, a stage-based conceptualization of the innovation process and the antecedents relevant to the stages in these models is central to achieving the objectives of this study. The diffusion of innovations (DOI) [12] and IS implementation [29] models describe the innovation process as passing through multiple stages: initiation, adoption, implementation, and use. Organizations adopt innovations to improve performance, both operationally and strategically and so the IS success model [30] can provide a robust lens through which to examine the influence of innovations, particularly IS innovations like ERP, on organizational performance.

One of the key stages described in these models is the adoption stage and its antecedents. The synergies offered by these models, in describing the innovation stages and the antecedents relevant to the stages (see comparative summary in Appendix B), provide a powerful theoretical grounding for us to examine the antecedents of the adoption stage of ERP. The DOI and IS implementation models provide the classification of antecedent factors within various dimensions: specialization, networks (organizational); hostility, competition (environmental);

compatibility, complexity, relative advantage (technological); autonomy, responsibility (task related); and cosmopolitanism, education (individual) factors. The IS success model additionally identifies system quality and information quality as antecedent factors of the subsequent use of an innovation and user satisfaction with it.

Based on the literature review and the factors proposed by the above three theories, we conclude the following:

(a) Important antecedents that seem to require further examination for their influence on the organizational adoption decision on ERP are: (i) OGRD (includes specialization and network aspects of the DOI and IS implementation models), (ii) system quality and information quality (IS success model), (iii) strategic value (includes the relative advantage and organizational benefits context of the DOI and IS implementation models); and (iv) environmental assessment (EVA) (includes hostility and competition aspects of the DOI and IS implementation models).

(b) While considerable literature shows the influence of information quality and system quality on individuals' adoption of innovations, limited work has been done to examine their role on organizational adoption, particularly as the individual's adoption is contingent upon organizational adoption.

(c) Some studies have examined components of the antecedents that we identify in (a), but they have not tested their influence on organizational ERP adoption.

Therefore, our study seeks to examine robustly the above-proposed antecedents via a model that includes them all and that has theoretical foundations.

RESEARCH HYPOTHESES AND CONCEPTUAL MODEL

As discussed, we selected five factors for further study as key antecedents in ERP adoption: perceived system quality (PSQ), perceived information quality (PIQ), Organizational readiness (OGRD), Environmental Assessment (EVA), and perceived strategic value (PSV). We define PSQ and PIQ as the perceptions of managers regarding the quality of an ERP system that they are considering adopting. A conceptual model, derived from these hypotheses, is built and presented in Figure 1.

Perceived System Quality (PSQ)

System quality is one of the most important enablers of IS success [30]. System quality is found to be positively associated with user satisfaction and the general success of the ERP implementation process [31]. It influences utilization of the system and affects individual user performance when using the ERP system [27].

ERP systems are believed to provide integration, flexibility, and optimum resource utilization, and thus provide high system quality. If the ERP system does not provide the desired quality, it can affect the level of use and user acceptance of the system, leading to suboptimal utilization of the system [32]. An organization can only really benefit from an ERP system when its staff use the system and unpack the knowledge embedded in the system.

User adoption of ERP is contingent upon organizational adoption of ERP; therefore, an assessment and understanding of the system quality of ERP before its organizational adoption is critical. It is expected to help in alleviating any potential problems due to non-acceptance or limited acceptance of the system, but also to put in place strategies and plans to deal with any issues of system quality. Therefore, we derived the following hypothesis:

> *H1. An organization's perception of ERP's ability to provide system quality is positively and significantly associated with its adoption.*

Perceived Information Quality (PIQ)

In most cases, ERP is adopted not just to replace the fragmented legacy systems, but also to effectively manage organizational data that were previously stored in separate places. This has been established as a critical factor in ERP use and system success [31].

Information quality has been found to have a profound influence on user acceptance, system use, and user satisfaction [27]. It contributes to shaping the behavioral intention to use ERP systems, influences work efficiency, and has an effect on the post-implementation success [31] of the systems.

ERP systems are generally regarded as providing reliable, accurate, timely, and well-presented information. Any changes in the information quality characteristics of an ERP system, such as changes to screen formats, report generation, data validations, functionalities, and processes, are generally considered a cost-intensive and a counterproductive exercise, due to problems that may occur in upgrades, maintenance and system support.

As such, once the systems are adopted and implemented, organizations have very little choice but to use the systems "as is". Hence, an assessment and understanding about the PIQ of the system to be adopted helps an organization to plan the ERP project on a sound footing. Thus, the following hypothesis was formulated:

> *H2: An organization's perception of ERP's ability to provide information quality is positively and significantly associated with its adoption.*

Organizational Readiness (OGRD)

OGRD assessment has been described as a key phase in the ERP adoption decision-making process [33]. The failure to identify potential organizational problems early on can adversely affect the organization's preparedness for ERP implementation [34].

An organization that practices knowledge sharing, possesses informal networks, and a supporting technical and human infrastructure, indicates an environment conducive to embracing change and, therefore, "readiness". Cooperation, rather than competition, between functional departments, and synergy between the three disciplines of IT, the business and the organization further signify OGRD for ERP adoption [35]. Ifinedo and Nahar [36] concluded that the availability of IT assets in the form of in-house employee skills (specializations) improves the chances of successful ERP projects. Bagchi et al. [16] emphasized the need to invest in the employees' development and to carry out preparatory work prior to ERP adoption to influence their attitude toward the system. It can be argued that all of the above factors contribute to or are indicators of readiness.

Grounded in the structural contingency theory of fit, Khazanchi [37] believes that "readiness" of an organization to adopt a certain technology is an important criterion for successful implementation and effect on performance. Based on the empirical evidence and discussion above, the following hypothesis is postulated:

H3: OGRD is positively and significantly associated with ERP adoption.

Environmental Assessment (EVA)

Competitive pressure, normative pressure, and customer power have been found to influence the adoption of technologies positively [38]. Hung et al. [24] claimed that competitive pressures influence adoption of ERP in small and medium enterprises. In addition, general economic environmental and government regulations influence ERP adoption in developing countries.

EVA or assessment of environmental uncertainty has been measured using a variety of indicator items, such as competitors' capabilities, external threats and opportunities, internal strengths and weaknesses, industry trends, trading partner readiness, and government policy initiatives [39]. However, in a strategic, technological innovation context, EVA has been conducted within three broad dimensions: hostility (threats from competition and availability of resources), dynamics (rate and unpredictability of environmental change), and heterogeneity (diversity in production and marketing methods, diversity in customer buying behaviors, etc.) of the environment [40, p.482–483].

A dynamic, heterogeneous, and hostile business environment reflects uncertainty and may affect the stability of demand, put strains on supply, generate a less loyal customer base, and result in fluctuating economic outcomes. ERP systems, with their integrative architecture, real-time information visibility, and global connectivity features can be expected to provide capabilities to forecast demand and supply variations, support sound decision making, help efficient utilization of resources, and achieve a competitive advantage. Therefore, the following hypothesis is postulated:

H4: An environment characterized by hostility, dynamism, and heterogeneity positively and significantly influence ERP adoption.

Perceived Strategic Value (PSV)

PSV is defined as the "level of recognition of the relative advantage" or the opportunity of obtaining positive outcomes from an IT investment [41, p.509]. Subramanian and Nosek [42] concluded that PSV can be measured by three factors: operational support, managerial productivity and strategic decision aid. IS such as ERP are considered key strategic assets of an organization's portfolio. Therefore, their adoption is motivated by business justification, and the PSV these new systems are considered to bring to the organization [42].

Sutanonpaiboon and Pearson [43] and Shiau et al. [25] found that PSV is an important determinant of adoption, albeit the former in an e-commerce context and the latter in an ERP context. However, the findings of Shiau et al. [25] should be viewed with caution, as they took a narrow view of the perceived benefits by only considering operational benefits. In contrast, Jang et al. [22] did not find a significant relationship between perceived IT advantage and ERP adoption.

The adoption of ERP systems entails disruptive changes across the whole organization, and its implementation involves considerable risks in financial, people, and business terms. Therefore, it is crucial that organizations have a clear understanding of the strategic goals and perceived values of adopting ERP [35]. Thus, the following hypothesis was developed:

H5: High PSV of ERP is positively and significantly associated with its adoption.

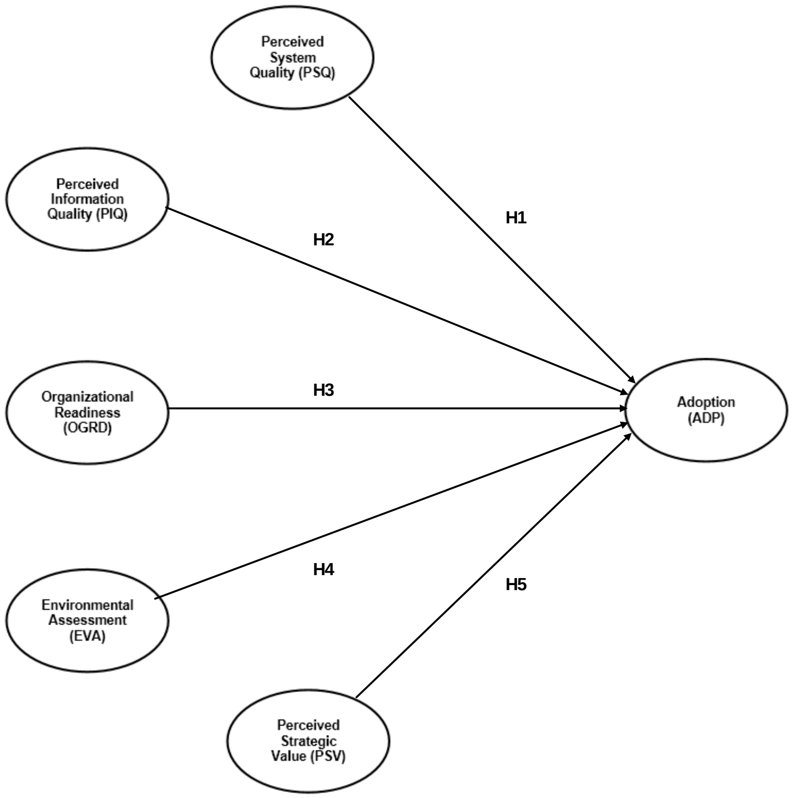


FIGURE 1: The Research Model

RESEARCH METHODOLOGY

We conducted a field survey to learn from the experiences of a large set of Australian organizations that have adopted ERP. The study involved gaining top-level information about the ERP adoption decision; therefore, the target respondents were senior managers, including the chief executive officer (CEO), chief information officer (CIO) or chief technical officer (CTO), and business managers with dedicated involvement in the ERP projects. These respondents were expected to have knowledge of, and a role in, the decision-making process of adopting strategic assets such as ERP and thus fit the criteria for data collection for the study [38]. Inviting a single key respondent for data collection is consistent with the approach adopted by other studies [34] and this was done.

Instrument Development and Data Collection

To seek strong construct validity, all the study variables shown in Figure 1 were measured using multiple reflective indicator items on a five-point Likert-type scale, ranging from “strongly disagree” (1) to “strongly agree” (5). We reused the measurement items that have been operationalized and tested in previous empirical studies to ensure good content validity and enhance the comparability and reliability of study results. Appendix C presents details of the measurement items and constructs.

The adoption was measured in a variety of ways [44]. In our survey, respondents were known to have implemented ERP. For our study, we developed and tested a new 4-item construct to measure the adoption. The “adoption” construct exhibited good psychometric properties (CR = 0.827, AVE = 0.546, see Table 2).

A two-phase process was used to pretest the survey instrument. The first phase involved testing the instrument with 15 academics who had relevant topic knowledge. Their feedback on the content, clarity of presentation, applicability, length, and format of the survey questionnaire resulted in considerable changes to the instrument. In the second phase, nine ERP practitioners or professionals responded to pilot tests of the questionnaire, which was by then transformed into its web version. As a result, further necessary modifications to the format and presentation layout were made to suit the context of the present study.

Survey and Data

We purchased a database containing information on Australian companies that included the following information on each company: the type and name of the ERP system adopted, if one was installed; the industry type and some financial information; and the contact information of senior managers by function. From this, we invited 2,002 organizations that had already adopted ERP to participate in our study. The appropriate manager was sent a survey package that included a covering letter highlighting the objectives of the research, a hard copy of the survey questionnaire, and a reply paid envelope. The survey was made available in online form at www.surveymonkey.com. We received 217 responses. An analysis of the final data set confirmed that no duplicated response had been received. A total of 167 respondents declined to participate in the study, whereas 46 envelopes were returned undelivered due to an incorrect address or movement of the addressee. The survey yielded a net response rate of 12.1% (217/(2002–167–46)), which is typical of such studies [18, 55], given that the data was collected from senior management people in Australian organizations who frequently receive such requests. The length of the questionnaire [45, 55] may also have affected the response rate.

We analyzed the data to determine the respondents’ characteristics and profiles. Of the 217 respondent organizations, about 30% represented the public and utilities sector and 16% were from the manufacturing, mining and automotive sector; 71% were large and 24% were medium sized. Of the actual respondents, 51% described themselves as a CIO/CTO or in another IT-related senior management role, followed by 26% who were a CEO/chief financial officer (CFO)/chief operations officer (COO). Table 1 summarizes the descriptive analysis of respondents.

TABLE 1: Results of the Demographic Analysis of the Data Sample			
	Frequency	Percent (%)	Cumulative %
Type of ERP			
SAP, Oracle, PeopleSoft, JD Edwards	99	45.62	45.62
BAAN, Pronto, QAD, MS Dynamics	42	19.35	64.98
Epicor, Ellipse, Civica, BPCS, SunSystems etc	33	15.21	80.18
Others	43	19.82	100.00
Year of ERP Implementation			
2007–2011	43	19.82	19.82
2001–2006	101	46.54	66.36
2000 and before	45	20.74	87.10
Others	28	12.90	100.00
Organizational Size			
Large	154	70.97	70.97
Medium	52	23.96	94.93
Others	11	5.07	100.00
Type of Industry			
Public Sector, Utilities, etc.	65	29.95	29.95
Healthcare, Pharmaceuticals and Miscellaneous	38	17.51	47.47
Manufacturing, Mining, Automotive	35	16.13	63.59
Higher Education & Research, Professional Services	28	12.90	76.50
Wholesale, Retail, Consumer Products	28	12.90	89.40
High-tech, Aerospace & Defense, Telecommunications	23	10.60	100.00
Job Title of Respondents			
CEO, CFO, COO, MD, GM	56	25.81	25.81
CIO, CTO, IS/IT Mgr, Technology Director, VP IT	112	51.61	77.42
Business Manager, Director, DM, FM, PM	32	14.75	92.17
Others	17	7.83	100.00

Data Adequacy Analysis

Consistent with prior studies [e.g., 45], we conducted an independent sample t-test for early versus late respondents on the five demographic characteristics, that is, year of ERP implementation, organizational size, type of ERP, industry typea and job title. The results did not show any significant difference ($p>0.05$, two-tailed test) between early and late respondents on any of the five characteristics. Hence, we conclude that non-response bias, a potential problem in survey-based studies, is not likely to be a concern of this study.

To examine the presence of common method variance (CMV), the study conducted Harman's single factor test on the data [46]. An exploratory factor analysis (EFA) on the data showed the presence of more than one factor. Further, as the first factor in the

EFA results explained 22.78% of the total variance of 65.75%, it is reasonable to conclude that it is unlikely that the data is affected by CMV.

We sought to investigate whether adoption of a major, well-known ERP system such as SAP or Oracle resulted in different adoption experiences compared to the adoption of a less comprehensive and less well-known one such as BAAN or Technology One. We grouped the types of ERP systems into three tiers based on popularity and market share (Appendix D). We conducted a one-way analysis of variance (ANOVA) of the adoption experience of respondent organisations classified into these tiers. ANOVA test results ($F(3, 197) = 1.094$, $p>0.05$) confirmed that no significant difference exists in the organisational experience on adoption of ERP due to the brand of ERP adopted by the responding organisations.

RESULTS

Assessment of the Measurement Model

We used SmartPLS 2.0, a specific structural equation modeling (SEM) package, to analyze the data. PLS (variance-based SEM) was preferred over covariance-based SEM (such as Amos or LISREL) as PLS is less sensitive to violation of assumptions of normality of sample data [47, 48]. Before proceeding with data analysis we removed data on 8 companies that we found had not yet adopted ERP which left 209 cases upon which our analyses were subsequently conducted. The quality of the measurement model was examined by (a) assessing the standardized factor loading for each measurement item and (b) for each construct we examined the reliability, convergent validity and discriminant validity as recommended in Henseler et al., [48]. In the discussion that follows, the term 'Latent Variable' (LV) and 'Construct' are used interchangeably.

The analysis shows that all the LVs in the model demonstrate adequate internal reliability as the composite reliability (CR) value for all the constructs is higher than 0.75 (Table 2). In PLS, CR is a preferred measure of internal consistency. This is because the traditional Cronbach's alpha tends to underestimate the internal reliability of constructs in PLS [48, p. 299].

An average variance extracted (AVE) value of 0.5 [47] demonstrates that the block of indicator items underlying a particular LV represent the same LV. Initially the AVE values for *EVA*, *OGRD* and *PSQ* were less than 0.5 and so we removed five indicator items (three from EVA, one from OGRD and one from PSQ) which had standardised factor loadings less than 0.7. This brought the AVE values to the required threshold level of 0.5. This then left 26 indicator items in the model from which all estimations of results were derived. The AVE value for all the constructs in the model is greater than 0.5 (Table 2); hence, the LVs are deemed to show requisite convergent validity. In addition, for each construct, the diagonal element (in Table 2) representing the square root of its AVE is greater than the correlation values with all other constructs, demonstrating its adequate discriminant validity.

We also analysed the factor loadings of measurement items. While some items have factor loading less than 0.7, we keep in consideration the PLS characteristic of *consistency at large* which recommends having a large number of indicator items.

Further, the *p-values* of factor loadings show that all our factor loadings are significant at p<0.05. Moreover, following the guidelines of Henseler et al., [48] and Churchill [49], who recommend that the indicator items with standardised factor loadings above 0.4 should be kept for analysis of a measurement model, we proceeded with data analysis without dropping any further items (Table 2).

TABLE 2: Results of the Tests of Reliability, Convergent Validity, Discriminant Validity, and Standardized Factor Loadings of the Variables

	No. of items	AVE	CR	ADP	EVA	OGRD	PIQ	PSQ	PSV
Adoption (ADP)	4	0.546	0.827	**0.7389**	0	0	0	0	0
Environmental Assessment (EVA)	3	0.510	0.7555	-0.1799	**0.7144**	0	0	0	0
Organizational Readiness (OGRD)	5	0.500	0.8324	0.3745	0.0199	**0.7070**	0	0	0
Perceived Information Quality (PIQ)	4	0.509	0.8047	0.3727	0.0208	0.3525	**0.7132**	0	0
Perceived System Quality (PSQ)	4	0.507	0.8023	0.4976	-0.0942	0.2856	0.5826	**0.7118**	0
Perceived Strategic Value (PSV)	6	0.524	0.8668	0.3556	0.0163	0.2521	0.3881	0.4196	**0.7242**

*** The diagonal elements are the square root of average variance extracted (AVE)**
**** CR = Composite reliability**

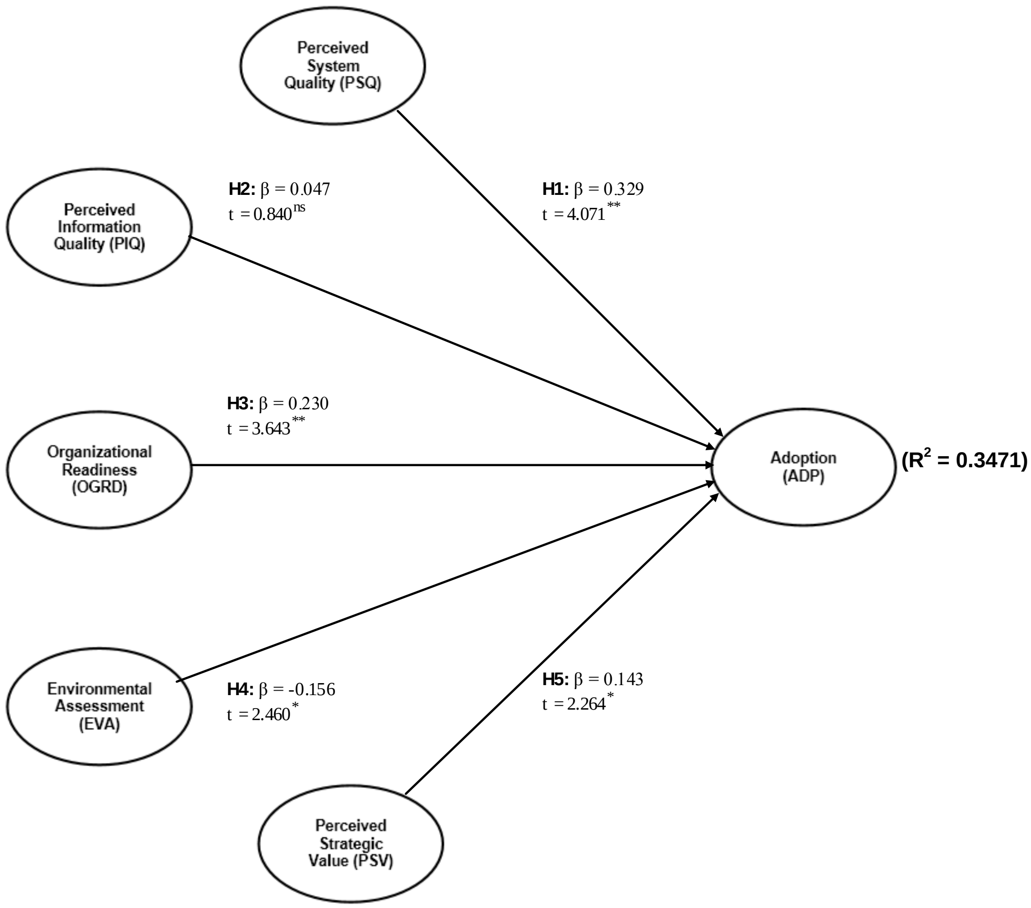
Standardized Factor Loadings

	ADP	EVA	OGRD	PIQ	PSQ	PSV			*p-values* (2-tailed)
adp1	0.8105								<0.001
adp2	0.7675								<0.001
adp3	0.6726								<0.001
adp4	0.6981								<0.001
eva1		0.7871							<0.001
eva2		0.7418							<0.001
eva5		0.6014							<0.05
ogrd2			0.6036						<0.001
ogrd3			0.7864						<0.001
ogrd4			0.7857						<0.001
ogrd5			0.6824						<0.001
ogrd6			0.6534						<0.001
piq1				0.6835					<0.001
piq2				0.7631					<0.001
piq3				0.6262					<0.001
piq4				0.7666					<0.001
psq2					0.6475				<0.001
psq3					0.7102				<0.001
psq4					0.8127				<0.001
psq5					0.6514				<0.001
psv1						0.5705			<0.001
psv2						0.6888			<0.001
psv3						0.7455			<0.001
psv4						0.784			<0.001
psv5						0.7381			<0.001
psv6						0.7936			<0.001

Assessment of the Structural Model

A three-step assessment procedure was employed to examine the quality of the structural model. These checked the R^2 values of endogenous LVs, path coefficient values, and goodness-of-fit (GoF) of the model [48, 50].

The results of the path model derived from the analysis are presented in Figure 2 below.



Structural Paths in the Model	Sign	PLS Path Co-efficient	T-statistic	P-value
H1: Perceived System Quality (PSQ) → Adoption (ADP)	+	β = 0.329	4.071	<0.001
H2: Perceived Information Quality (PIQ) → Adoption (ADP)	+	β = 0.047	0.840	ns (p>0.05)
H3: Organizational Readiness (OGRD) → Adoption (ADP)	+	β = 0.230	3.643	<0.001
H4: Environmental Assessment (EVA) → Adoption (ADP)	-	β = -0.156	2.460	<0.05
H5: Perceived Strategic Value (PSV) → Adoption (ADP)	+	β = 0.143	2.264	<0.05

*p<0.05; **p<0.001; ns = not supported (two-tailed significance)
Hypotheses supported: H1, H3, H4, H5;
Hypotheses rejected: H2
Variance explained: **ADP** = 34.71%

FIGURE 2: The Results of PLS Analysis

The R^2 value of the endogenous variable "adoption" in the inner path model demonstrates that the five independent variables (antecedents of adoption) explain 34.7% of the variance in the adoption variable, which signifies a medium to large value of variance explained (Chin [47] recommends R^2 values of 0.67, 0.33, or 0.19 for dependent variables as signifying substantial, moderate, and weak values respectively). It was found that PSQ (0.329, p<0.001), OGRD (0.230, p<0.001), and PSV (0.143, p<0.05) have a positive influence on adoption. Contrary to the a priori assumption, the EVA (–0.156, p<0.01) was found to have a negative significant relationship with adoption. The study found that PIQ (0.047, $p>0.05$) does not influence adoption of ERP. These effect sizes from the modeling results are given in Figure 2.

The GoF value for the model was calculated by following the procedure recommended by Tenenhaus et al. [50, p.173]. The GoF value of the model was found to be 0.35, which demonstrates a medium to large model fit (GoF values of 0.1, 0.25, and 0.36 signify small, medium, large values respectively, Wetzels et al. [51]). Thus, all three assessments demonstrate that the model is significantly reliable and adequately reflects the underlying assumptions.

DISCUSSION OF FINDINGS

Effect of Perceived System Quality on Adoption

The direct and positive effect of PSQ on adoption signifies the importance of the efficient delivery of IS through system attributes of flexibility, ease of access, reliability, and integration capabilities.

Until now, the examination of the role of system quality has generally been limited to the issue of the individual's adoption of ERP, while very limited research has been done on the influence of PSQ on the organizational adoption of ERP. The evidence provided by this study advances knowledge on the role of system quality in the organizational decision-making process of adopting ERP.

We conclude that organizations should endeavor to seek information about the quality of the system through visits to user sites to gain an understanding of the functionalities, management, and stability of the system. The potential adopter also needs to identify any potential misfit or misalignment between an ERP system's features and capabilities, and the organization's own requirements [see 32]. Some estimates need to be made about how much tailoring of the ERP system will be necessary, and what the risks are of having to tailor the system after implementation.

Effect of Perceived Information Quality on Adoption

Our results show that PIQ does not have a significant effect on adoption. Information quality has been found to influence individual adoption, acceptance, and user satisfaction of the IS (see above). However, its influence on organizational adoption of ERP has remained largely unknown. This study shows that information quality is not a significant factor in the decision-making process at the adoption stage. The current findings do not concur with those of Xu et al. [52], who concluded that (data) information quality problems are one of the key reasons why organizations implement ERP. This change in findings may be due to the increased level of maturity of current ERP systems compared to five to 10 years ago.

The result is somewhat unexpected. One possible reason for it is the growing maturity of ERP systems in providing an adequate level of information quality. It could also be due to the realization among organizations that the quality of information *input* is the primary determinant of the quality of information *output* by the system. Therefore, information quality could be as dependent on the level of staff skills and the organization's practices as it is on the system's processing capabilities. Organizations need to pay attention to the management of data entry into the ERP system. Some efforts need to be made to educate system users to detect patterns of corrupt data in the system once the system goes live.

Effect of Organizational Readiness on Adoption

Our findings show that OGRD positively and significantly influences adoption. The results reaffirm earlier research in which OGRD was found to be significantly associated with the adoption of technologies such as e-commerce (see above). The integrated and complex nature of ERP systems poses a peculiar set of problems at various levels of management of people, processes, organizational structure and culture, once ERP is adopted. Therefore, the findings offer some new evidence on the role of OGRD in explaining organizational ERP adoption behavior.

The conclusion emphasizes that organizations need to focus on certain elements that play a key role in the success of ERP projects. They are: (a) prior experience with network-based applications; (b) staff skills in network-based applications; and (c) a culture of enterprise-wide information sharing. Employees need to be groomed to be able to operate in an ERP environment [36]. Managers need to provide adequate internal business resources and show their commitment to employee development programs, even though these programs may be costly and time consuming. Organizations can promote an environment of knowledge sharing through culture change, staff development, and infrastructure upgrades to operate successfully in the ERP era [33]. Effective training can address some of these issues.

Effect of Environmental Assessment on Adoption

Our findings suggest that when the environment external to the organization is uncertain—characterized by hostility, dynamism, and heterogeneity—it negatively influences the decision-making process at the adoption stage to a significant degree. This is consistent with the findings in Chong's [53] study in an e-commerce adoption context. However, other studies have concluded a positive significant association between environmental pressure (competitive as well as normative) and adoption and assimilation of technologies, including ERP [e.g., 54]. Since the results of both this study and Chong's [53] are based on data collected from businesses within Australia, there is the possibility of country-specific or region-specific differences. Further research could be done to investigate such possible effects.

Being contrary to the a priori assumption (see hypothesis H4) of a positive relationship, the results imply that organizations actually do *not* adopt ERP when the market and customer patterns are uncertain. Instead, they adopt ERP when the markets are relatively stable. A turbulent environment may not be the time to make huge investment decisions such as the adoption of ERP.

The findings also suggest that the uncertainty and risks inherent in ERP projects make organizations more careful in their approach toward adoption of ERP. It may also be that managers are becoming proactive in their strategy toward adoption of technological innovations such as ERP. The tendency to adopt technologies in response to the mimetic, coercive or normative pressure of environmental forces may be receding. However, the downside of such a strategy (i.e., not being reactive to environment pressures) is the possible loss of an “early adopter” advantage [53], especially if the management takes too long to make investment decisions in innovations.

Effect of Perceived Strategic Value on Adoption

We found that PSV has a significant positive effect on adoption. Previous studies on ERP have demonstrated mixed results for the effect of the perceived benefits of ERP on the adoption decision. However, the focus of these studies was on the operational context of the benefits. This study offers new evidence on the comprehensive range of benefits, that is, the operational support, managerial productivity, and strategic decision aid, expected of ERP at the adoption decision stage of the organizational innovation process.

The results suggest that performing a proper assessment of PSV is necessary because, in many business cases, there is not enough justification for transition to ERP if only tangible benefits are assessed. The findings provide new insights into the organizational expectations of benefits to be gained from the introduction of ERP.

The conclusions drawn from the findings suggest that ERP vendors should communicate the benefits that organizations could realize by adopting ERP, particularly in relation to their business operations. Managers are generally cognizant of the overall perceived values of ERP, as they encounter such information in the marketing materials of the vendors or from other sources such as trade journals or targeted presentations. However, as every business has its own competitive differentiation, conducting an assessment of the potential value of ERP is critical for making a sound judgment about adoption. Additionally, an assessment of PSV will provide a benchmark for the organization to compare the actual benefits at the post-implementation stage with the predicted benefits. The learning gained from this exercise will help organizations to make improved decisions about future investments in technological or other types of innovations.

RESEARCH IMPLICATIONS, LIMITATIONS, AND FUTURE RESEARCH

The previous research on ERP has mostly focused on implementation. We empirically tested and found a significant influence on adoption of factors including PSQ and PSV. Additionally, factors identified by us are underpinned by three robust theories, which may improve the predictive power of current innovation process theories, and further research should seek to investigate this. Finally, we developed a new 4-item construct to measure the adoption, which could be used in other studies on adoption.

This study provided preliminary evidence on the issues that potential ERP adopters should consider at the ERP adoption decision stage. The conclusions support the need for a detailed evaluation of the environment, both internal and external to the organization, at the time of making a decision to adopt ERP. Organizations need to ensure that they gain information about the quality of any prospective ERP software, in order to avoid potential gaps between their users’ needs and the software system’s features. The ideas advanced by this study can help managers to mobilize and prioritize their resources, in order to achieve a favorable outcome of the ERP project.

The results of the study also have some limitations. We have developed arguments for proposing a set of key antecedents of the adoption decision for ERP systems. These may not be the only antecedents. To produce conclusive findings of this nature for an exhaustive set of possible antecedent factors would be extremely difficult and, generally, progress is made by successive studies over time. Ours is one such contributory study.

This study was conducted solely in Australia, a country characterized by a mature IT and resources infrastructure. Hence, the importance of the various factors in countries that are less developed and less mature in terms of such factors as infrastructure, facilities, skills and market size may be different. Nevertheless, we feel that our findings are generalizable to sets of companies that are similar to those in our sample, in economies that are similar to that of Australia. Finally, although the nature of the sample from which the data were obtained did not represent all industries and all countries, the sample was broader than in previous studies and so gives indications of what may be found more generally.

Future studies should investigate the management of antecedent factors identified by this study. A case study based approach could be adopted in this regard. Further, additional cross-sectional studies could be done to identify more factors that influence the outcome of adoption. Finally, further case study based research could examine the differences and similarities in practices, strategies, and factors specific to the adoption stage in Western versus Asian cultural contexts.

CONCLUSION

Using concepts drawn from two organizational innovation theories and the IS success model, this study developed and then empirically established that the antecedents of system quality, OGRD and PSV have a direct and positive effect on the outcome of the decision-making process at the adoption stage of ERP systems. While system quality has been shown to be an influencing factor for adoption in studies of individual behavior, its relationship to the organizational adoption of ERP systems had yet to be established. However, information quality was not found to be a determinant of ERP adoption. It may be that, with the growing maturity of ERP systems, organizations are generally satisfied with the increased information visibility and real-time information availability characteristics of ERP systems. Additionally, the study found a significant negative relationship between environmental stability assessment and ERP adoption. This result can mean that, while “environmental effects” can have an influence on ERP adoption, organizations adopt ERP when the market and customer patterns are relatively stable. This finding suggests that a turbulent environment period, as represented by environmental pressures, is not the time when most organizations make large investment decisions such as those involved in ERP adoption.

While some of the antecedents examined in this study have been examined in relation to their influence on adoption in other IS contexts, this study contributes to our knowledge by providing new evidence of their influence on the organizational adoption of ERP. Our study also differs from prior studies in that we examined the antecedents as LVs, which provides a more holistic understanding of, not only the individual significance of their influence on the organizational adoption of ERP, but also the combined structural influence of these variables. Our results show that PSQ, PIQ, PSV, OGRD, and EVA collectively explained variance in adoption of some 35% (R^2 = 0.3471 in adoption). Therefore, these findings go beyond the examination of the individual influence of certain variables and identify a set of antecedents of the organizational adoption of ERP that need to be collectively managed to achieve the adoption process.

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Appendix A: List of ERP Project Problems / Failures		
Organization Name	**Year**	**ERP Projects problems and failures**
National Health Service (NHS) United Kingdom	2011	NHS spent an estimated £12 billion (US$18.7 billion) on a project to centralize electronic health records of its citizens, but project did not meet the requirements and ultimately was abandoned.
Marin County, California, USA	2011	The failed ERP project at Martin County, California resulted in filing of lawsuit against SAP and Deloitte Consulting.
ParknPool, USA	2011	ParknPool sued Epicor over botched ERP implantation.
Montclair State University, New Jersey USA	2011	Oracle faced lawsuit over failed PeopleSoft implementation at Montclair State University.
CityTime Payroll System project, New York USA	2011	The project that was budgeted at $63 million failed due to cost overruns and spending of $760 million.
CareSource Management Group, USA	2011	The group halted the ERP project and sued Lawson that to pay damaged of $1.5million, as the software it provided did not delivered the expected results.
Ingram Micro Australia	2011	The SAP implementation ran into problems leading to Ingram Micro suffering a significant drop in its net income twice in 2011.
Whaley Foodservice Repairs, South Carolina, USA	2011	Epicor implementation cost the company more than 5 times the original estimated amount of $190,000 and Epicor was sued for the failed implementation.
Lumber Liquidators	2010	The company faced various problems with its SAP implementation
Dillard's, Inc.	2010	JDA’s i2 implementation failed to meet the project expectations
Sources: [5,6]		

Appendix B: Summary of Stages and Factors in Three Models			
Name of model	**Type of model**	**Stages in model**	**Factors identified by the model**
Diffusion of Innovation (DOI) model [12]	Process	Initiation - Agenda-setting - Matching Implementation - Redefining/Restructuring - Clarifying - Routinizing	Individual Factors: Relative advantage, Complexity, Compatibility, Trialability, and Observability Organizational Factors: Complexity, Formalization, Organizational slack Interconnectedness, Size
IS Implementation model [29]	Process	Initiation Adoption Adaptation Acceptance Use Incorporation	Specialization, Networks (Organizational / Structural); Compatibility, Complexity, Relative Advantage (Technological); Heterogeneity, Competition (environmental); Autonomy, responsibility (Task-related); Cosmopolitanism, Education (Individual)
IS Success model [30]	Process	Use User Satisfaction Individual Impact Organizational Impact	System Quality, Information Quality

Appendix C: Constructs and Item Details			
Constructs	**Indicator Items**	**Definition**	**References**
1. Perceived System Quality (PSQ)	5 items: Reliability, Flexibility, Ability to integrate, Timeliness of information, Ease of information access	The operational characteristics of the system	[55,56]
2. Perceived Information Quality (PIQ)	4 items: completeness, accuracy, format and up-to-datedness of information	Quality of the information that the system produces	[55,56]
3. Organizational Readiness (OGRD)	6 items: covering human, IT, financial resource availability	Ability of a firm to successfully adopt, use, and benefit from innovations.	[57,58]
4. Environmental Assessment (EVA)	6 items: covering three dimensions: environmental hostility, dynamism and heterogeneity	Evaluation of external information, identification of business needs, objectives, external opportunities, threats.	[40]
5. Perceived Strategic Value (PSV)	6 items: encompassing managerial decision making, operational efficiency, and support for the operations dimensions	Business value or the opportunity of getting positive returns from investments into ERP.	[18,42,59]
6. Adoption (ADP)	4 items: Top management support, visions & mission, cost-benefit analysis, selection of vendor based on a detailed evaluation	Decision of any individual or organization to make full use of an innovation as the best course of action available.	[60,61,62]

Appendix D: Respondent Organizations Groupings in Brand/Type of ERP Implemented	
Groups	**Type or Brand of ERP implemented**
Group 1	SAP, Oracle, JD Edwards, PeopleSoft
Group 2	BAAN, Technology One, MS Dynamics, Pronto, QAD
Group 3	The rest of ERP software implemented by the responding organizations