Knowledge management for ERP success

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Abstract

The business value of Enterprise Resource Planning (ERP) systems and in general large software implementations has been extensively debated in both popular press and academic literature for over three decades. Despite the positive motives for adoption, various organizations have reported negative impacts from these large investments. This 'disconnect' between large IS investments and firms' organizational performance may be attributable to the economic transition from an era of competitive advantage based on information to one that is based on Knowledge. This paper discusses the initial findings of a two-phased study that focuses on empirically assessing the impact of knowledge management on the success of Enterprise Resource Planning systems. The research study uses information gathered from twenty-seven public sector organizations in Queensland, Australia. Validation of the a priori model constructs through factor analysis identified two dimensions of knowledge management. Further analysis assessed the comparative differences in perceptions of knowledge management in ERP, across four employment cohorts.

Keywords: Knowledge, Enterprise Resource Planning, ERP success, IS success

Introduction

Information Systems (IS) investments are under increasing scrutiny and pressure to justify their value and contribution to productivity, quality and competitiveness of the organization. Assessing the value of IS is consistently reported by organizational executives throughout the world as a key issue (Ball and Harris, 1982; Brancheu and Wetherbe, 1987; Dickson, Leitheiser, Nechis, Wetherbe, 1984). Evidence on the impact of IS has been mixed. Some studies have shown positive impacts of IS in organizations (e.g. Barua and Lee, 1997; Barua, Kriebel, Mukhopadhyay, 1991; Brynjolfsson and Hitt, 1996; Lehr and Lichtenberg, 1999; Mukherjee, 2001), while others have shown nil or detrimental impacts (e.g. Brynjolfsson and Yang, 1996; Brynjolfsson, 1993; Cameron and Quinn, 1988; Wilson, 1993).

The 'disconnect' between large IS investments and firms' organizational performance may be attributable to the economic transition from an era of competitive advantage based on

information to one that is based on *Knowledge* (Malhotra, 2000). In the context of Enterprise Resource Planning systems, managing knowledge has been identified as a critical success factor (Bingi, Sharma, Godla, 1999; Davenport, 1998a; Davenport, 1998b; Davenport, 1996; Sumner, 1999). ERP literature suggests that *knowledge* must be carefully managed throughout the ERP lifecycle in order to maximize benefits. Although knowledge has been attributed as a key driver of ERP success, there has been very little work conducted to date that empirically assesses the impact of *Knowledge* on the Enterprise Resource Planning Systems success.

The main aim of the <u>study</u> was to develop a comprehensive measurement model for understanding the success of ERP systems in public sector organizations. ERP success is empirically measured, first through an exploratory survey aimed at inventorying a range of organizational experiences of ERP. A confirmatory survey was then conducted to quantify the ERP success and a ERP success model is proposed (*See details in: Sedera, Rosemann, Gable, 2001; Sedera, Gable, Rosemann, 2001; Sedera, Gable, Palmer, 2002; Sedera, Gable, Chan, 2003(a), Sedera, Gable, Chan, 2003(b), Sedera, Gable, Chan, 2003(c))*. This <u>paper</u> reports the preliminary findings that examine the relationship between knowledge as an antecedent of ERP success.

The study was conducted across 27 public sector organizations in Queensland – Australia that had implemented SAP during the second half of the 1990s. Using an a priori model of six ERP related knowledge constructs and insights from 310 responses, the impact of knowledge on ERP success is empirically measured and the refined ERP-knowledge model is proposed. The paper proceeds as follows. First it introduces the key areas of this paper: Knowledge and Enterprise Resource Planning systems. Then the paper briefly discusses the context of the study followed by an in-depth analysis to empirically assess the impact of knowledge management on the success of ERP systems.

Enterprise Resource Planning (ERP) Systems

Enterprise Resource Planning systems (ERP) encompass a wide range of software products supporting day-to-day business operations and decision-making. ERP systems serve many industries and functional areas in an integrated fashion, attempting to automate operations from the supply chain management, inventory control, manufacturing scheduling, sales support, customer relationship management, financial and cost accounting, human resources and many other functional areas in an organization.

Organizations adopt ERP systems for a variety of reasons. Two of the most prominent reasons for ERP adoption have been cited as: process standardization and process automation (e.g. O'Leary, 2000). While most organizations historically employed numerous disparate information systems to supply the breadth of functionality of an ERP system, ERP systems provide a standardized and integrated, process focused environment that is difficult to attain and viably maintain with stand-alone, custom-built software systems. Especially due to its process-oriented automation, the ability of ERP systems to disseminate information in real-time can substantively improves managerial decision making in organizations (e.g. O'Leary, 2000; Klaus, Rosemann, Gable, 2000; Bingi et al., 1999; Parr, Shanks, Darke, 1999; Li, 1999; Ross and Vitale, 1999). Despite the laudable motives of ERP adoption, there is a great deal of controversy

surrounding the 'potential' impacts of these systems (e.g. Bingi et al., 1999; Calogero, 2000; Gable, Scott, Davenport, 1998; Chung and Snyder, 1999). Managing knowledge in an ERP project is a complex and difficult task, as a typical ERP system entails many users, both internal and external, ranging from top executives to data entry operators, external consultants and software vendors. Many of the ERP applications span the organization and have a diversity of capabilities and functionality. Shanks et al., (2000) classify the ERP system lifecycle in to four phases: (1) planning, (2) implementing, (3) stabilizing and (4) improvement. Gable, Heever, Erlank, Scott, (1997) recognize three key players associated with the phases of the ERP system's lifecycle: (1) client organization, (2) vendor and (3) external consultant (implementation partner)

Knowledge as an antecedent of ERP success

Literature on Knowledge-ERP can be classified into two broad categories (1) ERP for knowledge management: implemented ERP systems serving as knowledge management tools; and (2) knowledge for ERP: understanding the impact of knowledge (and managing knowledge) that is required for the ERP lifecycle (Rosemann and Chan 2000). This study focuses on the latter – understanding the impact of 'Knowledge' in the context of ERP systems which is considered as an important antecedent to ERP success (Bancroft, 1996; Clemons, 1999; Kirchmer, 1999; Mahrer, 1999; Scott, 1999; Slooten and Yap, 1999; Sumner, 1999; Bryan, 1998; Marcus, Axline, Petrie, Tanis, 2000; Niehus, Knobel, Townley-O'Neill, Gable, Stewart, 1998).

Davenport (1998c) defines knowledge as a fluid mix of framed experience, values, contextual information and expert insights that provides a framework for evaluating and incorporating new experiences and information. In organizations, knowledge often becomes embedded, not only in documents and repositories, but also in organizational routines, processes, practices and norms. Knowledge can be *Tacit* or *explicit* (Brown, Duguid, 1991; Lave and Wenger, 1991; Nonaka, 1994; Romer, 1995). Tacit knowledge is subconsciously understood and applied, difficult to articulate, developed from direct experience and action, and usually shared through highly interactive conversation and shared experiences. In contrast, explicit knowledge is more precisely and formally articulated, although removed from the organizational context of creation or use. Explicit knowledge plays an increasingly larger role in organizations and many consider it the most important factor of production in a knowledge economy. Knowledge can be further classified into *General Knowledge* and *Specific Knowledge*. *General Knowledge* is broad, often publicly available, commonly shared knowledge. In contrast, *Specific Knowledge* is context specific and works through the elements of contextual relationships and categories in an organization. Davenport (1993) identifies three specific knowledge types that are required in an ERP project. They are: (1) *Software Specific Knowledge*, (2) *Business Process Specific Knowledge* and (3) *Organization Specific Knowledge*.

The Study Background

This study was conducted in a public sector ERP environment in Queensland – Australia. All Queensland state Governmental agencies (Departments) with live SAP systems were surveyed. Queensland is the first Australian state to implement common software statewide namely; The Queensland Government Financial Management System (QGFMS). In 1983, the Queensland Government adopted the Management Services America (now Dunn and Bradstreet), financial modules. A decade later, QGFMS, initially broadly considered a success, was in the minds of

many, 'inadequate' to support the Government's ambitious plans for the future. In 1994, Queensland Treasury sent a request for information (RFI) to key ERP vendors. In October 1994, Requests for Offers (RFO) were sought from three short-listed ERP vendors and in December 1994, a committee of agency representatives led by the Queensland Treasury, selected SAP R/3 to contribute to the continual improvement of financial management within the Queensland public sector. In 1995 the state government of Queensland commenced implementation of SAP Financials across all state Government agencies (later followed by Controlling, Materials Management and in some agencies Human Resources). The Queensland Government approach was very much focused on using the Enterprise Resource Planning System as a common reporting and financial management tool (Queensland Treasury, 1998, 2000a; 2000b; 2000c).

This study was first introduced to the Queensland State Government agencies in August 2001 at a special 'benefits realization' interest group gathering. The *exploratory survey* was conducted in September 2001, followed by the *confirmatory survey* in August 2002. Both surveys targeted twenty-seven Queensland Government agencies and are discussed below.

Research Methodology

The main aim of the exploratory survey was to identify and validate constructs and sub-constructs that are relevant to the study context. In the exploratory phase of the study, respondents were asked to specify impacts[1] associated with the SAP system in their organization. Citations of the exploratory survey were then codified and mapped to the five constructs (see Figure 1) and forty-two related sub-constructs reflected in the Delone and McLean (1992) model and related studies (Please see Appendix A for details). Sub/constructs that were not instantiated by the exploratory mapping exercise were further analyzed and validated through expert workshops, before being added to the *a priori* model. Several new sub-constructs reflecting the unique ERP and Public sector research context of this study were identified from the survey data and were added into the *a priori* model (Sedera et al., 2002).

The purpose of the confirmatory survey was to test the *a priori* model (see figure 1). The a priori model consists of two aspects: (1) dependent (success measures) and (2) an antecedent of success (knowledge). A survey instrument was designed to operationalize the five success dependent constructs of success depicted in figure 1[2] (See Details in Sedera et al., 2003a; Sedera et al., 2003b; Sedera et al., 2003c).

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[1] It should be highlighted that the word "impacts" in the exploratory survey round was used in the broadest sense, to encompass impacts on individuals, the organization, information, the system, etc.

[2] The final analysis of the dependent variables revealed an ERP measurement model with 37 measures arranged under four mutually exclusive dimensions.

Figure 1: *Knowledge management for ERP success model*
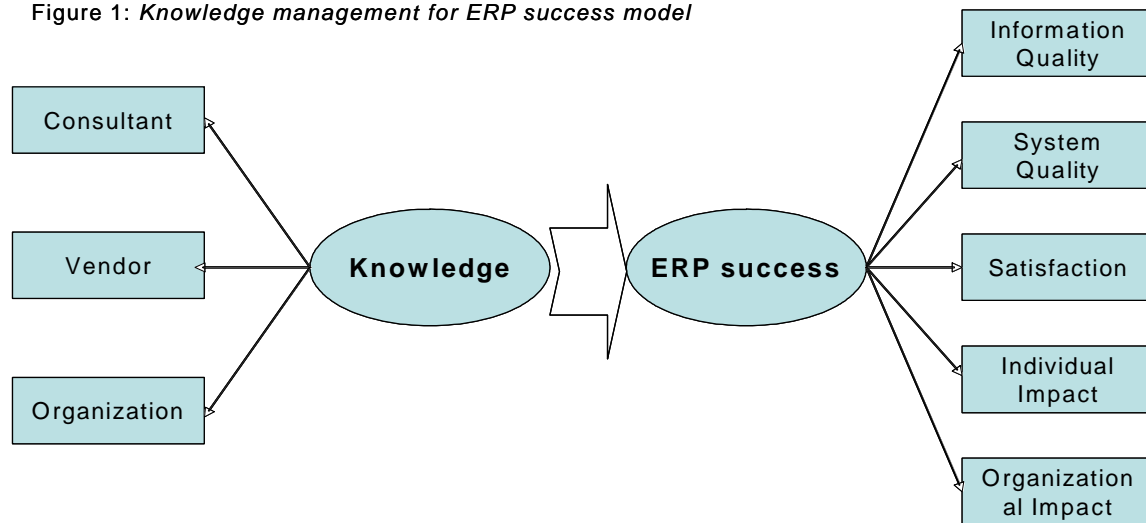
This paper discusses the independent construct (i.e. Knowledge) employed in the study. Knowledge was identified as a key driver of ERP success in prior studies with SAP in Queensland Government. The focus of those studies was to emerge the key issues in Queensland Government agencies and was not intended to measure the influence of knowledge. Twelve questions were derived from issues studies and were tested in the a priori model. Question items on the knowledge construct were derived to reflect six perspectives depicted in the matrix below[3].

Figure 2: a priori knowledge dimensions

	Vendor	Consultant	Organization
Software specific knowledge			
Organisation specific knowledge			

The three knowledge types introduced by Davenport (1993) are summarized into two phases to increase the practicality of the metrics (Shanks et al., 2000) and show the key players of an ERP installation in the second dimension (Gable et al., 1997).

"The research question whether knowledge results in an advantage between competitors at the market, entails a methodological challenge, as it assumes that knowledge or intellectual capital firstly is to be measured" (Davenport, 1998a, p.43). In the field of knowledge management there is growing demand for matrices and measures to further demonstrate the value of knowledge (and knowledge management) (Poage, 2002; Jaffe, 1999; Hughes and Holbrook, 1998; Liebowitz and Suen, 2000) and this study attempts to fulfill the gap in the literature.

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[3] Three questions have been employed to understand the level of knowledge *management* in Queensland Government agencies. This paper will only discusses the analysis of the nine knowledge items

All survey data except respondent's name and name of the respondent's department were mandatory. Items were measured on a seven-point likert scale with the end values (1) 'Strongly disagree' and (7) 'Strongly Agree', and the mid-value 'Neutral' (4). Dissemination of the survey instrument was completed through (i) a Web survey facility, and (ii) an MS Word instrument attached to email. Objective, quantitative and demographic data, such as the number of SAP user licenses, SAP version, number of employees, and other systems used (*if any*), were gathered separately from other sources (such as system documentation and interviews).

The respondents' 'Perspective' is an important design consideration for a measurement model. ERP systems typically have many stakeholders with multiple and often conflicting objectives and priorities. Therefore to obtain a more balanced and comprehensive view, it is importance to analyze and understand measures at multiple levels within organizations (e.g. Cameron and Whetton, 1983; Leidner and Elam, 1994; Tallon, Kraemer, Gurbaxani, 2000; Quinn and Rohrbaugh, 1983; Yoon and Guimares, 1995). This study evaluates the differences and similarities in perceptions of multiple stakeholder groups within the public sector, focusing on the ERP application. Four stakeholder groups have been identified in the current study (i.e. Process owners, Strategic users, Operational users, Technical staff) to understand the implications of knowledge on the ERP systems.

The Analysis

The following section analyses the survey data from 310 valid responses of the confirmatory survey of this research. The validity of the survey items (Content validity, Construct Validity, Criterion validity) will be established followed by the internal reliability of the items. The perceptions of the four employment cohorts are statistically established using *f ratio* and *t-test* results. The proposed ERP-knowledge research *model* will then be established. tested and the impact of knowledge on the ERP application under investigation will be established.

Content Validity

An instrument can be deemed valid or invalid on the ground of the content of the measurement items. Cronbach (1971) and Kerlinger (1964) suggest that an instrument is valid in the content, if that (*instrument*) (i) has drawn representative questions from a universal pool, and (ii) subjected to a thorough reviewing process of the items by experts until a formal consensus is reached. *Knowledge* was identified as the leading driver of ERP system's impacts in a prior study of 'issues' within a sub-set of Queensland Government agencies (Chang, She-I, Gable, 2000; Chang, She-I, Gable, Smythe, Timbrell, 2000). Furthermore, a separate study conducted within Queensland Government agencies (Chan and Rosemann, 2001; Chan and Rosemann, 2002) investigated the relationship between the ERP lifecycle, Knowledge lifecycle and types and knowledge and proposed a classification to catalog knowledge required in an ERP project. Inclusion of knowledge as a construct to test its impact on the ERP system under investigation and inclusion of sub-constructs can therefore be justified. Furthermore, a comprehensive literature review was completed to understand and confirm the knowledge types, key knowledge players and the ERP lifecycle. To comply with the second aspect of content validity, a series of

expert workshops (*with leading academic and industry representatives in the study domain*) were conducted and amendments were made to instrument items[4].

Construct Validity

Construct validity testing seeks evidence that the selected constructs are true depicters that describe the event, not merely artifacts (Cronbach, 1971; Campbell & Fiske, 1959). Construct validity of an instrument can be assessed through multi-trait-multi-method (MTMM) techniques (Campbell and Fiske, 1959) *or* techniques such as confirmatory or principal component factor analysis (Long, 1983; Nunnally, 1967)[5]. Table 1 report results of factor analyzing the 12 Knowledge items using principal component extraction and orthogonal (*Varimax*) rotation with loadings less than .3 suppressed. There were no missing values as all respondents answered all questions. In order to attain a more interpretable and parsimonious factor solution, 1 item was dropped (K1 - Overall, SAP help desk knowledge has been appropriate). Factor loadings explained 65.3% of the variance of the model. As anticipated, the client items load together on a separate construct (Internal Knowledge player). However, Consultant and Vendor items loaded together yielding a new factor now named External Knowledge players.

Table 1: Final factor solution

	Questions	Factors	
		1	2
2	Overall, SAP knowledge possessed by the vendor (SAP Australia) has been appropriate		0.75
3	Overall, SAP knowledge possessed by the consultants has been appropriate		0.75
4	Overall, SAP knowledge possessed by the agency has been appropriate	0.75	0.44
5	Overall, SAP knowledge has been re-used effectively and efficiently by the agency	0.79	0.42
6	Overall, SAP staff and knowledge retention strategies have been effective	0.74	0.33
7	Overall, knowledge of the agency, possessed by the vendor (SAP Australia) has been appropriate		0.74
8	Overall, knowledge of the agency, possessed by the consultants has been appropriate		0.84
9	Overall, the Agency knowledge of itself (e.g. Business processes, information requirements, internal policies, etc.) has been appropriate	0.57	0.43
10	Training in SAP has been appropriate	0.82	
11	Users have sufficient SAP knowledge	0.77	
12	The Agency has retained the knowledge necessary to adapt the SAP system when required	0.74	

The two-sources of knowledge are consistent with the Bierly and Chakrabarthi (1996, 1991) who classified knowledge according to the source of generation: *within* or *outside* the organization. Internal knowledge (*within) o*n an ERP project resides within employees of the organization, embedded in behaviors, procedures and the ERP software. The main sources of external knowledge (*outside*) in an ERP project are the consultants and the software vendors. Zack (1999) states that the internal knowledge; which tends to be unique, specific and tacitly held; is more

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[4] Detailed outcomes of the expert workshops can be obtained from the authors

[5] Concurrent and predictive validity are generally considered to be subsumed in the construct validity and thus will not be discussed in this paper.

valuable than the external knowledge. Furthermore, internal knowledge can be of high importance in gaining strategic advantages, especially for profit-oriented organizations.

Figure 3: Revised Knowledge-ERP model

	Internal Knowledge	**External Knowledge**
Software Specific Knowledge		
Organization Specific Knowledge		
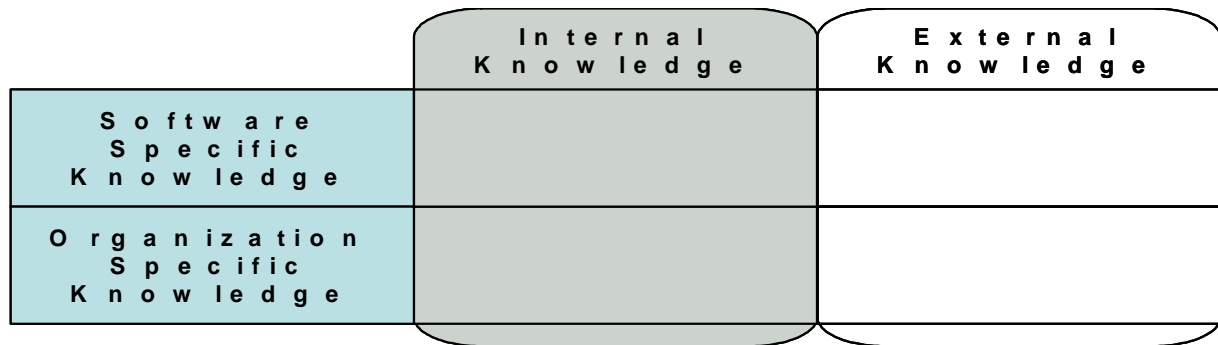
External knowledge; from outside the firm; can provide new thinking in the organization, but it is more widely available to competitors. The correlation analysis discussed in the next section shows a strong relationship between Success and *Internal Knowledge* and a weak relationship with *External Knowledge*. Gable et al., 1997 identify 'staff poaching' due to the late 1990's shortage of ERP experience and expertise in the marketplace, as a source of *internal knowledge* drain from organizations following and during ERP implementations.

The Revised Model

Figure 3 depicts the revised model. It has four quadrants (1) Internal software specific knowledge, (2) Internal organization specific knowledge, (3) External software specific knowledge, (4) External organization specific knowledge.

Criterion Validity

Besides items referenced thus far, the survey instrument elicited criterion measures of overall success in response to each of two statements: i) 'Overall, the impact of SAP on the <u>Agency</u> has been positive,' and ii) 'Overall, the impact of SAP on <u>me</u> has been positive.' With the objective of further assessing the content, construct and criterion validity of the factor solution, the criterion average is calculated using the simple average of the two criterion items. Furthermore Dimensions Average is calculated using the simple average of the five success dimensions. Table 2 shows results of correlating the criterion measures. From table 2 we can make several broad observations. The extent, to which each dimension or the dimensions average correlates

with the criterion scores, is evidence of their criterion validity[6]. *Internal Knowledge* construct depicts good correlations significant at the .001 level suggesting that *organizational knowledge* has a stronger influence on ERP success compared to *External Knowledge* dimensions.

Table 2: Correlation of Knowledge to ERP success

	Criterion Item 1	Criterion Item 2	Criterion Average	Information Quality	System Quality	Satisfaction	Individual Impact	Organization Impact
Internal Knowledge	0.54	0.51	0.55	0.54	0.53	0.51	0.39	0.52
External Knowledge	0.36	0.32	0.35	0.42	0.43	0.39	0.21	0.38
Knowledge Average	0.52	0.48	0.52	0.55	0.54	0.51	0.35	0.51

Reliability

The notion of reliability of a measure refers to its consistency. *Internal Reliability* is particularly important in connection with multiple-item scales. It raises the question of whether each scale is measuring a single idea and hence whether the items that make up the scales are internally consistent. The most widely used Cronbach's alpha is used here to determine the Internal Reliability of the measurement items. The Cronbach's alpha for Knowledge items is calculated at 0. 9059 and which exceeds the recommended minimum accepted level of 0.7 (Nunnally, 1967).

ERP Knowledge across employment cohorts

Table 3: Respondent composition

	#	%	Cum: %
Strategic User	124	39.1	39.1
Operational User	110	34.7	73.8
Process Owner	36	11.4	85.2
Technical Staff	47	14.8	100.0
Total	317	100.0	

To determine whether there is a difference in perceptions between the employment cohorts, (i.e. the overall satisfaction with ERP knowledge management), we apply One-Way analysis of variance (One-Way ANOVA).

 A low *F Ratio* were observed for the criterion item *(F = .106)* suggesting that there are no significant differences in perceptions on the *overall knowledge management* across the four employment cohorts (i.e. Strategic User, Operational User, Process Owner, Technical Staff). To further establish the similarities between employment cohorts, paired *t test* was carried out and the results are shown in table 4. These results further verify the results of the analysis of variance tests discussed above.

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[6] This method of validation assumes the criterion measures are valid (Kerlinger 1988).

Table 4: Paired T-Test						
	Mean	**St: Dev**	**St: Error**	**P**	**t-value**	**2-tailed probability**
Strategic Users	3.99	1.554	.140	.784	-.214	.831
Operational Users	4.04	1.619	.154			
Strategic Users	3.99	1.554	.140	.675	-.216	.829
Process Owners	4.06	1.567	.261			
Strategic Users	3.99	1.554	.140	.628	.367	.714
Technical Users	3.89	1.591	.232			
Operational Users	4.04	1.619	.154	.835	-.062	.950
Process Owners	4.06	1.567	.261			
Operational Users	4.04	1.619	.154	.802	.508	.612
Technical Users	3.89	1.591	.232			
Process Owners	4.06	1.567	.261	.985	.463	.645
Technical Users	3.89	1.591	.232			

Model Testing

The correlation analysis found a strong relationship amongst the knowledge and ERP overall performance. To further strengthen this finding of the correlation analysis the research model is tested using Structural Equation Modeling using LISREL 8.53.The revised research model with the two knowledge dimensions (*Internal knowledge and External knowledge)* and the five ERP dimensions is depicted in figure 3.

Figure 3: *Knowledge management for ERP success*
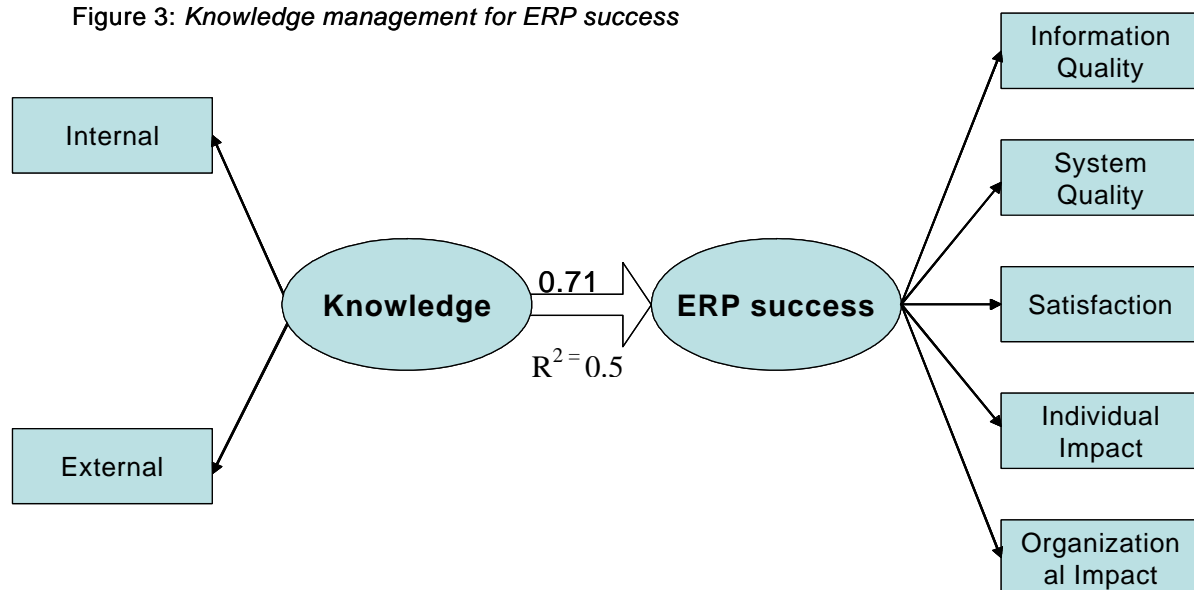
Conclusion

This paper presented the preliminary findings of a study aimed at identifying and assessing the impact of knowledge towards the success of an ERP system. Information received from 310 respondents from 27 Australian public sector organizations was used in the analysis. Responses were analyzed to statistically validate the constructs and sub-constructs employed in the survey instrument. The exploratory factor analysis identified four dimensions of ERP related

knowledge: (1) Internal software specific knowledge, (2) External software specific knowledge (3) Internal organization knowledge and (4) External organization knowledge. The analysis using LISREL showed a strong positive association between knowledge and the ERP system success. The respondents were classified into four independent employment cohorts for further analysis (employment cohorts: Process Owners, Strategic users, Operational users and Technical staff), but these different cohorts did not show any significant differences in perceptions across the two knowledge dimensions. Further analysis is required to understand the complete influence of Knowledge and other possible dimensions of knowledge.

Appendix A

System Quality	Information Quality	Satisfaction**	Individual Impact	Organization Impact
- Data accuracy - Data currency - Database contents - Ease of use - Ease of learning - Access - User requirements - System features - System accuracy - Flexibility - Reliability - Efficiency - Sophistication - Integration - Customization	Importance Availability Usability Understandability Relevance Format Content Accuracy Conciseness Timeliness Uniqueness	- Information ** - Systems ** - Overall ** - Knowledge management ** - Enjoyment	- Learning - Awareness / Recall - Decision making effectiveness - Individual productivity	- Organizational costs - Staff requirements - Overall productivity - Product / service quality - Business Process Change

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