Investigating Enterprise Systems Issues using a Modified Delphi Method and Exploratory Factor Analysis

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Abstract

This paper reports preliminary results from a three-round, non-anonymous Delphi-type survey of 23 government agencies within the Queensland State Government (QSG). The survey examined issues associated with the introduction of the SAP R/3 within that government. Our analysis employs a holistic, interpretive and inductive approach towards understanding the issues underlying the implementation of an enterprise system such as the SAP R/3. Factor analysis of "weights" given by respondents in the final round of the survey on the relative importance of the implementation issues reveals the emergence of seven factors that could undermine the successful implementation of an enterprise system.

Keywords

Enterprise Systems; Delphi Study; Factor Analysis

INTRODUCTION

In 1995 the Queensland State Government (QSG) in Australia selected SAP R/3 as its standard Enterprise System (ES) software. By end 1999 QSG were Y2K compliant, having replaced the central QSG mainframe-based legacy system.

Prior to implementation, QSG departments prepared a business case outlining benefits anticipated (eg. better reporting, lower costs) from deploying the SAP R/3 system. By end 2000 it was apparent that many departments were not realizing the expected benefits and all were experiencing, or had experienced, substantive issues related to the introduction of the SAP R/3 system. Some of these experiences mirror previously reported negative issues (Davenport, 1998).

A pilot study of 5 QSG departments was initiated in 1999 for the dual purposes of testing a variant of the Delphi (Dalkey & Helmer, 1963) method (described in Section 3) used in the current study and cataloguing an initial set of issues (Chang & Gable, 2001). This paper reports the progress on the full study of 23 agency departments in QSG, with an emphasis on knowledge-related issues--the most important issues identified in the pilot study. This study extends the pilot study in terms of the approach used in analysing and identifying the major issues underlying the implementation of SAP R/3 within the QSG. The methods employed in this extension study, however, differed from the initial study. In example, instead of synthesizing the major issues through experimenters' interpretation of the data collected from the respondents, this study allows the major issues to "emerge" through the factor analysis of "weights" assigned by the respondents from the final survey round.

This research program will contribute to an improved understanding of ES lifecycle implementation, management and support issues, thereby facilitating effective allocation of development, management, and training resources (Gable et al, 1998). Further, improved understanding of the relationship between issues faced early in the lifecycle (implementation), with those in subsequent phases (e.g. post-implementation) through the development and testing of a causal model in the future, may point the way to increased benefits realisation and economic-rents from the ES investment.

RESEARCH OBJECTIVES

The study began with the broad question posed to the respondents: "What do you consider have been the major issues in implementing, managing, and/or supporting the ES lifecycle in relation to the adoption of SAP Financials in your department?"

The objective of this research-in-progress paper is to report how the issues group together using factor analysis and provide some preliminary discussion of these groupings. Future research will examine a causal model exploring the effects of early lifecycle issues on those later in the lifecycle.

OTHER STUDIES OF ES ISSUES

Where previously there was little published in this area, a recent special issue of Journal of Information Technology reported several ES issues studies. Choosing companies that had reported problems, Markus et al (2000) used interviews, case study and literature reviews in their ES issues study. They grouped their issues by phase: 'project' (implementation), 'shakedown' (period after go-live) and 'onward and upward'. The research team grouped the issues into 'software modifications', 'systems integration', 'product and implementation consultants', 'turnover of personnel', 'an excessive functional view', 'cutting scope', 'cutting training', 'inadequate testing', 'not improving processes first', 'underestimating data quality and reporting needs', 'unknown / disappointing business results', 'fragile human capital', and 'migration problems'. Adam and O'Doherty (2000) used interviews to examine ES issues in Small-Medium-Enterprises (SMEs) using a single vendor product in Ireland and concluded that SMEs would have an easier time of ES implementation due to their lesser complexity. In this study the research team analysed the data in conjunction with the vendor's senior project manager. Lee and Lee (2000) used interviews, process analysis and document analysis to look at knowledge transfer issues in a single ES implementation. No indication is given in the article whether the research team analysed the data with the target organisation's staff. Based on traditional risk models (eg. Keil et al, 1998), Sumner (2000) used interviews and case study to identify risks unique to ES projects. Sumner structured her interviews around pre-chosen major issue categories. Kumar et al (2001) used interviews and a questionnaire to identify ES management issues. Their questioning methods were structured around specific a priori issues. The majority of ES issues studies found in this literature used interviews and case studies. The methods either employed a priori major issue categories or the major issue categories were determined without reference to the interview or case study pool.

The contribution made by this study is its use of the variant Delphi approach to uncover issues (rather than to confirm or validate pre-existing set of issues). The researchers did not use a priori major issue groupings in round one, preferring an open question. In round two the survey participants confirm the categorisation of the 'raw' issues gathered through an open question in round one. And finally, major issue groupings were determined using factor analysis of the weights gathered in round three. The factor analysis performed on the data confirms other previous qualitative studies but also uncovers the importance of some knowledge related matters.

THE MODEL BUILDING METHODS APPLIED

Similar to other studies of contemporary information systems, the issues we are investigating relate to emerging phenomena. Some of the previously mentioned ERP issues studies have used existing frameworks to analyse their results. In this research we have employed inductive methods; i.e. building models from data and identifying patterns in that data, in the hope those patterns in the evidence will surface compelling theory and explanation (Martin and Turner, 1986).

In summary our method follows this path: 1) Delphi round one - inventory issues; 2) Synthesize a master set of issues; 3) Delphi round two - confirm issues; 4) Delphi round three - collect weights of importance for each issue across lifecycle phases; 5) Use exploratory factor analysis to discover latent constructs; 6) Use structural equation modelling to test a causal model; 7) Confirm all findings in expert workshops. This study reports our current progress with step 5.

Pattern analysis and inductive approaches were applied during synthesis of the Delphi study issues from round one. The process consisted of the following: the original 512 issues were printed and sorted firstly into 12 major batches by 3 coders working individually. These major batches were then split into individual issues by another two coders working together. Where respondents would describe several issues in a single-issue entry these were decomposed. By decomposing the issues, the issue groupings became much clearer. Responses that were not issues were discarded eg. "Payroll Tax: This is now also done mainly by SAP" Issue groupings were checked for consistency, reviewed and re-arranged to maximise independence between groupings. This process resulted in a final list of 37 issue groupings.

The Round 2 instrument asked respondents to either verify the mapping of their issue against the master set as correct OR to re-map their original issue to another issue in the list OR to suggest a further issue category into which their original issue would map. The 'weights round' (round 3) was conducted in which respondents scored the importance of each issue across six lifecycle phases: plan, build, test, install, run, know. Preliminary, exploratory principal components factor analysis using weights reported in round three was then performed.

The research team specifically did not use existing frameworks or theories to group the issues to avoid tainting the data driven approach. The methods applied in this work are consistently inductive, data driven and holistic / interpretive approaches and are appropriate for any future derivation of a predictive model of ES Lifecycle Issues. This differs from the pilot study approach. During the extension study round one issue categorisation, coders did not refer to, nor were they familiar with, issue groupings from the pilot study. In the pilot study round two and round three instruments, the issues were grouped into ten major issue categories. The extension study instruments randomly listed the issues and did not present them in any grouping. Some issues listed in the pilot study were of a compound nature. This was avoided in the extension study so that respondents could apply weights to clear simple issues.

PRELIMINARY RESULTS

From 432 potential, relevant (involved directly with SAP) respondents, of which 76 were implementation partner or vendor personnel and 356 government client personnel, a total of 112 responses in the Delphi inventory round yielded 512 raw issues. Many individual issue descriptions were compound, and after decomposition the round 1 survey yielded 728 issues. During the confirmation round (two), several respondents asked for their initial responses to be re-coded against the synthesized master set. Finally the third Delphi round, the weights round, was distributed to the total population of relevant personnel generating 207 usable responses. Of these 207 responses, 188 were from government personnel and 19 from implementation partners; 76 were managers and 131 were operational staff. In the third round, participants were asked to rate the importance of the 37 major issues across six phases of the lifecycle.

Exploratory factor analysis employed principal components with Varimax rotation (using SPSS software package). The issues loaded naturally (without forcing the number of factors) in order onto the 7 factors set out in Table 1. Coefficients below 0.4 were suppressed. The Kaiser-Meyer-Olkin measure of sampling accuracy is very high at 0.907. 67.6% of the variance is accounted for in the analysis. For Bartlett's test of sphericity $p<0.001$. The factor descriptions were conceived by the research team after the factor analysis had been performed.

Table 1: Factor Analysis of ES Issues

Component	1	2	3	4	5	6	7
Factor 1: Poor management of the implementation project and processes.							
SAP knowledge lacking in project team, consultants or vendor.	0.814						
Project team staffing mismanaged.	0.811						
Insufficient resources allocated to project.	0.773						
Inadequate time management / planning.	0.702						
Poor executive or project management.	0.700						
Mis-managed change management.	0.697						
Project Team did not consult or communicate sufficiently.	0.691					0.431	
Project team lack of knowledge of the organizational context.	0.690						
Inadequate testing.	0.674						
Inadequate data conversion.	0.608						
Lack of stakeholder / management support and ownership.	0.566						
Insufficient SAP documentation.	0.550						
SAP suffered non-acceptance, non-use or lack of ownership.	0.531						0.433
Inadequate SAP configuration.	0.516	0.479					
Factor 2: The SAP system is inadequate or difficult to use.							
Inadequate SAP functionality.		0.700					
Inadequate reporting from SAP.		0.693					
Inadequate systems controls.		0.646					
The SAP system does not work as it should.		0.631		0.407			
The SAP system is too complex.		0.626					
Downtime, slow processing or unreliable hardware.		0.601					
SAP reporting tools difficult to use.		0.533					
Factor 3: Costs are too high or benefits relative to costs are too low							

	F1	F2	F3	F4	F5	F6	F7
High upgrade costs.			0.841				
High running costs.			0.810				
SAP is generally expensive to implement.			0.807				
SAP not value for money.			0.770				
SAP reporting is expensive.		0.415	0.671				
SAP not suitable for small organizations.			0.592			-0.435	
Factor 4: Knowledge required to support and run SAP was not managed effectively							
Users do not have sufficient SAP knowledge.				0.715			
Inadequate help desk knowledge.				0.690			
Inadequate training method / management.	0.504			0.658			
Under-resourced Help Desk.	0.421			0.606			
Ineffective staff / knowledge retention strategies.				0.462			
Factor 5: Lack of organisation-wide knowledge strategy reduces benefits							
The organization has not taken advantage of available SAP functionality.					0.714		
SAP knowledge not re-used efficiently by agencies	0.444				0.654		
Factor 6: Customisation increased the complexity of systems integration							
Too much customization.	0.420					0.538	
Problematic systems integration.						0.452	
Factor 7: Organisational restructuring affected implementation effort							
The SAP system was adversely affected by the machinery of government.							0.718

DISCUSSION

During the pilot study, the issues were pre-grouped into ten groups in the round-three instrument. These major issue groups were Cost / Benefit; Data Conversion, Knowledge Management, Lack of Consultation, Operational Deficiencies, Organizational Context, Reluctance to Accept a Dissenting View, Support, System Development and System Performance (Chang & Gable, 2001). In the current study, however, to avoid the round-three scoring to be affected by any suggested grouping, and to enable the major issues to emerge from the data directly, the 37 issues were randomly listed in the round-three instrument. Factor analysis of the weights assigned to the issues suggests that the issues related to the implementation of the SAP R/3 within the QSG can be divided into seven separate factors.[1]

The issues that load onto "Factor 1 - Poor management of the implementation project and processes" describe issues related to poor project and executive management of activities during the implementation period. The issues that load onto this are commonly cited (Esteves et al, 2002; Markus et al, 2000) and expected. An issue specifically relevant to ES projects appears to be effective application of the ES software capability within the organizational context. Knowledge of the organizational context by the project team is also paramount to a successful outcome. When the project team does not elicit business needs through poor consultation or methods employed, and / or the project team have insufficient knowledge of the software capability and therefore cannot apply it, the business outcomes can suffer from poor configuration. Sumner (2000) also found this.

The issues that load onto "Factor 2 - The SAP system is inadequate or difficult to use", describe users' experiences with the system itself. Possibly as a result of poor implementation practices, the functionality of the system does not satisfy user business requirements, e.g. inadequate SAP functionality, reporting, and systems controls; has perceived bugs, e.g. does not work as it should; has hardware issues or is difficult to use, eg. reporting tools are hard to use. Difficulty in use may result from poor knowledge transfer practices. Absorptive capacity by users is a knowledge transfer issue identified within an ES study (Timbrell et al, 2001).

"Factor 3 - Costs are too high or benefits relative to costs are too low" is a relative issue according to the resources available to the organization and how staff saw the application of financial resources to this project. There are two possible explanations why this factor emerges. One possible explanation is that respondents may have seen these costs relative to the previous software (non integrated / non ES) or relative to other applications

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[1] It may be argued that perhaps these factors emerge due to the similarity of the words used in issues that load together and hence do not represent any real, deep, conceptual constructs However, examination of the potential influence of similar wording revealed that there is as much commonality of critical words within factors as across factors.

of the funds. Another and a more likely explanation here is that the benefits relative to the cost of the SAP implementation were not visible or have not been realized. The cost issue has been previously identified.

"Factor 4 - Knowledge required to support and run SAP was not managed effectively" is a focus point of this research. The research team argues those ES knowledge management decisions / strategies taken early during the systems lifecycle affect knowledge related decisions required at later points in the lifecycle eg. if you outsource implementation management to consultants without properly constructed knowledge transfer mechanisms in place, problems can occur in support and upgrade phases (Timbrell et al, 2003). Poorly targeted or inadequate training will lead to a lesser staff knowledge base putting further pressure on help desk and support staff. The help desk is an integral feature of the knowledge self-sufficiency of an organization. Because it is often the last internal knowledge resource before seeking (often expensive) outside assistance, insufficient help desk knowledge can result in diminished ES and possibly organizational effectiveness. Further, careful management of help desk, support staff and divisional ES knowledge leaders can again influence system and organizational effectiveness and flexibility. While others have identified training as a key issue, no studies have been identified that focus on the importance of the help desk role and its impact on ES outcomes.

"Factor 5 - Lack of organization-wide knowledge strategy reduces benefits" reflects the perception that SAP expertise was not shared throughout the government, amongst the QSG agencies, to affect better implementation outcomes. While respondents believed that SAP was inadequate in some quarters, they perceived that SAP functionality that was not being used but could be applied in their business context. This inter-organisational knowledge issue is worthy of further research.

"Factor 6 - Customization increased the complexity of systems integration" might reflect the common tension between the "technology swap" implementation strategy and the "vanilla" strategy. The technology swap (change the system to the organization) approach is where the functionality of the previous system is configured into the new system and little or no process re-engineering takes place. The vanilla (change the organization to the system) approach is where the organization changes to the system's standard processes that purport to be best practice. Many QSG agencies took the customization approach, recognising it is easier and less risky (but perhaps more expensive) to manage technological change than organizational behavioural change. Choosing this approach increases the knowledge stress on the technological project team (having to solve the customization issues in a new environment) rather than the organization's user base who would have to learn new and unfamiliar systems and processes. Additionally, due to the complex nature of the system the technology swap option can make it more difficult to integrate both between customised SAP modules and other organizational systems.

"Factor 7 – Organizational restructuring affected implementation effort" reflects the regular change in ministerial portfolio makeup and the consequences on government agencies. Agency functions can be split or combined in various ways following a change in government to reflect the different political management approaches.

SUMMARY AND CONCLUSION

The statistical analysis of the 'weights' round suggest 7 groups (factors) of issues arising from the implementation of SAP R/3 in the Queensland Government. In order these are Project practices, Usage difficulty, Cost vs. Benefits, Knowledge required to run the system, Lack of inter-organisational knowledge strategy, customisation, and organisational restructuring. The factors present familiar issues grouped for example in the project management, cost and functionality areas. At a macro level several of these factors (cost is an exception) fall into broad lifecycle stages i.e. implementation and post implementation. The factors appear to load together in a logical, meaningful manner and hence could potentially be treated as constructs and related in a causal model that could be tested with structural equation modelling tools such as PLS-Graph (Chin, 1998) or LISREL.

The results corroborate reported findings in other studies but do so empirically. Furthermore, the importance of knowledge related issues arise from this statistical exercise as initially suspected in the broader research program. As a next step, the researchers can now vigorously pursue the knowledge perspective of these ES issues.

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