 Journal of Management & Organization (2009) **15**: 155–169.

The necessary alignment between technology innovation effectiveness and operational effectiveness

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ABSTRACT

Organisations are increasingly investing in complex technological innovations such as enterprise information systems with the aim of improving the operations of the business, and in this way gaining competitive advantage. However, the implementation of technological innovations tends to have an excessive focus on either technology innovation effectiveness (also known as system effectiveness), or the resulting operational effectiveness; focusing on either one of them is detrimental to the long-term enterprise benefits through failure to achieve the real value of technological innovations. The lack of research on the dimensions and performance objectives that organisations must be focusing on is the main reason for this misalignment. This research uses a combination of qualitative and quantitative, three-stage methodological approach. Initial findings suggest that factors such as quality of information from technology innovation effectiveness, and quality and speed from operational effectiveness are important and significantly well correlated factors that promote the alignment between technology innovation effectiveness and operational effectiveness.

Keywords: technological innovation, system effectiveness, operational effectiveness, information systems alignment, performance objectives

Innovative organisations are those that are able to use innovation to improve their practices, processes, systems or services (Tidd et al 2001). Organisations are faced with competitive pressures to improve efficiency and productivity through technological innovation (Ifandoudas & Chapman 2006). In addition, organisations need to respond to market changes through product or service innovation as performance improvement is derived, in large measure, from innovation

(Tidd et al 2001). Many service organisations are investing substantial resources in technological innovation such as enterprise information systems (EIS) to reengineer their processes, but the extent to which these technology innovations assist organisation to improve the operational performance is not yet well understood (Mabert et al 2003).

It is important to gain a better understanding of stakeholders' expectations in regards to the operational performance, and how a firm's innovation in the implementation of EIS can improve operational effectiveness, because such understanding can enhance an organisation's competitive advantage (Slack et al 2004). Previous studies (Kueng 2000, 2002) point to the importance of implementing measures of business processes. These studies also found that the majority of performance indicators that companies have in place are financial ones and non-financial aspects are partially measured but often they are not an integral part of the monthly or annual reporting. Although innovation is vital for many service delivery organisations, very little emphasis is put on the measurement of the expected operational performance improvements (Kueng 2002). Improving operational effectiveness involves determining key performance objectives and establishing benchmarks. Furthermore, some organisations are failing to benefit from the implementation of technology innovations because they either do not measure performance or what they do measure is inappropriate (White 1996). On the other hand, effectiveness needs to be measured from an information systems (IS) perspective as organisations need to better understand if the EIS they have implemented has contributed to achieving the expected organisational goals and benefits, or how far the EIS is from the reality of the needs of the organisation.

The dualism between the formulation and implementation of EIS, leads us to investigate the alignment between system effectiveness and operational effectiveness that needs to exist in any organisation after the implementation of an EIS. As the current literature is silent in regard to such interactions, this research proposes to address the question: 'Which factors promote an alignment between Technology Innovation Effectiveness and Operational Effectiveness that can enhance competitive advantage?' In answering this question, this research uses both qualitative and quantitative approaches, based on unstructured and structured interviews with employees at different levels in service organisations that have recently implemented EIS and analyses the results of a survey of employees in organisations from the electricity distribution and retailer sector and higher education sector. Thus, the aim of this research is to build on the existing literature and to further confirm and refine a theoretical framework.

Operational effectiveness

In order to respond to changing market conditions, service firms need learning processes to build the flexible capability to reconfigure and transform their processes. In dynamic and unstable environments firms need to constantly scan their environment and government policies, and develop agile behaviours or competencies to rapidly accomplish changes (Teece et al 1997). In addition, an increasing number of factors are prompting organisations to seek to operate more efficiently and to ensure they have effective operational processes (Slack et al 2004; Hill 2005). This involves the need to deliver value-adding products or services of exceptional quality, on time, at a competitive price. Organisations attempting to meet these objectives need to pay attention to their operational effectiveness as this is a primary driver of business performance (Wheelwright & Bowen 1996; Slack et al 2004).

Operational effectiveness refers to the ability to establish processes, based on core capabilities within the organisations, which work well (Porter 1996). Operational effectiveness involves improving process performance by leading and controlling the processes within the firm as well as measuring and improving the processes. A bet-

ter use of resources through these core processes enables the organisation to eliminate waste, and reduce costs, adapt more appropriate technology innovation and therefore perform better than competitors (Porter 1996). By studying how a firm performs the primary and supporting activities for service delivery, a firm can determine how it might add value at every stage of the service delivery process, and seek ways to continuously improve this process while meeting its operational performance objectives.

The five performance dimensions or objectives an organisation seeks to fulfil to attain operational effectiveness include cost, quality, flexibility, speed and reliability (Hill 2005). Improving cost performance means that an organisation seeks the elimination of waste which comes from inefficiencies attained in processes such as purchasing, production, and staff performance. An appropriate disaggregation of the cost components impacting on the total cost performance of an organisation gives the opportunity to identify the areas for improvement (Slack et al 2004). Furthermore, improving on quality provides an opportunity to bridge the gap between what organisations are capable of offering and what customers demand. That is, viewing quality as a consistent provision of services that satisfy customers rather than simply conforming to specifications without any clear continuous improvement. The third operational performance objective consists of being flexible, this includes an organisation's ability to adjust to changes in response to customers' needs (Slack 1991). Additionally, improving on speed prompts an organisation to be able to shorten the time between the service request and delivery of the service, with the frequency, and at the time, that a customer requests (Hill 2005). Finally, reliability suggests that an organisation's processes consistently perform as expected over time. That is, customers are satisfied by organisations that provide services that do not fail over a period of time or with services that are delivered as agreed (Porter 1996).

Operational effectiveness and business process reengineering

In the implementation of innovative technologies, managers need to identify specific sets of organisational capabilities to transform and reconfigure the organisation's core managerial competencies. EIS implementation, organisational change projects, continuous improvement and business process re-engineering require different competencies and capabilities. All reconfigurations and transformations continuously affect operational processes by the accumulation, selection and change of patterns of routines and practices (March & Simon 1993). The main difficulty about the implementation of innovative technologies such as EIS is the dramatic change they bring to business operations. An EIS project is as much about changing the way a business operates as it is about technology innovation (Davenport 2000).

Business process reengineering is defined by Hammer and Champy (1993), as the fundamental rethinking and radical redesign of a business process to achieve dramatic improvements in critical, contemporary measures of performance, such as cost, quality, service and speed. BPR changes dramatically the way work gets done in an organisation, the organisational structure and culture, the behaviours of workers throughout the company, and even business strategy, as all have to be restructured (Davenport 2000). Other work in the operations management area indicates that organisations cannot compete across all these activities. Thus they need to select appropriate performance objectives in order to create a competitive position (Russell & Taylor 2005).

The reengineering movement, with all its radical approaches to reorganising companies, turned out to be a mere preamble to the EIS era, which has brought even more ambitious and complex changes. Technological innovation should be seen as an enabler of business process reengineering, even if the extent of the technology change necessary is great (O'Neill & Sohal 1998; Davenport 2000). In fact, the business

process reengineering movement has largely been replaced by EIS initiatives (Davenport 2000). So to establish a competitive advantage over competitors depends on the ability of organisations to correctly implement the EIS and effectively adapt their business processes to the requirements of the EIS as their competitors may have the same or an equally effective EIS project already well implemented and correctly aligned with the operations of the organisation.

Technology innovation effectiveness

Technology innovation effectiveness or system effectiveness can be described as the extent to which information systems contribute to achieving organisational goals and benefits (DeLone & McLean 2003). Companies deriving the greatest benefits from their systems are those that, from the start, view them primarily in strategic and organisational terms. These companies stress the importance of operational effectiveness, not the system. However, the high failure rate in implementing such systems is a major concern (Davenport 1998). The medical informatics literature presents, by and large, a picture of successful implementation of Health Information Systems (HIS). Nevertheless, the current literature fails to report the failures found after implementation of information systems (Heeks 2005). Failure rates for large-scale system development projects are extremely high and many information system projects are failing to achieve their stated outcomes (Jamieson & Hyland 2004). However, as it is difficult to quantify, the real level of information system failure could be far greater than is reported (Jamieson & Hyland 2004). This prompts the need for a better understanding of the measures that assist managers in assessing the performance of an EIS through the evaluation of its dimensions.

The revised DeLone and McLean model (2003) includes six interrelated dimensions of information systems success: information quality, system quality, service quality, intention to use, user satisfaction, and organisational impact as dimensions to measure the dependent variable 'IS effectiveness'. In the DeLone and McLean's success model, system quality measures technical efficacy – the desired characteristics of the system. This assessment is based on the performance and productivity of the system.

Information quality is the measurement of output from EIS. It measures semantic success: characteristics of the information and its desired form, the degree to which information produced has the attributes of content, accuracy, and format required by the user. Service quality is the level of service received by the users of EIS and the manner in which the service is provided by the IS department as it influences the degree of satisfaction with an EIS.

Use and user satisfaction measure effectiveness success through studies that attempt to analyse and measure the interaction of the information product with its recipients, the degree to which the user believes that using a particular system has enhanced his or her job performance. User satisfaction is defined as the user's response to the use of the output of an EIS, the psychological state after the use of an EIS. User satisfaction goes hand in hand with user involvement, particularly during the phases of the analysis, design and implementation of an enterprise information system in an organisation. In addition, Baroudi et al (1986) argues that user involvement in information system development is generally considered an important mechanism for improving system quality and ensuring successful system implementation. Thus user involvement can be used as a dimension to measure system effectiveness. Many researchers (Doll & Torkzadeh 1988; Downing 1999; Chen et al 2000; Mohmood et al 2000; Berthon et al 2002; Norman et al 2002; Somers et al 2003; Bokhari 2005; Zviran & Pliskin 2005) have performed extensive reviews of research into end-user satisfaction, and concluded that user satisfaction is one of the most widely used measures of assessing the effectiveness or success of information systems within organisations.

Individual impact is the effect the information has on the behaviour of the user, including improving personal or departmental performance, relating to what influence the information product has on management decisions. This impact occurs when the information is received and understood by the users, and applied to their jobs. Organisational impact derives from research that investigated the effect of the information product on organisational performance (Rai et al 2002; DeLone & McLean 2003; Nielsen 2005). Individual impact is the effect the information has on the behaviour of the user, including improving personal or departmental performance, relating to what influences the information product has on management decisions. This impact occurs when the information is received and understood by the users, and applied to their jobs. Organisational impact derives from research that investigated the effect of the information product on organisational performance (Rai et al 2002; DeLone & McLean 2003; Nielsen 2005).

In measuring performance it is important to have a clear understanding of the outcomes from the investment of a significant amount of human and economic resources in EIS solutions that cannot always be properly adapted to particular circumstances. Management accounting systems have been traditionally used to measure performance which focuses on data such as profit, return on investment and cash flow. These types of measures merely rely on financial performance and do not reflect the requirements that an organisation must fulfil in today's competitive business environment, or operational requirements. EIS effectiveness should be measured in terms of the real operational benefits rather than through the achievement of information systems outcomes only.

Authors such as Cotteleer (2001), Masini (2003), Mcafee (2002) and Romano (2003) have conducted research in the context of enterprise information systems linked with operational effectiveness. These authors, however, have not considered the inclusion of the five operational performance objectives (cost, quality, flexibility, speed and reliability) as measures of effectiveness linked with technology innovation effectiveness dimensions (system quality, information quality, service quality and user satisfaction). Thus, the main purpose of this research is to build on and extend the existing literature and to put forward a theoretical framework that examines the following four propositions:

1. There is a correlation between dimensions of system effectiveness and operational effectiveness; and
2. A limited number of factors have the potential to explain the alignment between system effectiveness and operational effectiveness; and
3. There is a correlation between the emerging factors; and
4. The emerging factors are important to the alignment between technology innovation effectiveness and operational effectiveness.

Research method

Given the exploratory nature of this research, a three-stage methodological approach, with a combination of qualitative and quantitative methods, has been used. The first stage was unstructured interviews to identify preliminary issues and variables that were then investigated in more detail using semi-structured interviews in two large service organisations in Australia (Sekaran 2003; Sarantakos 2005). This research uses the interpretivist philosophical perspective and its particular implications for data collection, analysis methods and research outcomes where the unit of analysis is employees in the organisations involved in this study (Yin 2003). To provide triangulation, companies' documentation related to the information strategy, implementation and post implementation reports were analysed. The sample was purposive and was selected in order to cover a range of possible viewpoints and all of the interviewees are users of EIS applications. The stakeholders interviewed

and also targeted in the survey instrument include managers, engineers (technologist), and administrative and operational staff in the organisations as, according to Orlikowski and Gash (1991; 1994), different actors in an organisation have different assumptions, expectations, knowledge and perceptions of EIS application. Such interpretations of technology innovation, called technological frames, are central to understanding technological development, use, and change in organisations as they critically influence the way people act around technology innovation. Orlikowski and Gash (1991, 1994) also suggest that where the technological frames of key groups in organisations such as managers, engineers, and users, are significantly different, difficulties and conflict around the development, use, and change of technology may result. Thematic analysis was used to identify factors relevant to the research (Kvale 1996; Sarantakos 2005) and allow the researchers to identify the organisational factors that influence the effectiveness of EIS implementation and also the operational performance objectives and dimensions that were used in the construction of the questionnaire.

In the second stage, data was gathered through a self-administered questionnaire. The questionnaire was administered to employees and managers in organisations from the electricity distribution and retailer sector and from the higher education sector that had recently implemented an EIS. In the process of constructing measures of key variables and refining the survey instrument, we developed four pilot tests that enabled us to introduce a number of revisions that were incorporated to improve the survey instrument between the initial draft and the final instrument which is divided into six sections. The first section was used to identify the background, the areas of responsibility and involvement of the respondent in the use of enterprise information system applications. Sections two and three in the questionnaire were related to organisational culture and strategies. The fourth section related to technological innovation effectiveness, the fifth section related to operational effectiveness and the last section related to improvements in operational performance. Only sections four and five are part of this study.

Nineteen questions constitute the fourth section (technology innovation effectiveness) and the questions were selected from three previous studies mentioned in the DeLone and McLean (2003) ten-year update as an appropriate empirical test and validation of the DeLone and McLean IS success model. The studies are: Seddon and Kiew (1994) which surveyed 104 users of a recently implemented university accounting system, Rai, Lang and Welker (2002) which surveyed 274 users of a university student IS, and finally from Pitt, Watson and Kavan (1995) who administered their questionnaire in three service organisations in three different countries to test the validity of quality of the service as a measure of IS effectiveness. Rai et al (2002) believe that there is a danger that IS researchers will mismeasure IS effectiveness if they do not include in their assessment package a measure of IS service quality. They conclude that the effectiveness of an IS unit can be partially assessed by its capacity to provide quality service to its users. This supports our decision to include service quality measures in our questionnaire. Furthermore, this argument is supported by the findings in the first-stage interviews where interviewees manifested some nonconformities and complaints against the service from the IS department.

On the other hand, in the fifth part of the questionnaire, 20 questions about operational effectiveness were prepared from the literature review plus some arguments found relevant in the interview process with users of EIS in the researched organisation. No previous study has tested operational effectiveness linked with technology innovation effectiveness. This research argues that the effectiveness of the system cannot be measured accordingly without a real understanding of the operations of the organisation. It is essential to bring the dimensions of operational effectiveness into the IS context to have a better

understanding of the real effectiveness of the enterprise information system implementation.

Data were analysed and tested using principal components analysis and correlation analysis techniques. The emerging factors were named by using the previous knowledge about the theory. Next, Cronbach's alpha coefficients of the emergent factors were calculated and were used to assess convergent validity. The final stage was a confirmatory stage through structured interviews with managers, engineers and general staff from the organisations involved in the research. The main aim was to confirm the findings in the two previous stages. Thus this research involves both theory building and theory testing.

Case organisations

Respondents were employed in two large organisations from the Australian service sector (electricity distribution and retailer sector and higher education sector) they were selected for the first stage of this study as they had recently implemented EIS. The first organisation is a government owned electricity distribution network, covering a sparse, predominately rural environment, with significant clusters of mining and industry through its million square kilometres of territory. Its primary challenges include rapid consumer and load growth; increasing environmental challenges, limited human and capital resources, and impending technological transformation in its core operations. The organisation has a turnover around $1.5 billion, manages an asset base of $5.6 billion and employs over 4,000 people. The organisation is using an ERP (enterprise resource planning) system that had been developed initially for use in the mining industry. The developers adapted the EIS application to work in the electricity distribution and retailer sector arguing similarities in the business processes.

The second organisation is a relatively new Australian university with extensive operations across Australia. It started as a College of Advanced Education, becoming a University in 1992. The university has a number of campuses in its regional footprint and in major Australian cities, the latter being operated by a wholly owned subsidiary servicing full-fee paying, international students. The organisation has a turnover around $278 million with more than 1400 permanent staff. The organisation implemented an EIS, which was acquired with the main purpose of integrating the university's administrative systems and reengineering the administrative procedures and practices. Specifically, the ability for students to enrol themselves online and to manage their own personal details was seen as an essential strategic move for the university as existing paper-based enrolment and maintenance of student personal details were difficult to manage.

RESULTS

The results of interviews and analysis of some of the organisations' documents confirm the existence of the dimensions for systems effectiveness and operational performance, described in the background section of this paper. The respondents from the two organisations identified linkages between the quality of information and quality of the service stemming from the technology innovation effectiveness perspective, and the five performance objectives (cost, quality, flexibility speed and reliability) stemming from the operational effectiveness perspective. Those dimensions and operational performance objectives and also some of the conflicts with the quality of the service offered by the IS department, helped the researchers in the development of the questionnaire. The following sections explain the process to test the four propositions stated in this study.

Assessment of data validity

Before operational effectiveness and technology innovation effectiveness can be used together as a measure of the alignment in organisations after the implementation of EIS, it is necessary to assess its validity.

After gaining ethical clearance approval from the CQU Ethics Committee, the questionnaires

were emailed to employees in managerial or executive role, information technology / information systems or engineering role and operators or general staff in the selected service organisations. Of the 450 surveys distributed among the service organisations from the electricity distribution and retailer sector and higher education sector, 144 were returned (32% response). Each returned questionnaire was reviewed for completeness and, of the 144, 6 were considered unusable due to large amounts of missing data, lack of involvement of the respondent in the use of EIS, and the impossibility of identifying the role of the respondent (manager, engineer or operator-user).

The fourth section of the questionnaire (technology innovation effectiveness), reported a Cronbach's Alpha coefficient of 0.859. This indicates a high level of internal consistency within these measures as the generally accepted lower limit is 0.7, though some studies allow 0.6; for example, Hair et al (1998). The fifth section of the questionnaire (operational effectiveness), reported a Cronbach's Alpha coefficient of 0.936. This coefficient demonstrates the high internal consistency of the scale, and also support the argument to bring the dimensions of operational effectiveness into the IS context to have a better understanding of the real effectiveness of the enterprise information system implementation.

The strength and nature of relationships between the dimensions stemming from technology innovation effectiveness (User Satisfaction, System Quality, Service Quality, and Information Quality) and the performance objectives stemming from operational effectiveness (Quality, Cost, Speed, Flexibility and Reliability), highlighted areas in Table 1, were investigated using the Pearson product-moment correlation coefficient. Preliminary analyses were performed to ensure no violation of the assumptions of linearity and homoscedasticity and further tests for outliers and normality were conducted as required during the analysis. There are strong, positive and significant correlations between some variables, such as r=.631, p<.001 for Information Quality and Operational Effectiveness (OE) Speed, r=.596, p<.001 for Service Quality and OE Flexibility, r=.577, p<.001 for Service

TABLE 1: RELIABILITIES (CRONBACH'S ALPHA) AND PEARSON CORRELATION MATRIX

	No. of Items	1	2	3	4	5	6	7	8
1. User Satisfac$^{\gamma}$.	2								
2. System Quality	4	.184 (.030)							
3. Service Quality	8	.260 (.002)	.516 (.000)						
4. Info.$^{\varphi}$ Quality	4	.226 (.008)	.688 (.000)	.559 (.000)					
5. OE$^{\psi}$ Quality	9	.223 (.008)	.450 (.000)	.582 (.000)	.486 (.000)				
6. OE Cost	3	.101 (.238)	.510 (.000)	.577 (.000)	.439 (.000)	.641 (.000)			
7. OE Speed	6	.207 (.015)	.505 (.000)	.533 (.000)	.631 (.000)	.589 (.000)	.703 (.000)		
8. OE Flexibility	3	.158 (.065)	.559 (.000)	.596 (.000)	.570 (.000)	.765 (.000)	.707 (.000)	.651 (.000)	
9. OE Reliability	3	.087 (.309)	.508 (.000)	.553 (.000)	.572 (.000)	.652 (.000)	.646 (.000)	.682 (.000)	.755 (.000)

(Two-tailed test, significance in brackets)

(Satisfac.$^{\gamma}$: Satisfaction; Info.$^{\varphi}$: Information; OE$^{\psi}$: Operational Effectiveness)

Quality and OE Cost, r=.572, p<.001 for Information Quality and OE Reliability; as shown in the highlighted area in Table 1. Support is therefore found for proposition 1 that there is a correlation between dimensions of technology innovation effectiveness and operational effectiveness. This high correlation and significance means, that the performance objectives stemming from operational effectiveness can be used to measure the impact of the implementation of technological innovations such as enterprise information systems on operational performance. In addition, the dimensions stemming from operational effectives produce a more comprehensive model than the traditional Systems Effectiveness Success model developed by DeLone and McLean (2003).

Factor analysis

As the main purpose of the study is to explore the alignment between technology innovation effectiveness and operational effectiveness, the next step in the data analysis is to perform a factor analysis to reduce the dimensionality and to identify the most important clusters, while at the same time eliminating the items that are less representative. The factor analysis was performed using the maximum likelihood extraction method and oblique rotation method which allows the factors to be correlated. During the factor analysis process, four factors emerged. Hair et al (1998) argue that in order to ensure a power level of 80 percent, a factor loading of 0.55 is significant if the sample size is at least 100 observations at a significant level (α) of 0.05. Thus, only factor loadings of at least 0.60 have been considered. The solution resulted in a Kaizer-Meyer-Olkin (KMO) value of 0.832 with four factors accounting for 52.65% of the cumulative variance, indicating a satisfactory solution. Support is therefore found for proposition two that a limited number of factors have the potential to explain the alignment between technology innovation effectiveness and operational effectiveness. The four factors are: quality and speed stemming from operational effectiveness and quality of information and quality of the service stemming from technology innovation effectiveness. These four factors also demonstrate the focus that organisations need to consider when aligning technological innovations with operational effectiveness. It is expected also that this alignment will assist organisations to enhance operational performance.

Validity of the emerging factors

The emerging factors exhibited good internal consistency with a relatively high Cronbach's Alpha = 0.727. Correlation analysis was conducted to identify whether a relationship existed between the emergent factors. A general inspection of the correlation matrix in Table 2, supports the linkages between the four emerging factors. There is a significant positive correlation between OE Quality and OE speed ($r = .343$, $p < 0.01$), a significant positive correlation between OE Quality and SE information Quality ($r = .344$, $p < 0.01$), and a high positive correlation between OE speed and SE information Quality ($r = .567$, $p < 0.01$). In addition, there is a significant correlation among factors 1, 2 and 3 and SE Service Quality. Support is therefore found for proposition three that there is a correlation between the emerging factors. In addition, a positive relationship was found between quality of information and quality of the service from technology innovation effectiveness and quality and speed from operational effectiveness. This finding has an impact on the theory of implementation of information systems. As demonstrated by the background of this study there is too much focus on the dimensions stemming from system effectiveness, an little research on the operational performance objectives stemming from operational effectiveness, in the effective measure of the effectiveness of the implementation of an technological innovation such enterprise information system.

TABLE 2: RELIABILITIES (CRONBACH'S ALPHA) AND PEARSON CORRELATION MATRIX FOR EMERGING FACTORS

		Cronbach's Alpha if Item Deleted	Factor1	Factor2	Factor3
Factor1 Operational Effectiveness (Quality)		.711			
Factor2 Operational Effectiveness (Speed)	Pearson Correlation		.343**		
	Sig. (2-tailed)	.643	.000		
Factor3 System Effectiveness (Information Quality)	Pearson Correlation		.344**	.573**	
	Sig. (2-tailed)	.643	.000	.000	
Factor4 System Effectiveness (Service Quality)	Pearson Correlation		.396**	.397**	.394**
	Sig. (2-tailed)	.672	.000	.000	.000

** Correlation is significant at the 0.01 level (2-tailed).

Analysis of the emerging factors

To find additional support for proposition four, a set of analysis of data from the qualitative stage – interviews and analysis of the organisations' documents – were developed in the case organisations. This step corresponds to the third stage of this research.

Factor 1 – Quality of the operational service

Factor 1 contains statements related to quality of the services delivered by the studied organisations. The emergence of this factor is aligned with the findings from the first stage (qualitative) of this research, as it reveals the importance of quality as one of the most significant performance objectives for measuring the operations of the organisation. The relevance of quality is also supported by the literature, as shown by Hill (2005), who states that meeting, or better still exceeding, customer's expectations is an essential task for a business. The level of quality a company seeks to achieve is a strategic decision that eventually determines how a product is made or a service is delivered (Russell & Taylor 2005).

The first studied organisation, as an essential service provider, 'could cause significant social inconvenience and economic loss through poor quality energy delivery services', as stated by one regional manager. Effective communication with customers is a critical component of high quality service, reducing the impact of unavoidable interruptions in supply, and establishing realistic expectations in service delivery outcomes. 'Poor quality information in work management systems reduces the ability of management to target and allocate resources across a state-wide work queue, where the mean time to connect new customers may only marginally increase but the variance due to localised peaks causes significant impacts to some segments of the community' was also indicated by one of the members of the strategic team in the organisation. Quality of communication (Quality of Service) is critically dependant on a foundation of quality information allowing a rapid synopsis of any situation to be communicated to the customer. Poorly maintained asset records, or work progress, can cause an incorrect situation to be reported to the customer, either setting unrealistic expectations that exaggerate an operational situation or frustrate the customer through the company's obvious lack of awareness of a situation.

The second organisation has a quality framework to realize its goal of becoming acknowledged as a leader in flexible teaching and learning, and it is using different technologies as drivers of organisational change. In common with many other Australian universities, this organisation has implemented an EIS to improve its administrative procedures. More recently, to improve its learning and teaching, the university has reviewed its course management systems.

Factor 2 – Operational speed

Factor 2 contains elements of speed in the delivering of services. The rapid growth of IT/IS is helping organisations to shorten the time between the service request and delivery of the service with the frequency and at the time that a customer requests. Speed has become a source of competitive advantage for today's organisations (Russell & Taylor 2005). According to Hill (2005) in service organisations, user satisfaction is highly related to response time.

Reducing the cycle time of critical and highly sensitive consumer events is a key operational performance requirement of energy for the first organisation. As stated by a network manager, 'failure of our EIS to mandate critical fields, such as date of service request, and negotiated dates for service delivery, has resulted in not being able to identify or report process bottlenecks and inefficiencies'. Poor information quality has also resulted in 'an increase in otherwise unnecessary site visits' as stated by an electrical engineer, who also indicated, 'a significant impediment to a speedy service in the one million square kilometre service area'.

For the second organisation speed is seen as a critical aspect of the implemented EIS. 'The fact that the EIS cannot provide all the features or requirements for the operations of the organisations, forced the organisation to develop in-house applications to support some of the processes missed by the EIS', comments one member of the information technology division. The use of in-house applications is diminishing the speed of the operations and the overall quality of information and service.

Factor 3 – Quality of information

Quality of information is concerned with issues such as timeliness, accuracy, relevance, completeness and format of information generated by an EIS. It is important to understand that operational effectiveness quality and operational effectiveness speed (the two previous factors) are highly impacted by the quality of the information presented for the EIS application. The importance of the items that form this factor can be explained by the fact that key data is presented to users at different levels of the organisation in a format that enhances understanding of the issues, in the trust that users at different levels inside the organisation can deposit in the information that they can get from the information systems applications (EIS or ERP), due to its high quality, and finally in the fact that managers can make decisions based on the information from the information system application (EIS or ERP).

The first studied organisation faced some critical issues with the quality of information. For example, one user of the EIS application commented: 'I suppose the challenge to our organisation, is to actually provide the best benefit for the usage of our EIS application, by actually improving the quality and accuracy of our data and in this way we can speed up the decision making process which will improve the quality of the network maintenance'. Another user commented: 'The implementation of the new system is helping in decreasing the cost because you only have to fix the data up in one system once, whereas before we had 3 or 4 systems to have to fix the data in. We can't yet rely on the quality of the information, but at least it's in one place. We've got an initiative we call a data quality framework that's intended to improve the quality of our information'.

Factor 4 – Quality of the service

Employees at different levels, in the first organisation, expressed dissatisfaction with the provider

of the IT/IS service for the Implemented EIS. One network manager pointed out, 'Our current ERP is sub-standard and is costing the organisation money not saving money. We see this as a poor outside political decision that has zero support internally and we are stuck with a dog that barks every day'.

The second organisation is implementing a 'fix at first contact' measure, where 75% of all staff/student requests are resolved by the person who receives the request. Thus, improving the 'time to resolve' for any IT/IS related problems. This approach is improving the quality of the service, speeding up the time of response and at the end improving the overall quality of the services across the organisation.

Service quality is consequently influencing the degree of satisfaction of the users of the EIS application in the two service organisations. Support is therefore found for proposition four as the four emerging factors are important to the alignment between technology innovation effectiveness and operational effectiveness.

Conclusion

In answering the research question, 'Which factors promote an alignment between Technology Innovation Effectiveness and Operational Effectiveness that can enhance competitive advantage?', this research has found four factors that explain the alignment between technology innovation effectiveness and operational effectiveness. The four factors are: quality and speed stemming from operational effectiveness and quality of information and quality of the service stemming from technology innovation effectiveness. It is expected that giving priority to these four dimensions or performance objectives in the implementation of enterprise information systems will assist organisations to enhance operational performance and gain competitive advantage. It is important to note that decisions about innovation are made based on information, so organisations need high quality information. One of the problems in continuously innovating organisations is that although they implement EIS systems these do not lead to improved operational effectiveness. The organisations studied are becoming more complex and more dynamic, and they are seeking to innovate to deliver high quality services cheaper and faster. However, the extent to which this innovation helps organisations in the delivery of better services and in reducing operational cost is questioned by this study. The challenge for these organisations is to improve the quality of the information as the research has revealed a lack of trust, in the information from the EIS applications, by stakeholders. The first organisation has started the 'Information Improvement Program' and the second organisation is running a program to reduce cost and size and is expecting to improve its technologies to provide better services at less cost.

The interviews and analysis of the organisation's documents reveals that stakeholders are aware of the performance objectives defined in this study. In addition, the quantitative stage has demonstrated that the linkages between technology innovation effectiveness (system effectiveness) dimensions and operational effectiveness performance objectives are important and significantly correlated. The high positive correlations between technology innovation effectiveness and operational effectiveness dimensions provide strong empirical support to include the stated operational effectiveness dimensions or performance objectives in the measurement of EIS success. Furthermore, these new dimensions will assist organisations to measure in a more accurate way the impact of the EIS implementation on the business processes and operations of the organisation. Simultaneously, promoting the alignment between technology innovation effectiveness and operational effectiveness in the implementation of enterprise information systems, as the literature has not discussed this relationship previously.

System use has been measured by several studies described in the DeLone and McLean (2003) updated model as frequency of use, time of use, number of accesses, usage pattern, and depend-

ency as a measure of IS success. Seddon (1997) further argues for the removal of system use as a success variable, claiming that use is a behaviour. We agree with Seddon (1997) in the removal of system use as a dimension to measure IS effectiveness. Furthermore, the evidence of this research demonstrates that system use must be seen as the efficiency of the business process and operations of the organisation after the implementation of any EIS, and how the use of this EIS is improving the operations. It does not matter how long or how frequently the EIS is used, what matters is the improvement in business processes in the five performance objectives stated in this research. Organisations must be more conscious of the practical consequences of the EIS on the processes and operations of the organisations such as improving the quality of the service/product, improvements in the speed of the delivery of service/products, reduction or elimination of waste which will reduce the cost of operations, augmenting the reliability of the services/products and finally creating flexible processes supported by EIS that will not degrade other processes in the organisation when innovative changes and improvements are required as demonstrated by this study. We also claim that technology innovation effectiveness should be measured through the fulfilment of business outcomes rather than only on an IS basis. For usability of the system to be more objective, it is important to include the operational effectiveness dimensions or performance objectives which will bring a more reliable and accurate measurement of the performance of the organisation. We understand that the implementation of EIS is typically far from easy. However, the lack of understanding and research of the five performance objectives in the process of implementation of EIS is increasing the gap between what is proposed and what is delivered by the EIS application. The main reason is too much focus on the traditional dimensions of information systems success models and lack of understanding of the operational effectiveness performance objectives.

Managerial implications

By shedding some light on the complex phenomena that link technology innovation effectiveness, operational effectiveness and improvements in the performance of organisations, this work provides useful insights both for managers and academics in the implementation of technological innovations such as enterprise information systems. This research has demonstrated that the relationship between operational effectiveness and technology innovation effectiveness is important, because an optimal alignment has a positive influence on the bottom line. The main concern for the organisations is to reduce and control increasing cost and allocating resources. However, the identification of appropriate systems dimensions and performance objectives becomes essential for continuous improvement. Competition is constantly increasing so business and corporate strategies should be supported by this alignment. Furthermore, organisations need to understand their operations, and adapt the systems to the operational requirements. Also, causes of user dissatisfaction should be estimated, information outcomes should be properly assessed and finally, the performance of operations and systems should be properly evaluated, because if organisations do not pay attention to these issues, they are more likely to continue allocating resources to EIS that do not make business sense. The solution is based on enhancing the effectiveness and efficiency of operational and system processes in an aligned approach so technology innovation such as EIS can deliver the expected outcomes and help organisations to gain competitive advantage. Additionally, the four factors identified in this research demonstrate the focus that organisations need to consider when aligning technological innovations with operational effectiveness. The four factors are: quality and speed stemming from operational effectiveness and quality of information and quality of the service stemming from technology innovation effectiveness.

Further research

This exploratory study reveals the need to incorporate new constructs in the framework which influences the optimal alignment between technology innovation effectiveness (system effectiveness) and operational effectiveness when implementing any EIS. It is important to explore more confirmatory interviews and more statistical analysis to test the different linkages among technology innovation effectiveness, operational effectiveness, and also the inclusion of the organisational factors that influence this alignment. In addition, it is important to understand the different interpretations of technology innovation effectiveness and operational effectiveness by different actors such as managers, engineers and general users; as such interpretation can bring a better understanding of the issues raised in the implementation of enterprise information systems.

References

Baroudi JJ, Olson MH and Ives B (1986) An Empirical study of the impact of user involvement on system usage and information satisfaction, *Communications of the ACM* 29(3): 232-238.

Berthon P, Pitt L, Ewing M and Carr CL (2002) Potential research space in MIS: A framework for envisioning and evaluating research replication, extension, and generation, *Information Systems Research* 13(4): 416-427.

Bokhari RH (2005) The relationship between system usage and user satisfaction: A meta-analysis, *Journal of Enterprise Information Management* 18(1/2): 211-234.

Chen LD, Soliman KS, Mao E and Frolick MN (2000) Measuring user satifaction with data warehouses: An exploratory study, *Information & Management* 37: 103-110.

Cotteleer M (2001) *Operational performance following ERP implementation*, Harvard University Press, Cambridge MA.

Davenport T (1998) Putting the enterprise into the enterprise system, *Harvard Business Review* 76(4): 121-131.

Davenport T (2000) *Mission critical: Realizing the promise of Enterprise Systems*, Harvard Business School Press, Boston MA.

DeLone W and McLean E (2003) The DeLone and McLean model of information system success: A ten-year update, *Journal of Management Information Systems* 19(4): 9-30.

Doll WJ and Torkzadeh G (1988) The measurement of end-user computing satisfaction, *MIS Quarterly* 12: 259-274.

Downing CE (1999) System usage behavior as a proxy for user satisfaction: An empirical investigation, *Information & Management* 35: 203-216.

Gash D and Orlikowski W (1991) *Changing frames: Understanding technological change in organizations*, Working paper, Sloan School of Management 3368-92, Massachusetts Institute of Technology.

Hair JF, Anderson RE, Tatham RL and Black WC (1998) *Multivariate data analysis*, Prentice Hall, Englewood Cliffs NJ.

Hammer M and Champy J (1993) *Reengineering the corporation: A manifesto for business revolution*, Nicholas Brealey, San Francisco CA; Allen & Unwin, London.

Heeks R (2005) Health information systems: Failure, success and improvisation, *Medical Informatics* 75: 125-137.

Hill T (2005) *Operations management*, Palgrave Macmillan, New York.

Ifandoudas P and Chapman R (2006) 'Strategic ICT implementation within SMEs for business Improvement: The COSTWORTH project'. Paper 6th Intl CINet Conference, Brighton.

Jamieson K and Hyland P (2004) 'IS failure: Just too much information?' Paper presented to 8th World Multi-Conference on Systemics, Cybernetics and Informatics, Orlando FL.

Kueng P (2000) Process performance measurement system: A tool to support process-based organisations, *Total Quality Management and Business Excellence* 11(1): 67-85.

Kueng P (2002) Performance measurement systems in the service sectors: The potential of IT is not yet utilised, *International Journal of Business Performance Management* 4(1): 95-114.

Kvale S (1996) *Interviews: An introduction to qualitative research interviewing*, Sage Publications, London.

Mabert VA, Soni A and Venkataramanan MA (2003) Enterprise resource planning: Managing the implementation process, *European Journal of Operation Research* 146: 302-314.

March JG and Simon A (1993) *Organizations* (2nd ed) Blackwell, Cambridge.

Masini A (2003) 'The ERP paradox: An empirical investigation of the impact of enterprise systems

on operational effectiveness', PhD thesis, Institut Europeen d'Administration des Affaires, France.
Mcafee A (2002) The impact of enterprise information technology adoption on operational performance: An empirical investigation, *Production and Operations Management* 11(1): 33-53.
Mohmood MA, Burn JM, Gemoets LA and Jacquez C (2000) Variables affecting information technology end-user satisfaction: A meta-analysis of the empirical literature, *International Journal of Human-Computer Studies* 52: 751-771.
Nielsen J (2005) Critical success factors for implementing ERP system. In *Qualitative Case Studies on Implementation of Enterprise Wide Systems*, Idea Group Inc. pp 211-231.
Norman A, Ngai EWT and Cheng TCE (2002) A critical review of end-user Information System satisfaction research and a new research framework, *Omega The International Journal of Management Science* 30: 451-478.
O'Neill P and Sohal A (1998) Business process reengineering: Application and success - an Australian study, *International Journal of Operations & Production Management* 18(9/10): 832-864.
Orlikowski W and Gash D (1994) Technological frames: Making sense of information technology in organizations, *ACM Transactions on Information Systems TOIS* 12(2): 174-207.
Pitt LF, Watson RT and Kavan CV (1995) Service quality: A measure of information systems effectiveness, *MIS Quarterly* 19(2): 173-188.
Porter M (1996) What is strategy? *Harvard Business Review* Nov/Dec.
Rai A, Lang S and Welker R (2002) Assessing the validity of IS success models: An empirical test and theoretical analysis, *Information System Research* 13(1): 50-69.
Romano K (2003) The influence of organisational culture, leadership, and structure on operational effectiverness in the aerospace industry, Doctoral thesis, School of Advanced Studies, University of Phoenix.
Russell RS and Taylor BW (2005) *Operations management - Quality and competitiveness in a global environment* (5th ed) John Wiley, Hoboken NJ.
Sarantakos S (2005) *Social research* (3rd ed) Palgrave Macmillan, New York.
Seddon P (1997) A respecification and extension of the DeLone and McLean model of IS success, *Information System Research* 8(3): 240-253.
Seddon S and Kiew M-Y (1994) 'A partial test and development of DeLone and McLean's model of IS success'. Paper presented to International Conference on Information Systems, Atlanta GA.
Sekaran U (2003) *Research methods for business* (4th ed) John Wiley & Sons, New York.
Slack N (1991) *The manufacturing advantage*, Mercury Books, London.
Slack N, Chambers S and Johnston R (2004) *Operations management* (4th ed) Pearson Education.
Somers TM, Nelson K and Karimi J (2003) Confirmatory factor analysis of the end-user computing satisfaction instrument: Replication within an ERP domain, *Decision Sciences* 34(3): 595-621.
Teece D, Pisano G and Shuen A (1997) Dynamic capabilities and strategic management. *Strategic Management Journal* 8(7): 509-533.
Tidd J, Bessant J and Pavitt K (2001) *Managing Innovation* John Wiley, New York.
Wheelwright SC and Bowen H (1996) The challenge of manufacturing advantage. *Production and Operations Management* 5(1): 59-77.
White G (1996) A survey and taxonomy of strategy-related performance measures for manufacturing, *International Journal of Operations and Production Management* 16(3): 42-61.
Yin R (2003) *Case study research: Design and methods* (3rd ed) Applied Social Research Methods Series Vol. 5, Sage Publications, Thousand Oaks.
Zviran M and Pliskin N (2005) Measuring user satisfaction and perceived usefulness in the ERP context, *Journal of Computer Information Systems* 45(3): 43-52.

Received 19 May 2008 *Accepted 28 October 2008*