System effectiveness and Operational effectiveness: can an optimal balance be obtained?

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ABSTRACT

Organisations are increasingly investing significant resources, time and money, in complex information systems. In most cases there are important claims made concerning how these expensive systems will produce considerable improvements in the operational performance of the organisations. However there is evidence that shows many of these systems fail to deliver and often fail completely. This paper attempts to provide linkages between system effectiveness and operational performance that will enable managers to better understand the interaction between information systems and operational performance. Drawing on literature on both information systems and operational effectiveness this paper puts forward a model for further empirical investigation.

Keywords**:** *System effectiveness, operational effectiveness, performance measurement*

1. INTRODUCTION

Organisations are increasingly investing significant resources to obtain the benefits of new developments in enterprise information systems. Nevertheless, the implementation of these systems is constantly questioned from an operational perspective and their contributions towards organisation performance enhancement are not yet well understood (2003). Enterprise information systems (EIS) are expected to increase firms' operational effectiveness (e.g., decrease operational costs, increase flexibility and reliability, improve quality). Likewise, there is also an expectation that enterprise systems are able to not only boost profitability (Masini 2003), but also to ensure survivability and enhance competitive advantage. That is, organisations need to clearly identify how their operations can satisfy market (or regulator – in the case of a monopoly) expectations and differentiate themselves through well-defined performance objectives. Gaining a better understanding of the relationship between market and stakeholders expectations and operational performance leads to adopting and implementing EIS with a focus on improving operational effectiveness (Slack, Chambers & Johnston 2004; Staughton & Johnston 2005). The improvement of operational effectiveness may involve the determination of key performance objectives to establish a benchmarked assessment. However, it is here where some organisations seem to be failing as they either do not measure performance or what they do measure will not lead to improvement of operational effectiveness (White 1996; Neely 1999).

Effectiveness also needs to be measured from the system (system effectiveness) perspective. The implementation of EIS by organisations has increased in importance as companies

become more aggressively competitive or come under heightened regulator scrutiny. In the last two decades the advent of Enterprise Information Systems (EIS) (Turban, Aronson & Liang 2005) or Enterprise Systems (Davenport 1998), has made available technological improvements that are helping companies to automate procedures and support their daily activities and decision making processes. Nevertheless, as a result of growing concerns about EIS effectiveness (Shanks, Seddon & Willcocks 2003), there is a need to evaluate them to demonstrate real benefits to the operational performance inside organisations. Reactive under-investment in technology is not an appropriate response to competitors adopting technology. Earlier studies found that organisations dedicating resources to information systems expect productivity improvement (Masini 2003). However, adopting systems after identifying and targeting objectives that can drive performance improvement and increase in productivity is not an easy task. Identifying the objectives requires an understanding of the firm's core capabilities as well as its market needs and how the system can enhance these core capabilities and operational effectiveness.

Thus the aim of this paper is to demonstrate that there is a need for a better understanding of the optimal balance between operational effectiveness and system effectiveness that must exist not only after the implementation of a new EIS but at all significant funding points in the cycle of ES. Essentially, we argue that while there has been research on the identification of the dimensions to attain system effectiveness and other researchers have addressed the issue of operational effectiveness by identifying the key measures that will ensure performance is improved, there has been insufficient research that links system effectiveness to operational improvement. So, it is important to explore whether an optimal outcome can be attained if both operational and system performance objectives are taken into account when adopting EIS.

2. LITERATURE REVIEW

Enterprise information systems such as Enterprise Resource Planning (ERP) systems enable the integration of information available to all departments and functions across an organisation. ERP consists of a number of integrated applications, such as manufacturing, logistics, distribution, accounting, marketing, finance, and human resources (Turban, Aronson & Liang 2005). EIS can be best described as an organisation-wide system that enables people to communicate with each other electronically and access appropriate data through an enterprise. (Turban, Aronson & Liang 2005; Ifinedo 2006). This paper discusses issues primarily related to ERP systems. It is estimated that during recent years organisations worldwide have spent around US$18.3 billion annually on ERP (Shanks, Seddon & Willcocks 2003). However, despite the difficulties and risks encountered by organisations

when adopting and implementing these systems, ERP adoption continues to grow globally. Moreover, there is a relatively small number of academic research publications within the information systems community on ERP systems compared to the size of the business they generate (Estevez & Pastor 2001).

The implementation of EIS such as ERP systems is problematical because of the generic off-the-shelf nature of most systems (Mabert, Soni & Venkataramanan 2003). In the past, organisations first studied their needs through the four steps of the system development life cycle (SDLC): system planning and selection, system analysis, system design and system implementation and operation. SDLC is defined by Turban, Aronson and Liang (2005) as a systematic process for the effective selection or construction of large information systems. It is claimed that the SDLC process guaranteed that the new system would fit the organisational needs (Valacich, George & Hoffer 2004). Another alternative is to analyse what is needed and then choose the application that would support requirements (Davenport 1998). However, ERP has changed the sequence, as companies have to adapt their business to the characteristics of the ERP application. It is the vendor who defines the requirements of the business as they claim to have analysed similar business characteristics and written a system solution that can be adapted to other businesses just by changing the configuration or some parameters. In essence the company can choose the modules that will fit their needs and then the organisation can configure the module to their particular requirements. (Davenport 1998). This is not always an easy task as it may involve adapting some of the functionalities of the system to the uniqueness of each process. By making these changes companies do not realize that they are impacting other areas or functions of the system that were not designed for that particular process. One example of this is ERP adoption and implementation in service institutions. Because the majority of ERPs were originally designed for use in manufacturing, their operability differs considerably to the requirements of a service institution. The terminology used across the institution has to be changed to fit the ERP requirements, causing considerable uncertainty, and the adoption has been rejected by some users (Von Hellens, Nielsen & Beekhuyzen 2005). Changes in the system can also affect the organisational culture. According to Moss (2000), successful companies empower people to innovate. When organisations are innovative and flexible, it is very likely that staff will attempt to modify the system as they are constantly improving processes in the organisation. This may harm the overall operability of the system, if the system is not flexible enough to effectively incorporate those changes. Hence the innovation and the flexibility of the company is diminished or moderated by the unlikelihood of making continuous changes in the system (Robbins 1997). The paradigm for investment in ERP has changed; businesses used to invest wholly in system effectiveness by designing a unique system for themselves based on their

own requirements. Now, through the availability of packaged ERP's enterprises must find the balance between redefining their operations (examining operational effectiveness) and changing the packaged ERP (managing system effectiveness) (Swanson 2003).

System Effectiveness

System effectiveness can be described as the extent to which information systems contribute to achieving organisational goals and benefits (DeLone & McLean 1992). Companies deriving the greatest benefits from their systems are those that, from the start, viewed them primarily in strategic and organisational terms. These companies stressed the importance of the enterprise not the system (Davenport 1998). Some case studies reported by Masini (2003) showed the EIS adoption as successful as they brought the expected benefits, but also induced important modifications in the firm's business model. Some of the expected benefits identified by Masini (2003) are: homogenization of information and its timely availability, significant reduction of data entry points with a consequent decrease of potential inconsistencies and errors and better utilization of resources, and some departments inside organisations have also obtained direct benefits after the replacement of the multitude of old legacy systems which had organisational IT integration problems (Mcafee 2002). From an information management perspective, the centralization and the rationalization of the different data management systems has generated unquestionable benefits (Masini 2003). According to Hesseldenz & Morefield (2005) other institutions report new organisational capabilities and a considerable improvement in different operational areas. The new ERP system has also helped the institution enhance its ability to adapt to change, create new knowledge and performance measures, and even identify a new strategic horizon.

Due to the constraints of this paper we will discuss only some of the benefits reported by diverse authors. ERP systems benefits include gains in coordination, communication, and organisational efficiency (Trimi, Lee, Olson & Erickson 2005). The gains in efficiency are primarily obtained through incorporation of industry-wide best practices. ERP systems have also been credited with providing adopters with a real-time computing environment. While in practice, ERP systems have been seen to initially slow down some systems, they seem to provide long-run gains in efficiency. This technology is increasingly replacing discrete, in-house systems with an integrated, ERP-wide infrastructure that will streamline organisational activities and eliminate duplication of effort and data (El Amrani, Rowe & Geffroy-Maronatt 2006). Despite the claimed benefits, ERP systems have not proven to be all-encompassing panaceas (Trimi, Lee, Olson & Erickson 2005). Although ERP systems can enhance competitive advantages to organisations, the high failure rate in implementing such systems is a major concern (Davenport, 1998). Failure rates for large-scale system development projects

are extremely high and many information system projects are failing to achieve their advertised outcomes (Jamieson & Hyland 2004). A project has failed if the solution does not integrate well with the business environment, if there is a lack of consistency between the initial requirements and final solution, or if the project simply does not make business sense (Jamieson & Hyland 2004).

The issue of how to measure success or failure is not easy as the success or failure of a system is subjective and is seen as a matter of interpretation and that interpretation can change over time (Myers 1994). Measuring success of information systems has been a concern for those within the information systems discipline. Although success is complex, and therefore difficult to measure, researchers have made efforts to identify dimensions and measures that facilitate the process of understanding information systems success. On the other hand, due to the multitude of different approaches to the measurement of information systems success, it is unlikely that a single measure of EIS effectiveness can be agreed upon and, therefore there is a need for multiple measures. The DeLone and McLean's (2003) model, which is based on the empirical and theoretical contributions of researchers who have tested or discussed the original model, includes six interrelated dimensions of information systems success: information quality, system quality, service quality, intention to use, user satisfaction and net benefit are dimensions to measure the dependent variable information systems effectiveness. In essence, in the DeLone and McLean (1992) success model, "system quality" measures technical success – the desired characteristics of the system; "information quality" measures semantic success – characteristics of the information and its desired form; and "use and user satisfaction" measures effectiveness success – studies that attempt to analyse and measure the interaction of the information product with its recipients; "individual impact" relates to what influences the information product has on management decisions, and "organisational impact" derives from research that investigated the effect of the information product on organisational performance (DeLone & McLean 2003; Nielsen 2005).

In measuring performance it is important to have a clear understanding of the outcomes derived from the investment of a significant amount of human and economic resources in ERP solutions that cannot always be properly adapted to particular circumstances, and therefore parallel systems need to be run (Jones 2003). Moreover, it is increasingly expected that EIS effectiveness should be measured in terms of the real operational benefits rather than through the achievement of information systems outcomes only. So are EIS helping companies to improve operational effectiveness? Do organisations understand what is meant by operational effectiveness? Do organisations know how to measure and what to measure to improve their operational effectiveness? In attempting to address these questions we need to understand key elements of operational effectiveness and the links between operational effectiveness and system effectiveness.

Operational Effectiveness

An increasing number of factors are prompting organisations to operate more efficiently and to ensure they have effective operational processes (Hill 2000; Slack, Chambers & Johnston 2004). This involves, for instance, the need to deliver value adding products or services of exceptional quality, on time, at a competitive price. Thus, 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).

Operational effectiveness refers to the ability of setting 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 better use of resources through these core processes enables the organisation to eliminate waste, adapt more appropriate technology and therefore perform better than competitors (Porter 1996). Performance is considered a judgmental assessment of the organisation's performance relative to benchmarks in a certain period. Adequate measuring of performance enables organisations to continuously and systematically seek out opportunities to improve.

Measuring performance might create paralysis by analysis as organisations tend to follow the principle of what gets measured gets done but in the process managers either do not clearly understand what it encompasses or are overloaded with a wealth of costly measures and information that does not lead to improvement of effectiveness and fast response. Measuring performance is described as the "process of quantifying action" (Slack, Chambers & Johnston 2004), which encompasses the selection of what activities to measure and why, performance standards and benchmarks (Hill 2000). 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.

There are three basic questions to be answered when measuring performance: *what will be measured* and *how will it be measured* (White 1996) and *why is it measured* (Neely 1999; Hill 2000). The answer to the question *what will be measured* concerns the scope of interest and firm's competitive priorities (White 1996). Some authors such as Slack, Chambers and Johnston (2004) have suggested different performance measures based on the competitive priorities and their merging and categorisation has resulted in a composite set of widely accepted objectives when seeking competitive advantage. Accordingly, it has been suggested that at a more operational level, performance needs to reflect the extent to which an

organisation is able to differentiate on five specific performance dimensions when satisfying market needs.

The five performance dimensions or objectives an organisation seeks to fulfil to attain operational effectiveness include cost, quality, dependability, flexibility and speed (White 1996; Hill 2000). Creating competitive advantage is not an overnight task, thus excelling on some of the objectives and being competitive on each of the others gives an organisation an edge in the market (Wheelwright & Bowen 1996). Competing on cost means that a firm seeks the elimination of waste which comes from efficiencies attained in processes such as purchasing, production, and staff performance (Russell & Taylor 1995). 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, Chambers & Johnston 2004). Furthermore, competing on quality provides an opportunity to bridge the gap of what organisations are capable of offering and what customers demand. That is, viewing quality as a consistent provision of products and services that satisfy customers rather than only minimizing defects and conforming specifications without any clear market orientated continuous improvement (Russell & Taylor 1995). The third operational performance objective concerns being flexible which includes an organisation's ability and the extent to adjust (what it does, how it does and when it does) to changes to respond to customers (Slack 1991). Additionally, competing on speed prompts organisations to be able to shorten the time between the service or product requesting and service or product reception and deliver a product or service with the frequency and at the time that the customer requests (Hill 2000). Finally, reliability suggests that firms' processes consistently perform as expected over time. That is, customers being satisfied by organisations that produce goods that do not fail over a period of time or with services that are delivered as has been agreed (Corbett 1992).

Once an organisation has identified what needs to be measured, it needs to answer the second question *How will it be measured*? This concerns the incorporation of some steps that look at different stakeholders of the organisation as sources for improving performance. This will increase the company's competitiveness. The first component relates to the need for measuring performance from data available at the interior of the firm as well as from more valuable and richer data outside the organisation including customers, suppliers, and competitors (Keegan, Eiler & Jones 1989; Cross & Lynch 1992). For instance, flexibility can be measured internally by the ability to change the procedures required for a service, and it can also be measured externally through such measures as the ability to offer more customised services. Type of data is the second step of *how performance will be measured* and it focuses on whether the data to be collected will be based on opinions and perceptions,

usually external to the company, or based on observable facts, most likely more objective and from inside the organisation (White 1996). Source and type of data is followed by the establishment of benchmarks, that is, comparing with the competitors or comparing with other areas within the organisation. Benchmarking provides a systematic way of setting targets for improvements based on best practices (Hill 2000). The final step suggested by White (1996) encompasses measuring both process inputs and process outcomes.

The *why measure* performance question has been addressed by researchers in the field of business performance such as Eccles (1991), Kaplan and Norton (1992), Neely (1999), and Bourne, Mills, Wilcox, Neely & Platts (2000). Some of the reasons for measuring performance encompasses the improvement of productivity (Tangen 2004), identifying where problems exist and where improvements are necessary as well as showing if planned improvements actually happened (Parker 2000), addressing the issues of where the company wants to go, how to get there and knowing that it got there (Lebas 1995), and encouraging long-term thinking perspective, supports, and enhancing improvements as well as better resources allocation. Other research suggests that due to factors impacting on organisations during the last decade such as the increasing changes in the business environment, increasing competition, changing organisational roles and changing external demands have been prompting organisations' need to have a more holistic and proactive (Neely 1999) approach of performance measurement. This holistic approach involves the setting of performance measures by considering not only the shareholders and customers needs, which to a great extent is included in Kaplan and Zairi's (1992) balance score card framework, but also by taking into consideration some other stakeholders.

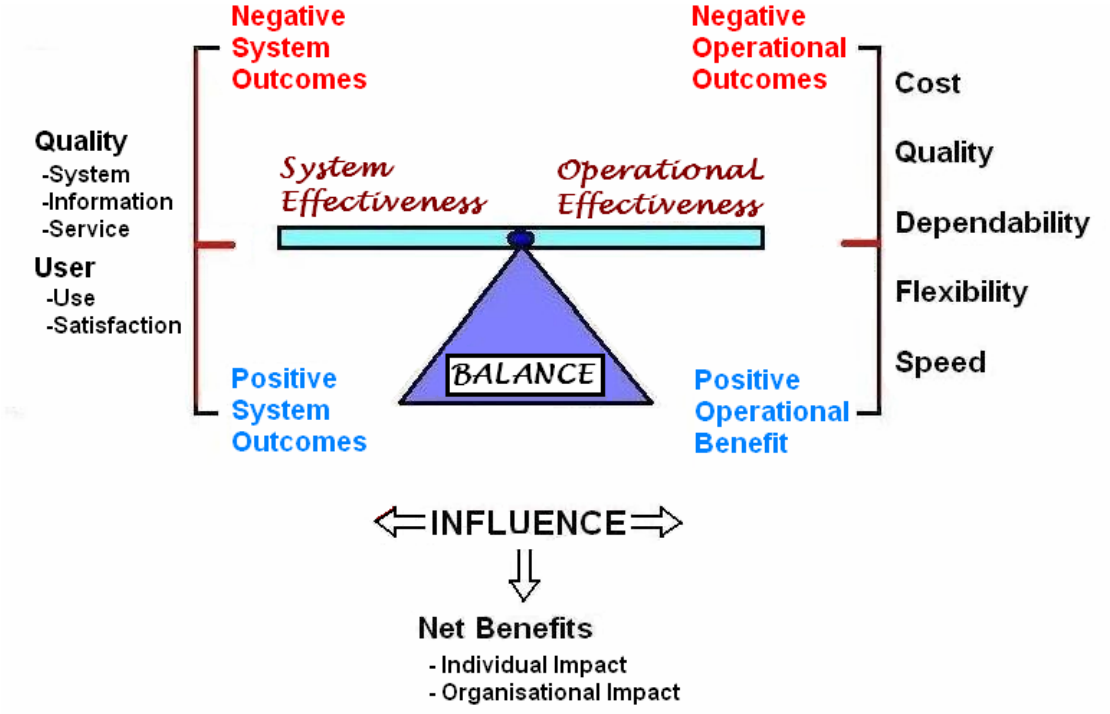
The need to survive, improving performance and attaining competitive advantage based on the firm's stakeholders needs and wants are urging organisations to identify what to measure, why to measure and how to measure their performance at every level including the operational. In addition, it has been argued throughout this research that it is equally important to measure the effectiveness of systems as organisations invest a considerable amount of money in EIS implementation arguing that this deployment of financial resources leads to the reduction of operational costs. This argument seems contradictory as the money invested, in many cases, exceeds the initial budget, and the adopted solutions are increasingly failing to meet organisations' performance objectives. Consequently, a model is put forward in the next section to explain that decisions regarding the implementation of EIS could have either negative or positive outcomes from both the systems and operational view depending on how lopsided the decision is.

3. CONCEPTUAL MODEL

In view of the review of the existing literature and discussion, the conceptual model (see Figure 1) is put forward. The model suggests that lopsided decisions could influence either negatively or positively both operational and system effectiveness. That is, if enterprise information systems decisions are merely driven by the attainment of positive systems outcomes, the operational effectiveness cannot be improved as the performance objectives are not likely to be met. For instance, an organisation might want to increase the data transfer speed of its system as the result of a request of users who constantly complain about the slowness of their transaction. If the company decides to upgrade the bandwidth of its network and the impact of the investment is not well assessed, the company could end up making a decision that does not meet one of the operational performance objectives, i.e. cost.

Figure 1

System and operational effectiveness balance approach



Source: Developed for the purpose of this study.

On the other hand, if enterprise information systems decisions are just driven by the achievement of operational outcomes and do not take into consideration the system requirements, the system will fail due to the lack of, for instance, systems capacity. One should ask what would happen if a company stresses the importance of operational outcomes rather than the information systems outcomes? The expected results would be more positive operational benefits but more negative information systems outcomes. In the short term this

may lead to high operational benefits, however the low system benefits will ultimately produce an overall low net benefit.

The proposed model (Figure 1) also shows the ideal situation (optimal outcomes) when deciding on the adoption of enterprise information systems. In this case the company would make decisions based on technical criteria but the solution is integrated with the business environment; the initial requirements are consistent with the final solution enhancing competitive advantage and operational effectiveness. Additionally, the model proposes that the decision to embrace enterprise systems requires an optimal balance approach and better understanding of the net benefits to be pursued based on the measures of operational and system effectiveness.

It is expected that the model would be useful for discussions on the assessment of operational performance both before and after the introduction of a new technology (ES) as there could be a small body of performance change resulting from ES adoption. Some of the gains in operational effectiveness, such as greater order fulfilment response time, increase in sales due to the availability or dependability of the system, flexibility in customised services, less material waste, better inventory control, and so on, might not be significant when seen as a whole (net benefits) with the outcomes of the system effectiveness. These net benefits also include the influence of the enterprise system on the quality of the information, which could not be measured without seeing the quality of the system as a technical component, and the support offered by the vendor of the enterprise system. Furthermore, a net benefit encompasses the influence of the new solution on the overall users across the organisation and their perception of the system and the intention of use of the application (DeLone and McLean 2003; Masini 2003; Mcafee, 2002; Slack, 1991).

4. IMPLICATIONS AND CONCLUSIONS

Organisations that deploy resources in new enterprise information systems may find they have wasted money if there is a lack of solid understanding of what type of improvement they pursue and how to measure it. A firm investing, for instance, significant resources to manage and measure the effectiveness of category management can easily face challenges with unsatisfied suppliers if its distribution systems cannot cope with the variation in sales volume that accompany the point of sale promotions. Conversely, organisations could spend considerable resources on setting metrics and performance measurement systems that assess their performance, without a clear stakeholder satisfaction in mind, and never find the enterprise system that ensures that the organisation operational performance improves incrementally. It is therefore important to evaluate whether the adoption of enterprise

information systems leads to improvements in operational effectiveness. If this is the case, it is relevant to identify dimensions of the enterprise information system, operational performance objectives that are associated with the successful adoption. The identification of the right success objectives requires an understanding, firstly, of the key objectives that drive the operational performance of organisations and the industries they participate in, and secondly, of the way the enterprise information systems would influence those key objectives. Accordingly, comprehensive empirical research is needed to investigate the influences, if any, between the system and operational effectiveness under a balance approach which could help organisations determine whether they have obtained the expected benefits from the enterprise information system decision. Current conceptual models are not effective in addressing these issues. This research aims to develop a model to identify the key performance objectives that would assist in an understanding of what is an optimal approach so survivability and competitive advantages will be enhanced through the correct balance described in the research. An interrelation must be explored considering the dimensions of system effectiveness mixed with the measurements of operational effectiveness as organisations need to clearly understand their core operational capabilities and how these fit into the corporate strategic plan before any ES related decision or adoption is taken into consideration.

The model presented in this research is used in the context of a new system implementation, but it could also be used to assess the decision to modify any enterprise information system. However the discussion of this topic would require further and more comprehensive research beyond the scope of this investigation.

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