A Simulation model for decision support in Small Medium Enterprises (SMEs) for ERP systems implementation

Abstract

Small medium enterprises face considerable challenges in implementing enterprise resource planning (ERP) systems however due to their benefits ERP systems are becoming an essential and integral part of SMEs business strategy. This study investigates the implementation of enterprise resource planning (ERP) systems in small medium enterprises (SMEs) and the role played by certain critical success factors (CSFs) in its successful implementation. Based on extensive literature review and list of critical success factors is established. A questionnaire survey in carried out to assess the role played and weight each CSF carries towards the implementation. The primary data collected is analysed and based on result of the analysis a simulation model is proposed. This simulation model can assist in running implementation scenarios under different constraints and variables. By drawing upon this model, we can relate to how SME can better utilise and prioritise different CSFs and resources by choosing the best implementation strategy before real life implementation.

Introduction

The last decade has seen the use of Enterprise Resources Planning (ERP) systems increasing many folds. This may be due to increased competition, globalisation and need for greater visibility into business functioning. ERP systems have risen up to the expectations of

industry. ERP systems is an information system that manages, through integration, all aspects of business including production planning, purchasing, manufacturing, sales, distribution, accounting and customer service (Scalle and Cotteleer, 1999), which allows seamless integration of information flows (Davenport, 1998) and business processes (Mabert et al., 2003) across functional areas within a company. They support information sharing along company process flow and help it to achieve better productivity and results. ERP packages offer a workflow engine to generate automated workflow according to business rules and approval matrices so that information and documents can be routed to operational users for transactional handling, and to managers and directors for review and approval (James et al., 2002).

ERP systems have greatly enhanced and revolutionalised the operational working of organisations by making them productive, competitive and integrated. However, despite all the advantages that can be attained by implementing ERP systems, its implementation is still a very time consuming, detailed and complicated process. Therefore it constitutes a major challenge for the implementing organisation, not only in the form of complete process restructuring, but also constraint on resources. ERP implementation budgets are often expressed in millions of dollars and implementation schedule is spread over several months or maybe years. It may be noted here that not every implementation has lived up to its expectations and it is very common to observe a gap between expectations and results. Wang et al. (2005) suggested that average over cost for implementation is 178 percent and implementation period is 2.5 times longer than anticipated. Also, it has been observed that 66 to 70% of ERP implementation projects fail to achieve their corporate goals (Buckhout et al., 1999; Lewis, 2001; Carlo, 2002). The literature provides numerous examples of failed implementation such as Whirlpool, Hershey, Waste Management, Inc., and W. L. Gores and Associates (Wah, 2000). In the context of small medium enterprises (SMEs), because of their

Electronic copy available at: http://ssrn.com/abstract=1734346

limited resources and market share, a failed implementation can have catastrophic consequences for SMEs which may lead up to bankruptcy. SMEs also face limitations in implementing new IT systems due to a lack of modern information technology, old legacy system and lack of perceived usefulness towards new technology. In spite of the risks, the benefits of ERP systems make it essential technology for SMEs. In order to minimise the chances of failure, it is essential that SMEs must plan well for the implementation and use their resources appropriately to get best result. Also for a successful implementation, it is essential that SMEs should carefully evaluate some key implementation decisions. In order to assist SMEs in implementing ERP systems successfully, there is need for a better understanding of the implementation process with particular emphasis on the factors that play a key role in implementation.

This paper explores the key considerations and role played by certain factors in successful implementation projects such as management support, project management, vendors support, data/infrastructure and users. Based upon the initial findings, this paper addresses the next stage in improving understanding of the ERP implementation systems by proposing a simulation model, and discussing its implication, benefits and functionality. The next section provides a literature review of ERP implementation. Section 3 describes the methodology used in collecting data and analysis. Section 4 describes the finding and proposed a simulation model and section 5 presents conclusion and recommendations for future research.

Literature review

An Enterprise Resource Planning (ERP) system integrate all information and processes of an organisation into a consolidated system that addresses how people and organisation access,

gather, store, summarize, interpret and use information. Van Hillegersberg et al (2000) define ERP systems as configurable information system packages that integrate information and information based process within and across functional areas in organisations, however, ERP implementation is an extensive, meticulous and a costly process. The complexity and high cost of these systems have meant that their use/implementation have been restricted to larger companies as the smaller SME's are unable to invest in these systems. As the market for ERP systems in large enterprises begin to mature and decline, and small medium enterprises (SMEs) began to recognize and appreciate the functionality and significance of ERP systems (Koh and Simpson, 2005), companies such as SAP, Infor, Microsoft Dynamics, Baan, Oracle/PeopleSoft have began to focus attention on SMEs, by developing and targeting their product towards SMEs requirements by offering simplified and low cost solution for their organisational and technological needs.

ERP systems are the subject of number of studies (Esteves and Bohoroquez, 2000; Moller et al., 2004) and the relatively new phenomenon of the ERP implementation in SMEs is subject to the attention of researchers and the professionals in the field. Research has shown that different aspects of implementation, such as uncertainty management using ERP systems (Koh and Saad, 2006), specific methods of ERP requirements analysis (Vilpola and Kouri, 2005; Vilpola et al., 2007), the relevance of local characteristics (cultural, social value, management style) the ERP has to cope with (Liang and Xue, 2004, Yousef et al.,2006), pre-implementation issues (Brem et al., 2008), critical success factors (Holland & Light, 1999; Akkermans & van Helden, 2002; Hong & Kim, 2002; Hung et al., 2004) have been studied. Literature indicates other important studied factors such as ERP alignment with firm's competitive strategy in order to obtain best result (Yen et al, 2003), the importance of the marketing abilities of supplier and the collaboration between vendors and clients (Morabito et al., 2005, Xie et al., 2005), the inadequacy of ERP packages for niche companies (Olsen and

Saetre, 2007), the extension of ERP across the entire supply chain (de Burca et al., 2005) and the evaluation of readiness before the introduction of ERP (Raymond et al., 2006).

An important characteristic element of most ERP systems is the use of the single central database for information collection and sharing. The process of integration of different sections in organisation for the information sharing purpose can involve technical issues pertaining to architecture, data standards, configuration, and hardware and software integration (e.g. Olinger 1998; Jordan and Krumwiede, 1999; Markus and Tanis, 2000). In order to overcome the technical and organisational issues for successful implementation, researchers have stressed upon the role of certain factors that can be key to successful implementation. These factors, also known as critical success factors (CSFs), have received a wide attention (Akkerman & van Helden, 2002; Holland & Light, 1999; Somers & Nelson, 2001). Bullen and Rockhart (1981, p.383) define CSF in IS (information systems) as "the key areas of activity in which favourable results are absolutely necessary for a particular manager to reach the goal". Successful project managers must focus their resources, their time, "on those things that make a difference between success and failure". There exist a amount of literature proposing different critical success factors, such as Top management support (Laughlin, 1999; Holland and Light, 1999; Brown and Vassey, 2003), Project Champion (Nah et al., 2001), Users (Sneller, 1986; Bingi et al., 1999; Nah et al., 2001) and external expertise (Markus and Tanis, 2000; Wang and Chen, 2006). However, most of the studies simply mention these factors or list them in order of adaptability but fail to mention the role they can play in improving the process or interrelation between these factors.

It can be observed from the literature review of CSFs that most of the aforementioned studies are empirical research work and are conducted using either case studies, surveys and literature reviews, therefore, the conclusion obtained from these researches are mostly valid only to the companies involved in the research work or a particular implementation. The

CSFs identified in research studies can assist the SMEs to focus and concentrate on these factors during implementation. However, how effective these CSFs can be, how far they can assist in implementation and how the SMEs will make effective use of them is ambiguous. Also, recognising and providing only the list of CSFs is less than what practitioners are looking for in their struggle to understand the implication of their actions during implementation.

To address the issues during implementation and to understand the effect of the CSFs on implementation, researchers have developed and proposed different process models that can help to gain a better understanding of the implementation process and also to understand certain guidelines for successful implementations (Bancroft, et al., 1998; Ross 1998; Markus and Tanis 1999), but none of those models considered the CSFs. Parr and Shanks (2000) develop a project phase model for ERP implementation project and studied the relationship between implementation phase and CSFs. Using two case studies, one unsuccessful and one later successful, they proposed important CSFs during particular phase. Akkermans and van Halden (2002) using the secondary data attempted to built a relationship model between different CSFs. In order to better understand the relationship between CSFs, a dynamic ERP simulation model was proposed by King and Burgess (2006). This proposed simulation model based on qualitative data analysis tends to encourage exploration of more appropriate implementation strategies. Sawah et al. (2008) proposed a model to describe ERP implementation success as function of interrelated CSFs and the organizational culture.

Research has shown that the understanding and focussing on specific CSFs during a particular implementation phase can be part of strategic decision making. Further analysis of the implementation process suggests that cost (Chan, 1999; Rao, 2000; Loh and Koh, 2004; Ngai et al., 2008) and project duration period (Sneller, 1986; Kirchmer, 1998; Nah et. al, 2001; Summer, 2005) are very important determinant for successful implementation. In order

to find methods to minimise the cost and forecast project duration, Plaza and Rohlf (2008) investigated the learning and performance in ERP implementation project and attempted to find out how the training strategy can minimize the project cost, providing an analytical method for predicting a project completion date and finding a theoretical basis for empirical studies of learning and ERP implementation. Likewise, Sun et al (2005) studied the relationship between CSFs in the context of time, cost and achievement and proposed a mechanism to suggest average completion time, achievement and relevant cost.

Whilst improving understanding of the interrelationship between CSFs is a step forward and proposed implementation models can assist in understanding the complexities of the implementation, however, most proposed models are theoretical models and they lack the practicality of real life implementation. The ERP systems implementation in the real world is different experience; it is complex, it includes on-time decision making and allocation of resources, striving for optimize performance and search for the best implementation strategy. Optimized time, cost and achievement are the essence of successful implementation.

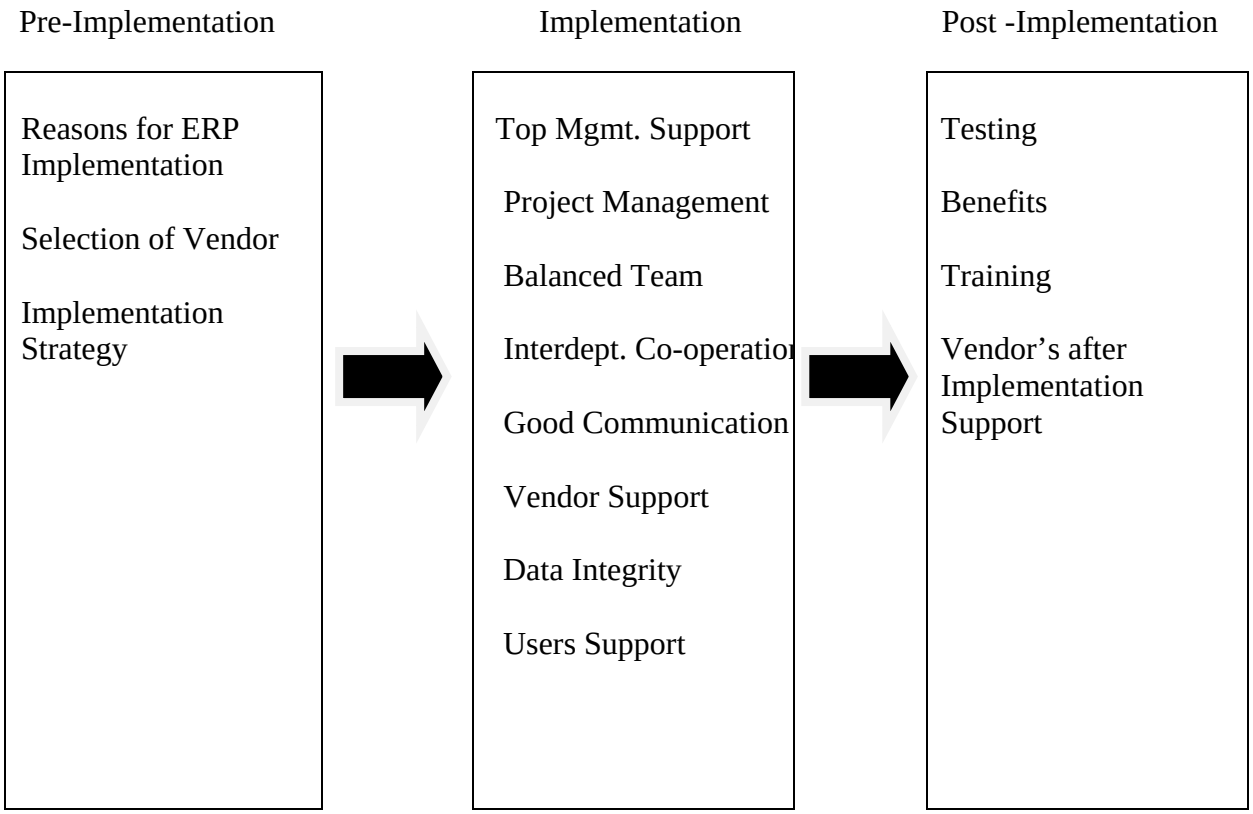
In order to make the best use of available resources while saving time and cost and keeping in consideration the performance of CSFs, a simulation model has been proposed. This simulation model performing as a Decision Support System (DSS) for ERP implementation can assist in facilitating the operational decision making in different phases of ERP implementation while evaluating and enhancing the whole process. This simulation model will combine two types of model, first, ERP analytical model, in which ERP cost and project duration period are obtained and analyzed using statistical analysis tools and studying the relationship between the variables. Second, ERP simulation model which will provide a dynamic view of the real life ERP implementation process and performance. This simulation model can be used to explore the effect of CSFs to implementation process and to link CSFs directly to the implementation outcomes. This simulation model aims to enhance the decision

making ability of implementation team since it will provide them a tool to study performance relationship between CSFs, implement different implementation scenarios and find the optimize solution without actually doing in real life while saving time and resources.

ERP systems and Small Medium Enterprises

Small medium enterprises (SMEs) are considered as the backbone of the economy of the many countries around the world. There is no single generalised definition for SMEs. Some of the most widely used criteria to characterize a SME include size, number of employees, sales volume, asset size and capital requirement (Ibrahim and Goodwin, 1986). According to Department of Trade and Industry (DTI) UK, SMEs include the organisation that that have less than 250 employees and excludes micro SMEs that have less than 10 employees. While the Small Business Administration (U.S. Small Business Administration, 2006) describes a small business as “one which is independently owned and operated and which is not dominant in its field of operation”. There 23 million functioning SMEs in USA and they employ 50% of private workforce (U.S. Small Business Administration, 2006). Similarly, SMEs provide 64% of all Canadian private sectors (Industry Canada, 2006) and in European Union they provide 67% employment (Eurostat, 2007).

SMEs due to their specific characteristic and functioning, as suggested by some scholars, cannot be considered scaled-down larger ones, and theories applied and proved in large



ERP implementation process in SMEs

enterprises are not be suitable for small business (Schubert et al., 2007; Thong et al. 1996). Similarly the introduction of ERP system in SMEs is not the duplication of the implementation experience of larger organisations since ERP implementation in SMEs involves certain characteristics and features that must be explored (Federici, 2009). ERP systems developers have been studying the functioning and requirements of the SMEs from different perspective, especially keeping in view their technical capabilities, limited requirements and cost conscious attitude. Alongside, SMEs has also begun to realise and appreciate the functionality and utility of ERP systems in order to be productive and compete. In this scenario, many SMEs are opting for enterprise systems that are comparatively simple with lower price tag. Some of the ERP system provider have also come up with 'ERP Light' version (such as eresourceERP Light) to cater the need of SMEs. However, research suggests

that configuring and implementing ERP systems in SMEs is still a complicated task. The company's inadequate information about the ERP systems technical issues may make or break its decision to either continue or abandon an ERP implementation. In order to avoid this situation a "best practice" scenario is proposed by Malhotra (2009) which is based on critical decision, found from previous research, which are important to implementation. The proposed critical decisions include project team structure, implementation strategy, selection of transition technique, database conversion strategy, risk management strategy and change management strategy.

An important aspect of sound implementation strategy involves laying a solid ground work for successful implementation. Project team need to develop activities that fosters successful implementation such as planning and installing activities, educating users and communication (Muscatelle et al., 2003). These activities will lay a strong foundation for the implementation and keep all people involved in a closed loop. However, high cost and technology can have negative effect on ERP adoption since SMEs tend to have limited IT skills and lack of resources. To make the best use of the resources a five stage deployment model is developed by Berchet and Habchi (2005). This model consists of five stages including selection of vendors and software, deployment and integration, stabilization, progression and evolution. This model can assist users in different stages of implementation by assisting them in planning allocation of resource for different stages of implementation.

ERP systems focus on integrating different business entities and establishing central database for all the information sharing. The database keeps the updated information and knowledge of the system, and makes it available to all the departments. Alongside with a central database it is important that SMEs should have some mechanism for information sharing and knowledge management. SMEs should ensure that their knowledge management initiative fits into their organisational culture, or otherwise they should be prepared to change it to make the most out

of the implementation (Metaxiotis, 2009). This would create an added value to the organisation and make them more competitive since implementing ERP is about increasing the competitive advantage by making them responsive and agile to change (Koh and Simpson, 2007). However Tagliavini et al. (2002) disagree with these findings and suggest that SMEs make use of ERP systems mostly for contingency, exogenous reasons rather than accurate analyses of their needs and opportunities.

Research suggests that ERP systems provide SMEs with long needed tool to be competitive and efficient. Holsapple and Sena (2005) conclude that ERP systems indeed offer substantial decision support benefits and the most highest rated benefit include better knowledge processing, decision reliability, decisional substantiation, competiveness and faster decision making.

Research Methodology

The research methodology for this study consists of two steps. As a part of first step of research methodology, an extensive research study was carried out of the current literature in the field of ERP implementation. The literature studied involved academic journals, online resources such as AMR research, ERP vendors' website such as SAP, Oracle and online ERP web forums. This leads to a general classification framework for ERP success factors for a successful implementation. It includes CSFs that have played a vital role in implementation in industry over past many years. They include top management support, project management, database/infrastructure, vendors support and users. In order to better understand the functioning of the each of the five CSFs, they are further described by their respective

attribute, with a total of 27 attributes. Analysis of CSFs according to their attributes can assist in understanding the characteristic of individual CSF, since attribute contribute to the overall performance of the CSF and the level of attention paid to each attributes will contribute to the overall achievement and implementation results. The proposed CSFs and their attributes are show in table 1.

On the basis of the findings from the literature review and relevant above mentioned sources, a self administered survey questionnaire was designed. A survey approach was preferred over a case based approach because of its efficiency and empirical nature. The questionnaire was designed to capture the organisational experiences in implementation, role played by different CSFs and also to find out to sequence in which CSFs can be aligned to get better results. The questionnaire was pre-tested with four respondents who have working experience with the ERP systems to check its validity. Their suggestions were incorporated in the final version of the questionnaire. The research sample for the study involves organisations that either already had implemented or in the process of ERP system adoption. The questionnaire was mailed out to the organisation and the professionals in the field who have been involved in ERP systems implementation in SMEs.

Critical Success Factors	CSF Attributes
Management	Commitment Clear objectives/goals Level of Support Experience
Users	Education Training Skills development Experience (of working with new ERP system) Involvement Communication
Project Management	No. of members Training Experience Role and responsibilities of team Time and cost Project Champion Vision
Infrastructure/Database	Hardware/Software Customization Data Integration Relibility Data Structure Master/Transactional Files
Vendors Support	Selection (Company size/experience) Support (one time or ongoing) Experience with vendors Training

Table 1 : CSFs and Attribute

The data analysis (Table 2) of responses suggest that majority of the respondents considered the top management support as one of the most critical factor for a successful implementation. Top management support covers a wide horizon of implementation starting right from the planning phase thru post implementation. It has been observed that top management support helps in smooth functioning of the process, create a clear line of communication and convey acceptable performances standards. Management must also define new objectives in order to give employees a clear vision of the organisation's goal.

Second important CSF suggested is 'users' of the system. Researchers have greatly stresses upon the importance of users and suggested that they must be involved from start to finish during the process. User's involvement and participation is also crucial for achieving targets. Also, since they are the end users of the systems, success and failure of the systems depends upon how they perceive the system.

Next important CSF according to the survey is effective project management. Project management consists of the establishment of a cycle of activities that will make it possible to ensure that implementation proceeds as planned (Esteves and Pastors, 2002a; Zhang et al. 2005). Some authors consider knowledge, skills, abilities and experience of an ERP project manager to be the important determining element in successful ERP adoption (Trepper, 1999). Effective project management involves proper project planning including elaboration of project goals and the scope of the project, involving experience project manager and a good balanced project team.

Table 2: Top priority CSFs	
(from 1=low to 3=High)	Mean
Top Management Support	2.7
Users	2.6
Effective Project Management	2.5
Vendors Support	2.2
Data Integrity/Data Migration	2.2

According to respondents, the next important CSFs are vendors support, and Data migration and integrity. In SMEs context vendors' support is a crucial factor because of SMEs lack of IT experience and technical infrastructure. Most respondents agreed that knowledgeable, on-time and reliable vendors support played important role during implementation. The last CSF 'data' covers the aspect of data migration from legacy to enterprise system and success in maintaining the integrity of data during this process. Since the input of erroneous data into the new ERP system may have devastating effect, because of the integrated nature of the ERP software. According to the survey data integrity was found to be a concerning factors and respondents agreed with the notion that maintaining the data integrity of the master files is a very important and crucial phase of implementation process.

Some other important findings include great importance on inter-departmental communication by respondents (2.8 value out of 3), presence of full time project manager and stress on the importance of users training and education by the respondents. Survey results also shows that only fifty percent of the implementation projects were finished within original planned budget while seventy percent of the implementation projects were successful.

Modelling and Simulation

The second part of research methodology involves designing and developing a simulation model. In this section a dynamic simulation model for ERP implementation is proposed (fig. 1). This model is based upon the observed interrelationship between CSFs and their attributes from the findings of the survey. The purpose of this simulation model is to explore possible outcomes using a realistic model of a situation without doing in real life. According to Shtub (1999) a model is simplified presentation of the reality. Most real problems are very complex because sheer size, the number of different factors considered and the dynamic, Stochastic (uncertain) nature of the interaction between many of these factors. By making simplifying assumption it is possible to develop a model of the problem which is simple enough to understand and analyse, and yet provides a good presentation of the real problem. When the level of the uncertainty is high, statistical models are used to represent the stochastic nature of the important factors or variables.

The main objective of developing a simulation model is to create a platform/instrument that can assist project managers in running and studying different implementation scenarios under variety of constraints and observe the relationship between different variables and make a smart and informed decision accordingly. A real life implementation can be very expensive, time consuming, fraught with challenges and with ever present risk of failure. Also, as compared to large enterprises, small medium enterprises due to their limited resources and technical knowledge may not be able to withstand a failed implementation and may even cease to exist. In these circumstances, a simulation model that can assist SMEs in implementation process is the best option. Using the simulation model SMEs implementation team can run different implementation scenarios and study the behaviour of variables under different constraints. By exploring different outcomes, the appropriateness of different course

of action can be evaluated and compared, thereby leading to improved practice while saving resources and time. Levy et al. (1988) suggested the following objectives in simulation modelling:

- To understand a relationships within a complex system.
- To experiment with the model to assess the impact of actions, options, and environmental factors.
- To test the impact of various assumptions, scenarios, and environmental factors.
- To predict the consequence of action on a process.
- To examine the sensitivity of a process to internal and external factors.

Balakrishnan et al. (2007) suggest following advantages of simulation modelling;

- It is straightforward and flexible. Properly implemented, a simulation model can be made flexible enough to easily accommodate several changes to the problem scenario.
- It can be used to analyse large and complex real-world simulations that cannot be solved by using conventional decision model.
- Simulation allows what-if types of questions. With a simulation model, a manager can try out several policy decisions within a matter of minutes.
- Simulation modelling does not interfere with the real-world system. It maybe too disruptive, for example, to experiment with new policies or ideas in a hospital, school, manufacturing plants. With simulation, experiments are done with the model, not on the systems itself.
- Simulation allows us to study the interactive effects of individual components or variables to determine which ones are important. In any given problem scenario, not all inputs are equally important. We can use simulation to selectively vary each input (or combination of inputs) to identify the one that most affect the results.

- “Time compression” is possible with simulation. The effect of the ordering, advertising, or other policies over many months or years can be obtained by a computer simulation model in short time.
- Simulation modelling allows for the inclusion of real-world complications that most decision models cannot permit. But simulation can use any probability distribution that user defines.

The model here depicts the ERP implementation process in which five commonly believed important CSFs are implemented in order of importance and role they play as per findings from the survey. Such as CSF Top management support is followed by users, project management, vendors’ support and data integrity/migration. SMEs must focus on each CSF individually during implementation, however CSF top management support can be ongoing required factor. Following Sun et al. (2005), the CSFs are addressed in terms of cost, schedule and achievement. Addressing CSFs according to cost, schedule and achievement will further elaborate the performance of the CSFs, and can also suggest which CSF(s) are most crucial to successful implementation with highest performance level. In order to find out the total cost, project duration and the results of the implementation, additional data collection will be required to identify and quantify these CSFs within the context of the framework. A questionnaire will be designed to collect additional empirical data such a cost, schedule and achievement. Research sample for this part of the study involve organisations that have implemented ERP systems, however the successful or failed implementation doesn’t matter. Once data is collected and responses will be analysed to observe and build a relationship between dependent and independent variables by using statistical regression analysis. Regression analysis is a statistical tool to study the relation between dependent variable and one or more dependent variables. It

assist in understanding how the typical value of dependent variable changes when anyone of the independent variable is varied, while other independent variables remain constant.

Based on the established relationship between the dependent and independent variables using regression analysis, a simulation model in MS Excel will be developed. The built-in ability to generate random numbers and use them to select values from several probability distributions makes MS Excel excellent tool for conduction simulation of different levels. Spreadsheets in Excel are also very powerful for quickly tabulating results and presenting them using graphs. It is because of this applicability and wide range of function choices that Excel, according to the study, is a vey popular software in simulation modelling and 15 packages (out of 55 simulation packages), almost 27%, have made referral to using the spreadsheet or Microsoft Excel as reporting tool. This shows the strength of MS Excel as used in simulation (Abu-Taieh, E.M.O. and El-Sheikh, 2007). The aim and objective behind designing and developing a simulation model is to imitate a real-world situation mathematically, study its properties and operating characteristics, and finally, to draw conclusions and make action decisions based on the results of the simulation. In this was, the real-life system is not touched until the advantages and disadvantages of what may be a major policy decision are first measured on the system's model. Also, a simulation model like the one proposed here, is useful in clearer understanding of the relationship between CSFs and to encourage exploration of more appropriate implementation strategies.

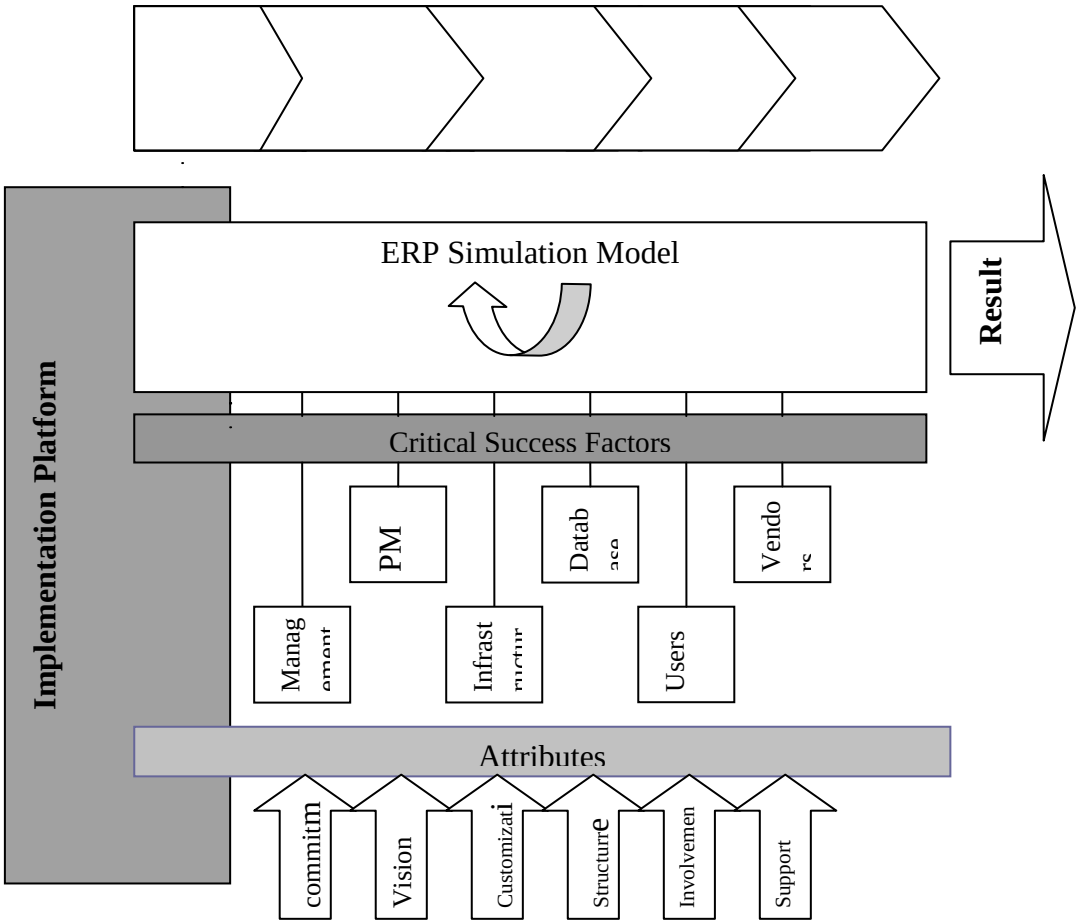


Fig.1 Proposed Simulation Model

Using the model

The dynamic model shown in Fig. 1 has yet to be converted into a simulation model. Once it is developed, different implementation scenarios can be envisaged. For example,

- What would be the point where the each CSF gives optimum performance?
- If the performance of one CSF is low, how it can be compensated by the other critical success factors.

- To find out the overall performance of the systems under different constraints.
- Similarly, how much time and cost is required to reach optimum performance point.

In order to have valid and robust results from the simulation model, it must be replicated many times to get consistent summary results. This can be performed by using Excel procedure called Data Table. The primary use of this procedure in Excel is to plug in different values for a variable in a formula and compute the result each time. The proposed simulation model aims to have 200 built-in replications and the final results will be shown as average cost and achievement of each CSF.

The main advantage of the simulation model, as Shtub (1999) stated, is to assist decision makers in finding a good solution to the problem, by analysis, represented in a model. Using simulation, implementation strategies maybe developed and evaluated to ensure that the pre-defined goals set by a company are satisfied in acceptable manner. Other advantages of simulation modelling may include enhancing the decision maker's ability to handle large-scale or complex problems, shorten time associated with making a decision, improve the reliability of decision processes and outcomes, encouraging exploration or discovery by a decision maker, reveal of stimulate new approaches to thinking about a problem space or context, furnish evidence in support of a decision or confirmation of existing assumptions, and create a strategic or competitive advantage over competing organisation (Holsapple and Sena, 2003). Simulation modelling can also assists in improving the practice by exploring different outcomes, and evaluating and comparing them, thereby leading to improved practice.

Conclusion and future work

ERP system implementation is an important undertaking in an organisational lifecycle. It requires complete transformation of business process and the decision to implement an ERP system in a SME usually has profound impact on the organisation. However, organisations still do so since the promise of internal and external integration is understandably attractive in a world where competition, service excellence, agility and efficiency are defining factors for survival. There exist an abundant body of literature identifying ERP implementation processes and critical success factors. However, vast majority of the studies about CSFs focuses on listing CSFs based on empirical findings. The CSFs identified in these researches help the SMEs to better understand the impacts of the CSFs, however, the extent of these impacts are not clear and SMEs will not be able to make effective interventions in ERP implementations. In order to overcome this problem, few researchers have proposed implementation model based on CSFs, however, these model are theoretical models and lack the practicality of real life. The work presented here addresses this issue by proposing a dynamic ERP implementation model based of the performance of CSFs and their attributes. This proposed simulation model can serve as an implementation guide for any SME considering ERP implementation. Integrating the implementation framework with simulation model and prioritising CSFs, a SME can meet the goals of reducing cost and time, while increasing desired success level.

The model is currently under development and is to be validated via rigorous hands on practicing, real life implementation data and via interviews with users' of ERP systems. Once simulation model fully developed, it is planned to be tested by organisations in the industry. The simulation model not only will assist SMEs in ERP implementation but also can be used

for further research into ERP implementation and users education where different implementation scenarios can be applied and results explored.

References

Abu-taieh, E.M.O. and El Sheikh, A.A.R. (2007) 'Commercial simulation packages: a comparative study', International Journal of Simulation, 8(2), 66-76

Akkermans, H.A. and van Helden, K. (2002) 'Vicious and virtuous cycles in ERP implementation: a case study of interrelations between critical success factors', European Journal of Information Systems, 11, 35-46

Akkermans, H.A., Bogerd, P., Yucesan, E., and van Wassenhove, L.N. (2003) 'The impact of ERP on supply chain management: exploratory findings from a European Delphi study', European journal of Operational Research, 142(2), 284-301

Balakrishnan, N., Render, B., and Stair, R. (2007) Managerial Decision Making with spreadsheet, 2nd edn. Pearson International, New Jersey, NJ

Bernroider, Edwards W.N. (2008) 'IT governance for enterprise resource planning supported by the DeLeone-Mclean model of information system success', Information & Management. 45(5), 257-269

Bingi, P., Sharma, M.K., and Godla, J.K. (1999) 'Critical issues effecting an ERP implementation', Information System Management, 16(3), 7-14

Blumberg, B, Cooper, D R and Schindler, P.S. (2008) Business Research Methods, 2nd edn, McGraw-Hill Education, Berkshire, UK

Bose, I., Pal, R. and Ye, A. (2008) 'ERP and SCM systems integration: The case of a valve manufacture in China', Information and Management, 45, 233-241

Brem, A., Kreusel, N. and Neusser, C. (2008) 'Performance measurement in SMEs: literature review and results from a German case study', Int. journal Globalization and small business, 2(4), 411-427

Bryman, A, and Bell, E. (2003) Business Research Methods, Oxford University Press, Oxford, UK

Buckhout, S.E., Frey, J. and Nemec, J.R. (1999) 'Making ERP succeed; turning fear into promise', Strategy and Business, 2nd Quarter. Booz-Allen and Hamilton http://www.strategy-business.com (assessed on 12th July 2010)

Bullen, C.V. and Rockhart, J.F. (1981) 'A primer on critical success factors', The Rise of Managerial Computing, 383-423

Buonanno, G., Faverio, P., Pigni, F., Ravarini, A., Sciuto, D. and Tagliavini, M. (2005) 'Factors affecting ERP system adoption, A comparative analysis between SMEs and large companies', Journal of Enterprise Information Management, 8 (14), 384-426

Calisir, F., and Calisir, F. (2004) 'The relation of interface usability characteristics, perceived usefulness, and received ease of use to end-user satisfaction with enterprise resource planning (ERP) systems', Computer in Human Behaviour, 20, 505-515

Carlo, M. (2002) 'Enterprise software has to fit like a good suit', Advanced Manufacturing, available at http://www.automationmag.com/erp-software.html (accessed on 13th July 2010)

Cox. J.F. and Blackstones, J.H. (1998) 'APICS Dictionary', 9th ed., APICS, Alexandria, VA

Cresswell, J. W. (2007) Qualitative Inquiry and Research Design, Sage Publishing, London, UK

Davenport, T.H. (2000) Mission Critical: Realizing the promise of Enterprise System, Harvard Business School Press, Boston MA

Deep, A., Guttridge, P., Dani, S. and Burns, N. (2007) 'Investigating factors affecting ERP selection in made-to-order SME sector', Journal of Manufacturing Technology Management, 19(4), 430-446

Eurostat (2007) 'European Business – 2006 edition – Chapter 1: Business economy review', available at: http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-BW-06-001-01/EN/KS-BW-06-001-01-EN-PDF (accessed 22nd June 2008)

Ghauri, N., and Gronhaug, K. (2005) Research Methods in Business Studies: A Practical Guide, 3rd edition, Pearson, London, UK

Gill, J. and Johnson, P. (1997) Research Methods for Managers, 2nd Edn, Paul Chapman Publishing, London, UK

Gimenez, C., and Lourenco, H.R. (2004) 'E-supply chain management: reviews, implications and directions for further research'

Goshal, S.(1987) 'Global Strategy: an organizing framework', Strategic management journal, 8 (5), 425-442

Harland, C.M., Caldwell, N.D., Powell, P. and Zheng, J. (2007) 'Barriers to supply information integration: SMEs adrift of eLands', Journal of Operations Management, 25 (6), 1234-1254

Holland, C.P. and Light, B. (1999) 'Global enterprise planning implementation, in: 32nd International Hawaii Conference: HICSS'99, Big Island, Hawaii, 1999

Huin, S.F. (2004) 'Managing deployment of ERP systems in SMEs using multi-agents',

International Journal of Project Management, 22, 511–517

Huin, S.F., Luong, L.H.S and Abhary, K. (2002) 'Internal supply chain planning determinants in small and medium-sized manufacturers', International Journal of Physical Distribution & Logistics Management, 32 (9), 771-782

Hung, Shin-Yuan; Chang, She-I; and Lee, Pei-Ju (2004) 'Critical Factors of ERP Adoption for Small- and Medium-Sized Enterprises: An Empirical Study', PACIS 2004 Proceedings. *Paper 57*

Hussey, J. and Hussey, R. (1997) Business Research, Macmillan Press, UK

Industry Canada (2006), "Key small business statistics – July 2006)", available at: http://stratgies .ic.gc.ca/epic/site/sbrp-rppe-nsf/en/rd02030e.html (accessed 22nd June 2008)

King, S.F. and Burgess, T.F. (2005) 'Beyond critical success factors: A dynamic model of enterprise system innovation', International Journal of Information Management, 26, 59-69

Koh, Lenny S.C. and, Saad, S.M. (2006) 'Managing uncertainty in ERP-controlled manufacturing environment in SMEs', International Journal of Production Economics, 101(1), 109-127

Koh, Lenny S.C., and Simpson, M. (2005) 'Changes and uncertainty in SME manufacturing environments using ERP', Journal for Manufacturing Technology Management, 16(6), 629-653

Kumar, K. and Van Hillegerber, J. (2000) 'ERP experiences and evolution', Communications of the ACM, (4), 22-26

Lengnick-Hall, C.A., Lengnick-Hall, M.L. and Abdinnour-Helm, S. (2004) 'The role of social and intellectual capital in achieving advantage through enterprise resources planning (ERP) systems', J. Engg. and Technology management, 21, 307-330

Lewis, B. (2001) The 70-percent failure, Infoworld, available at http://www.infoworld.com/articles/op/xml/01/10/29/011029opsurvival.html (accessed on 13th July 2010)

Liang, H., and Xue, Y. (2005) 'Coping with ERP-related contextual issues in SMEs: a vendor's perspective', Journal of Strategic Information Systems, (13)4, 399-415

Love, P.E.D., Irani, Z., Standing, C., Lin, C. and Burn, J.M. (2004) 'The enigma of evaluation: benefits, costs and risks of IT in Australian small-medium-sized enterprises', Information and Management, 42(3), 947-964

Malhotra, R. and Temponi, C. (2009) 'Critical decision for ERP integration: Small business issues', International Journal of Information Management,doi:10.1016/j.ijinfomgt.2009.03.001

Morabito, V., Pace, S. and Previtali, P. (2005) 'ERP Marketing and Italian SMEs', European Management Journal, 23, 590–598

O'kane, J.F. (2003) 'Simulation as an enabler for organizational excellence', Measuring Business Excellence, 7(4), 12-19

Parr A., Shanks G. and Darke P. (1999) 'Identification of necessary factors for successful implementation of ERP systems, In New Information Technologies in Organizational Processes', Ngwenyama, O., Introna, L.D., Myers, M.D. and DeCross, J. (ed.), Kluwer Academic Publishers, Boston, 99–119

Porter, M.E. (1996) What is Strategy? Harvard Business Review 74 (6), 61-78

Raymond, L. and Uwizeyemungu, S. (2007) 'A profile of ERP adoption in manufacturing SMEs', Journal of enterprise information management, 20(4), 487-502

Sarkar, S. and Lee, A.S. (2003) 'Using a case study to test the role of three key social enablers in ERP implementation', Information and Management, 40(8), 813-829

Saunders, M, Lewis, P, and Thornhill, A. (2007) Research Methods for Business Students, 4th Edn, Pearson Education Ltd, Essex, UK

Scalle, C.X. and Cotteleer, M.J. (1999) Enterprise Resources Planning (ERP), Harvard

Business School Publishing, Boston, MA

Schneider, B. and Bowen, D.E. (1995) Winning the service game. Harvard Business School Press, Boston, MA

Shang, S. and Seddon P.B. (2002) 'Assessing and managing the benefits of enterprise systems: the business manager's perspective', Information Systems Journal, 12 (4), 271-299

Shanks, G., Parr, A., Hu, B., Corbitt, B., Thanasankit, T. and Seddon, P. (2000) 'Difference in critical success factors in ERP system implementation in Australia and China: A cultural analysis', European Conference in Information Systems, *Austria*

Sledgianowski, D. and Tafti, M.H.A. (2008) 'SME ERP system sourcing strategies: a case study', Industrial Management & Data Systems, 108(4), 421-36

Somers, T.M. and Nelson, K. (2001) 'The impact of critical success factors across the stages of enterprise resource planning implementation', Proceeding of the 34th Annual Hawaii International Conference on System Sciences, Maui, HI

Sun, A.Y.T., Yazdani, A., and Overend, J.D. (2005) 'Achievement assessment for enterprise resource planning (ERP) system implementation based on critical success factors (CSF)', International Journal of Production Economics, 98 (2), 189-203

Tarn, J.M., Yen, C.D. and Beaumont M. (2002) 'Exploring the rationales for ERP and SCM integration', Industrial Management & Data Systems 102(1), 26-34

US Census Bureau (2004), "Statistics about business size (including small business) from the US Census bureau", available at: www.census.gov/epcd/www/smallbus.html (assessed on 9th July 2010)

Wanatabe, C. and Hobo, M. (2004) 'Creating a firm self-propagating function for advanced innovation oriented projects: lesson from ERP', Technovation, 24(6), 467-481

Wang, E. and Chen, J (2006) 'Effects of internal support and consultant quality on the consulting process and ERP system quality', Decision Support Systems, 42(2), 1029 – 1041

Xie, Y., Hickman, S. and Zhou, L. (2007) 'A critical evaluation of Enterprise Resource Planning (ERP) software sourcing and provision using theoretical construct', Int. Journal of Integrated Supply Management, 3 (4), 327 - 344

Yoon, C. (2008) 'The effect of organizational citizenship behaviours on ERP system success', Computers in Human Behaviour, 25(2), 421-428

Yen, H.R. and Sheu, C. (2004) 'Aligning ERP implementation with competitive priorities of manufacturing firms; An exploratory study', Int. J Production Economics, 92, 207-220