International Journal of Accounting & Information Management

An integrated framework for ERP system implementation

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Received 18 April 2016
Revised 12 July 2016
Accepted 23 August 2016

Abstract

Purpose – The purpose of this paper is to propose an alternative integrated approach based on the stage-gate method to implement enterprise resource planning (ERP) systems which will enhance the effectiveness of ERP projects.

Design/methodology/approach – A literature review was conducted on ERP system implementation and its effectiveness. The need for improving implementation approaches and methodologies was examined. Based on the insights gained, a conceptual framework for ERP system implementation is presented by combining the state-gate approach with the pre-implementation roadmap.

Findings – The proposed framework aims to enhance the overall ERP implementation outcomes, ensuring critical success factors and eliminating common causes of failures. A pre-implementation roadmap is identified as a key element for eliminating many causes of failure including lack of organisations' readiness for ERP. The post-implementation stage can be used for further improvements to the system through internal research and development.

Research limitations/implications – The development of the framework is an attempt to contribute to improving ERP implementation. This research is expected to motivate researchers to work in this area, and it will be beneficial to practicing managers in the identification of opportunities for improvements in ERP systems. Case studies will be valuable to refine and validate the proposed model.

Originality/value – This paper explores research in a needy area and offers a framework to help researchers and practitioners in improving ERP implementation. This framework is expected to reduce the implementation project duration, strengthen critical success factors and minimise common problems of ERP implementation projects.

Keywords ERP implementation, Implementation cycle, Selection methods, System options

Paper type Research paper

Introduction

Over the past two decades, many organisations have implemented enterprise resource planning (ERP) systems across a range of industries for various reasons and motivations with a view to re-engineering business processes at the operational level. ERP systems are business software packages that enable organisations to:

- integrate their business functions (sales, production, human resources, finances, purchasing, etc.);
- share common data, information and knowledge throughout the entire enterprise;
- automate critical parts of its business processes; and
- generate and access information in real-time environment using a single database.

Because these systems are complex and require significant investment of capital and time, effective adoption of such ERP systems is becoming more important than ever

International Journal of Accounting & Information Management
Vol. 25 No. 1, 2017
pp. 91-109

1834-7649
DOI 10.1108/IJAIM-04-2016-0038

before. However, earlier adoption of ERP systems has resulted in many failures, including failure to be fully implemented (Gargeya and Brady, 2005). Thus, there seems to be a strong need for enhancing current implementation practices for better outcomes.

The literature suggests that many ERP projects have not produced the desired results for a variety of reasons (Gargeya and Brady, 2005; Momoh *et al.*, 2010). Thus, there is a strong need for enhancing the effectiveness of ERP projects while being fully aware of problems, shortcomings and their resolutions. Enhancements can be two-fold, namely, improvements to the implementation cycle itself and incorporation of certain pre-implementation activities as part of overall roadmap, which many projects have overlooked in the past. Abdinnour-Helm *et al.* (2003) concluded from a survey that the level of involvement in pre-implementation training with consultants appeared to have little influence on attitudes towards ERP. However, there are many pre-implementation activities which have not been considered in the past and are potential candidates for further investigation for better ERP implementation outcomes.

In this paper, an alternative approach to the current implementation cycle is proposed. The new approach is based on the stage-gate method, which has been successfully used for planning and implementing technology transfer projects. The stage-gate approach is extended by incorporating both pre-implementation and post-implementation activities. In the proposed approach, a pre-implementation roadmap substitutes the first two stages of the stage-gate model. Furthermore, key activities of pre-implementation stage are represented by an analytical hierarchy process (AHP) model, taking relative importance of key activities into consideration. Other stages are modified according to the requirements of ERP implementation and issues associated with current practices.

The reminder of the paper is structured as follows. First, it provides an overview of ERP implementation aspects including common practices, issues and success and failure factors. The stage-gate model is outlined next, with details of each stage and gate and how each stage links with pre-implementation and post-implementation stages. Next, possible deployment of IT in ERP implementation from a technology transfer perspective is discussed. Finally, the paper concludes with findings and future directions.

Overview of enterprise resource planning implementation aspects

ERP systems can bring substantial value for the firm through best business practices, delivered through various functional applications supported by comprehensive process and data integration (Koh *et al.*, 2011). While recognising complexities of ERP system implementation projects, effective implementation can enhance the firm performance (Sense and Kiridena, 2014). Furthermore, recent studies have pointed out that knowledge sharing plays a mediating role linking information systems maturity and firm performance (Rao *et al.*, 2015). It can enhance the business value by increasing investor confidence (Ajit *et al.*, 2014), return-on-assets and return-on-investment, increasing technological competence (Galy and Sauceda, 2014). However, the implementation and adoption of ERP systems across many industries and organisations have resulted in both failures and successes. Implementation of ERP systems in organisational settings has been a topic of research and discussion among many practitioners and researchers (Hwang *et al.*, 2015; Tsai *et al.*, 2011; Peslak, 2006; Sharma *et al.*, 2006; Gargeya and Brady, 2005; Stijn and Wensley, 2001). Many have identified causes of failures, critical issues, critical success factors and areas of improvements in the recent past (Gajic *et al.*, 2014; Al-Mashari and Zairi, 2000;

Amoako-Gyampah, 2004; Ettlie *et al.*, 2005; Kim *et al.*, 2005; Loh and Koh, 2004; Muscatello *et al.*, 2003; Xu *et al.*, 2002; Al-Mashari *et al.*, 2006). Some have even proposed various implementation approaches, methodologies and frameworks for ERP implementations (Norton *et al.*, 2013; Metaxiotis *et al.*, 2005; Schniederjans and Kim, 2003; Chakraborty and Sharma, 2007).

Davenport (2000) describes the major elements of a rational approach to implementing an ERP system. Preparation of people and technical system are two key parts of this approach.

Organisations face similar challenges in implementing ERP systems irrespective of whether it is a total ERP system or selected modules of an ERP system. Implementation has been identified as a key of the ERP projects, compared to development as a key for traditional software development (Sandoe *et al.*, 2001). Implementation itself consists of six phases from initiation to full scale operations (go-live) and initiation plays a significant role in ERP system implementations, especially in the pre-implementation stage (Sandoe *et al.*, 2001; Sumner, 2005). Furthermore, Kale (2000) argues that the implementation cycle can be strengthened by incorporating two aspects, namely, ERP evaluation and selection of the right ERP system for organisational requirements.

Successes and failures of ERP system implementations have been widely cited in the literature, including the high failure rate (Davenport, 2000; Kim *et al.*, 2005). Kim *et al.* (2005) reviews a number of previous implementation projects and concludes that most critical success factors are related to functional coordination problems. Nah *et al.* (2001), through a thorough literature review, identified 11 critical success factors including well-established factors such as top management support (MS): Muscatello *et al.* (2003) based on multiple case studies show that effective executive management is a key success factor for small- and medium-sized enterprises to achieve success in ERP implementation. Abdinnour-Helm *et al.* (2003) conclude from their preliminary studies that employee attitudes are a key factor in determining ERP implementation success or failure. Gargeya and Brady (2005) identify the lack of appropriate culture and organisational (internal) readiness as the most important factor contributing to failure of ERP implementation in 15 companies they studied.

Although ERP implementation is considered to be the largest investment in IT (Davenport, 2000; Huang *et al.*, 2004), treating ERP implementation projects as IT only projects has caused many failures, costing many organisations millions of dollars in lost revenue and in some cases even bankruptcy. While ERP systems are supported by new IT, database and communication technologies, they are not IT systems rather they are application systems (Samaranayake, 2009). Therefore, to increase the level of success, project teams should consist of not only IT personnel of the organisation but also business and management personnel.

The high failure rate of ERP implementation has made a strong case for a better understanding of critical success factors (Zach *et al.*, 2014; Zach and Bjorn, 2012; Somers *et al.*, 2000). Among many critical success factors, business process reengineering and establishing a total quality management culture have identified as key approaches that play important roles in ERP implementation (Hsu *et al.*, 2015; Schniederjans and Kim, 2003). Furthermore, the need for better implementation of ERP systems has led to the focus on improving implementation approaches and methodologies. Metaxiotis *et al.* (2005) have argued that implementation cost and time are reduced, and adoption of the processes makes implementation easier by using goal directed project management (PM) methodology.

Research on the critical success factors and causes of failure for initial and ongoing ERP implementation cases is limited and fragmented (Zach and Bjorn, 2012; Nah and Lau, 2001). Harwood (2003) argues that the problems tend not to be with the technology but with the people. The notion of "people issues" as significant is endorsed by Monk and Wagner (2006)

who states that most challenges to ERP implementation involve managing personnel and their reactions to change rather than managing technical issues. Most of the critical success factors, issues and causes for failure identified in these studies can be addressed and/or linked to one of the phases of the implementation cycle. For example, effective change management is a critical success factor for many ERP implementations when dealing with a lot of changes, in particular "people issues" as a result of behavioural changes. Thus, change management has become part of the implementation cycle. Furthermore, Xu *et al.* (2002) identify data quality as one of the critical issues during the implementation of an ERP system. Stijn and Wensley (2001) argue that process knowledge is an issue where it is either lost or represented in different ways in different parts of the organisation. Because most of these issues are associated with phases of the implementation cycle, implementations can be improved by addressing these issues within the implementation cycle. However, the lack of readiness assessment, identified as one of the key failure factors (Samaranayake, 2005) over many implementation projects, cannot be addressed within implementation phases because it is outside the current implementation cycle. This means readiness assessment needs to be looked at as part of pre-implementation and should be linked with the implementation cycle at appropriate times for better implementation outcomes.

Implementation of information technology projects such as ERP system has been a challenge for companies. Many researchers pointed out that the success of implementation depends upon the available resources and how those resources are mobilised to support the implementation (Barney, 1991; Sirmon *et al.*, 2007; Ferguson and Seow, 2011). In their study of small accounting firm, Pan *et al.* (2014) found that collective leadership and managing change are instrumental in enriching resources in the IT capability development process, whereas effective governance structure, extensive IT knowledge and business experience and stakeholder commitment play a supporting role.

Research on many aspects of ERP projects are either narrowly focused on a particular industry/perspective or considers only part of the implementation phase. Looking at a broader perspective of the implementation cycle, Samaranayake (2006) proposed an alternative to the implementation cycle through not only improvement to phases within the current implementation cycle, including implementation methodology, but also enhancement of the whole implementation cycle by incorporating pre-implementation and post-implementation activities. However, an integrated approach for ERP system implementation, providing a decision-making process with assurance of critical success factors at each stage is still lacking.

It is important to note that many critical success factors are either part of the implementation cycle or linked directly to the implementation, whereas causes of failure are mainly outside the implementation cycle. Furthermore, careful analysis of causes of failure indicates that main failure causes are lack of organisations' readiness and weaknesses of the implementation cycle itself. This strengthens a case for organisations to be involved in the pre-implementation stage, supported by an enhanced implementation cycle if organisations were to eliminate the main causes of implementation failures. This is because an ERP system implementation cycle does not evaluate the organisation's readiness for an ERP and bypasses the feasibility study, along with other associated activities, such as readiness assessment, system options and selection methods. Furthermore, the implementation cycle itself lacks evaluation and monitoring of progress during the implementation. Therefore, it is expected that outcomes of ERP system implementation be enhanced through the stage-gate approach, where pre-implementation activities are incorporated at the respective stage and evaluated for making decisions at the gate before going to the next stage. Thus, this

research focuses on integrating the pre-implementation stage with the stage-gate model for the implementation cycle.

Stage-gate model for enterprise resource planning implementation

The stage-gate model was developed based on the earlier work by Jagoda and Ramanathan (2005). The stage-gate model essentially delineates a complex process into a set of predetermined stages and gates. The stages are made up of prescribed tasks with cross-functional and simultaneous activities. The gate or controlling point is at the entrance to each stage. These checkpoints usually give go/kill/hold/recycle signals to the transfer process (Jagoda and Ramanathan, 2005). At every stage and gate the project team exchanges information with its environment. The stage-gate model for ERP implementation constitutes three levels of stage-gate models, where the pre-implementation roadmap, implementation cycle and post-implementation are represented by respective stages and gates relevant to ERP implementation. The schematic view of such a stage-gate model for an ERP system implementation is shown in Figure 1.

Figure 1 shows the complete stage-gate model for the ERP system implementation, incorporating a pre-implementation roadmap, implementation cycle and post-implementation stage. Depending on the priorities of the firm (ERP system requirements vs cost-benefit analysis), this stage can be initiated with system options or selection methods. Thus, the pre-implementation roadmap is incorporated into the model as a very specific stage-gate. Furthermore, both implementation cycle and post-implementation stage consist of appropriate stages and gates as shown in Figure 1. Apart from stages and gates, there are also loops within the implementation cycle for enhancing the stages involved based on the status of gates.

This stage-gate model presents an integrated approach to the planning and execution of ERP system implementation projects. According to the requirements and competitive landscape of the firm, some stages and gates may be implemented in a short period. The scope and extent of the activities within these stages could change, depending on the nature of the technology involved and could be considered in terms of complexity, cost and other external factors. It is possible to implement the first two stages of the pre-implementation roadmap simultaneously; however, those two stages have to be completed before proceeding to the ERP readiness assessment. In the implementation cycle, firms need to follow the stage-gate sequence as indicated in the model. The post-implementation stage evaluates the impact of the ERP system and acts as the platform for the further refinement and/or maintenance and upgrade of the existing ERP system. It should also be noted that it is not necessary to implement the ERP system in all departments or all functional areas (i.e. marketing, production, human resources, etc.); rather, it can be implemented by individual modules using a phase approach.

It is noted from applications of stage-gate approach across many technology transfer-related projects that the approach can be further improved through careful analysis of the requirements and competitive landscape of the firm (Vieira Junior *et al.*, 2014; Jagoda *et al.*, 2010). Because requirements are fulfilled through various activities in each stage and the competitive landscape of the firm influences the decision maker on the choice at each gate, the need for further refinement of the stage-gate approach is sought. In this regard, it is important to recognise the importance of different weights of activities at each stage, given requirements are not equally important when evaluating criteria for decision-making. To allow for this, activities in selected stages of the proposed approach are evaluated using AHP. The AHP is a multicriteria decision-making approach in which decision criteria are weighted and arranged in a hierarchical structure for making a decision through evaluation of criteria (Saaty, 1990). The AHP considers the relative weight of each criterion/activity at each stage. Based on relative weights of criteria/activities at

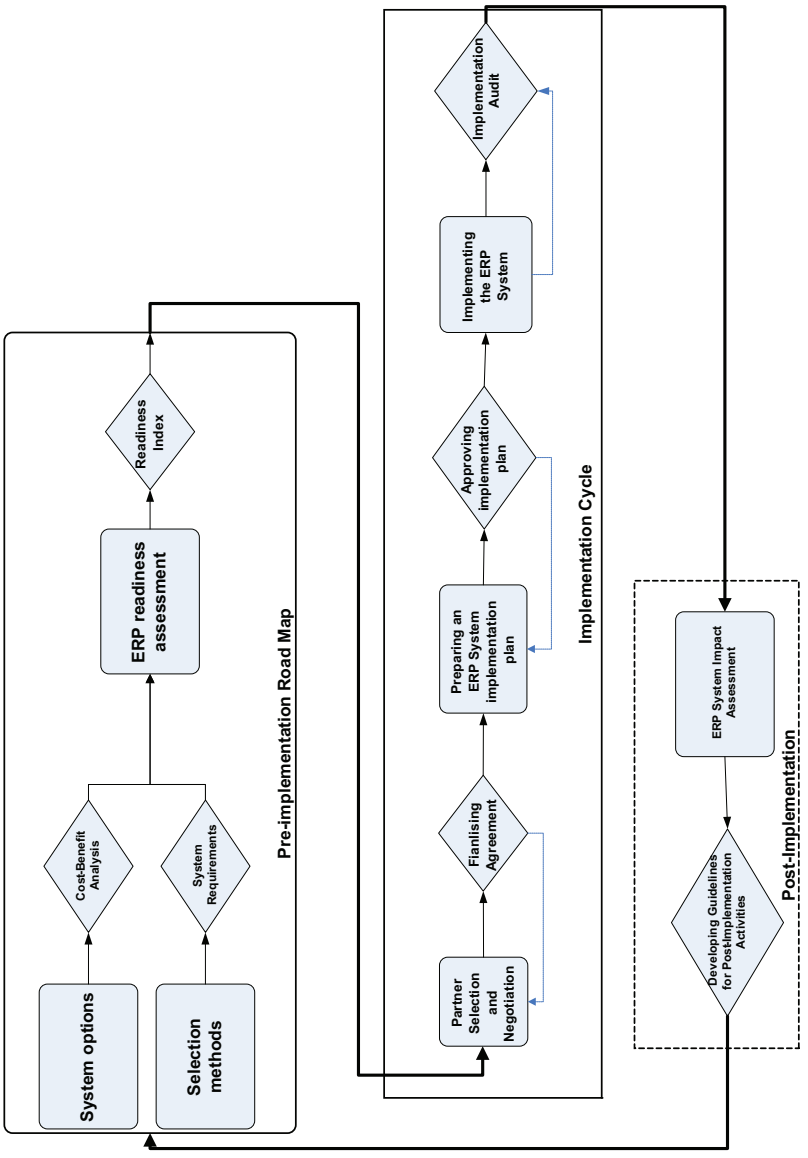

Figure 1.
Stage-gate approach for ERP system implementation

each stage, a weighted index is evaluated for making a decision at each gate. The enhanced stage-gate approach is outlined by incorporating relevant AHP models at selected stages of the implementation cycle.

Pre-implementation roadmap

The pre-implementation roadmap consists of three main components: system options, selection methods and ERP readiness assessment (Olson, 2004; Samaranayake, 2006). These components support each other through links among them, as shown in Figure 1. System options are based on cost-benefit analysis and can provide the best option for initiation of the project within the implementation. Furthermore, selection methods are based on system requirements, whereas readiness assessment is based on selection criteria. Selection criteria can be used to measure the readiness as a percentage for a combination of selected ERP systems with system options.

Olson (2004) discusses various system options available for ERP implementation. Those system options include full implementation (FI) of vendor product, partial implementation (PI) of vendor product, minimal implementation (MI) of vendor product, in-house development (ID) and do nothing (DN). In other words, system options are mainly based on the cost-benefit over a selected period of return rather than ERP system requirements of the organisation. However, the decision on system options can correctly be made if the selection methods based on requirements are evaluated prior to the system options. Also, there can be further enhancements if ERP evaluation is carried out for evaluating different ERP vendors based on three main areas: technical capabilities, operational flexibilities and financial viabilities. Therefore, system options can be incorporated into the stage-gate model where options available are considered in the gate, whereas the decision on the system is considered as the gate for the next stage.

Selection methods are similar to system options but choices in the selection methods are based on requirements and usually consist of a number of options because of the nature of the ERP system's landscape. Main options available for selection methods vary from "develop in-house" to "access to an ERP system through an application service provider (ASP) mode". Because selection methods are based on requirements rather than cost-benefit analysis, the options available in this process are much more than that in system options. Apart from having a full or partial system in the site, it is also possible to have access to what the organisation needs from an external ASP. Similar to system options, selection methods can also be incorporated into the stage-gate model through appropriate stage(s) and gate(s).

ERP readiness assessment is the major part of the pre-implementation roadmap (Samaranayake, 2006). Readiness assessment can be seen as a key for eliminating the main cause of many failures: not knowing the organisation's readiness before embarking on a large or small ERP system implementation project. It also directly links with a number of assessment bases, where each base has a number of characteristics linking with critical success factors. Depending on the assessment basis and the individual characteristics, readiness assessment can take a different score through different weights and ratings on various aspects of the implementation.

Thus, these three components of pre-implementation roadmap can be incorporated into the overall stage-gate model using appropriate stage or gate at each component. To allow for relative importance of each criterion/activity at the pre-implementation stage, enhanced stage-gate model is proposed, by adopting AHP for both system options and readiness assessment stages, where requirements and benefits are considered for making a decision at respective gate. The proposed AHP model with key criteria and sub-criteria comprising of alternatives is shown in Figure 2. Furthermore, the overall pre-implementation roadmap can

also be connected to the implementation cycle with appropriate relations between them. To plan and execute activities within the pre-implementation roadmap as part of the stage-gate model, the organisation needs to establish an ERP Implementation Steering Committee (EISC). It is expected that EISC is involved in activities throughout the implementation including the post-implementation. If necessary, EISC can be expanded by incorporating process and technical experts.

The decision structure shown in Figure 2 involves a single hierarchy with two criteria (requirements and cost/benefit analysis) and five decision alternatives (FI, PI, MI, ID and DN). Depending on the competitive landscape of the firm, the organisation can rank relative importance of two criteria. Once the relative importance of each criterion is identified, the organisation can rank each alternative from a standpoint of requirements and cost/benefit analysis. Once the above ranking is set, ranking of each alternative using composite weight can be evaluated for the final decision on system option. Numerical evaluation of the proposed AHP is not provided because it is beyond the scope of the research presented here.

Similar to the AHP approach for system options stage, readiness assessment can also be considered with a hierarchical decision structure so that the overall pre-implementation stage can be improved. In this case, the decision structure comprises two criteria (requirements and failure/risk analysis) and five alternatives (improvement projects [IP], process-oriented organisation, MS, infrastructure support and PM experience). These five alternatives are considered from a point of prior experience rather than decision variables. For example, prior experience of IP such as business re-engineering can be vital in implementing a brand new ERP system, and therefore its importance can be considered at high level. The resulting hierarchical structure of two criteria and five alternatives is shown in Figure 3.

Depending on the level of requirements and competitive landscape of the firm, the relative importance of requirements and failure/risk analysis can be decided. Careful analysis of prior

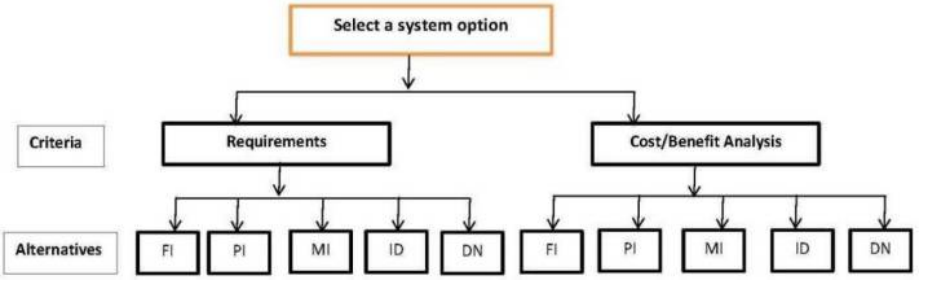

Figure 2.
Hierarchical structure of system options

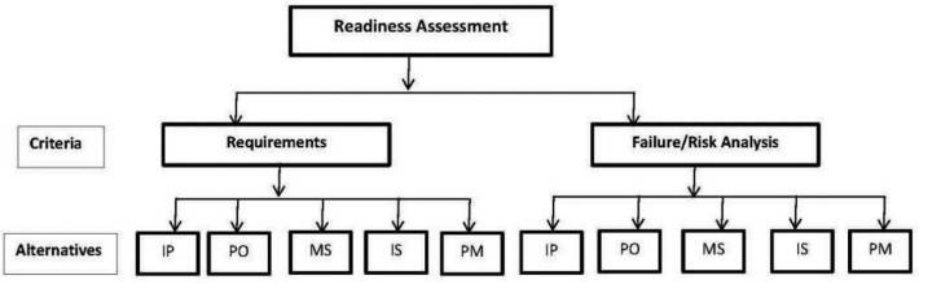

Figure 3.
Hierarchical structure of readiness assessment

experience of each alternative and its relevance to the level of implementation preferred, relative importance of each alternative can be decided. Once relative importance of individual alternatives and criteria are set, ranking of each alternative using composite weight can be evaluated for the final decision on readiness assessment as part of overall pre-implementation stage and subsequent decision at the gate.

Implementation cycle

The implementation cycle consists of three stages: partner selection and negotiation, preparation of an ERP system implementation plan and implementation of the ERP system. Three gates – finalising agreement, approving implementation plan and implementation audit – follow the stages. These components follow the stage-gate approach as shown in Figure 1. At each stage, prescribed and mandatory activities are done, and, at the gate, decision is taken to go/no-go/hold or recycles. If the activities are not carried out satisfactorily at the stage, EISC will take decisions at the gate to revisit the activities at the stage.

Partner selection and negotiation is a critical stage, where the EISC selects and negotiates with the potential ERP system vendors, hardware vendors and implementation partners. Based on the recommendations made in the pre-implementation cycle, a clear set of specifications must first be developed for the ERP system and hardware being sought. Based on these specifications, EISC develops a shortlist of potential vendors and partners that can deliver the required ERP system and its implementation. If the negotiations with the first vendor do not lead to a satisfactory outcome, then the EISC may move to the next. The outcomes of this stage will significantly determine how the ERP project will proceed and under what conditions. Furthermore, the terms agreed upon can have far reaching implications for all parties.

Traditionally, ERP system and associated technology negotiations have been adversarial in nature, but, in a globalised setting, a "win-win" approach based on trust and understanding are likely to produce better outcomes. The main activities in this stage are the following:

- developing a preferred vendor profile, focusing on desired ERP functional capabilities, experience in ERP projects, business strategy, past performance and cross-cultural expertise;
- developing a list of firms that are capable of providing the desired ERP system, initiating communication and gathering information in accordance with the vendor profile criteria;
- agreeing upon a basis for the evaluation of the ERP system and components and reaching agreement on issues related to payments and intellectual property protection;
- reaching agreement on each party's contribution and responsibilities towards the ERP project;
- reaching agreement on issues and methods related to the knowledge transfer methods including training and documentation;
- establishing effective channels of communication among all parties;
- reaching agreement upon payment amounts, procedures, and time-frames; and
- preparing a detailed ERP system implementation agreement based on the outcomes of the above-mentioned activities.

The finalising agreement gate is initiated once the EISC has reached an agreement with an ERP vendor and other parties. Once all parties have expressed the desire to finalise the ERP system implementation, EISC, with the consultation of all parties, draws up a legal agreement. Even in its simplest form, such an agreement should contain the exact identity of the parties involved, subject matter of the implementation, protection of intellectual property, the scope of implementation, payment structure, vendor's obligations, system users' obligations and obligations common to all parties.

At the beginning of the stage, preparing an ERP system implementation plan, a vendor for the ERP system would have been chosen. This stage is based on the premise that the creation of a sound organisational infrastructure is critical to the implementation of an ERP system. The activities during this stage are aimed at preparing the user organisation to receive the new system and include the following:

- identifying changes to be made to the organisational structure and work design based on an understanding of the ERP functional components;
- identifying changes to be made in the knowledge management system and policy regimes to accommodate the new ERP system;
- developing pragmatic training and education schedules for the workforce that matches with the functional components to be implemented;
- formulating measures to build good relationships between the ERP vendor personnel and consulting partner;
- formulating a realistic ERP project implementation plan that can form the basis of a working relationship between the ERP vendor and the user; and
- reaching agreement upon milestones to help strengthen PM and control.

At the approving the implementation plan gate, top management will carefully evaluate the project schedule and may suggest refinements to the EISC. Specific areas that may be carefully scrutinised are adequacy of training, validity of the suggestions made for the modification of the organisational infrastructure, adequacy of intellectual property protection measures, durations of critical activities, sufficiency of quality assurance procedures and affordability of payment schedules. If these are satisfactory, then a go-ahead signal may be given. Top management may also approve an initial payment to the vendor if such a payment has been specified in the agreement.

ERP system implementation requires rigorous PM practices because of the size and complexities involved. Training is a key area throughout the implementation and must proceed without delay. Furthermore, the timely arrival of all software, hardware and consulting services is essential to ensure go-live as planned. Based on traditional implementation activities (Sandoe *et al.*, 2001), the following activities have been identified as critical and important for the success of ERP system implementation projects:

- identifying configuration changes to be made to the system to suit local business conditions and making the necessary adaptations;
- recruiting skilled personnel not already available within the organisation and conducting training programs for existing staff;
- developing an improved remuneration plan to facilitate change management;
- formulating arrangements with ancillary vendors of software and hardware components and services based on in-house or out-sourced decision; and
- go-live the ERP system on or before schedule.

Implementation audit gate is aimed at gaining an understanding of barriers to the successful implementation of ERP systems. Top management may set up an internal audit committee or an external auditor to compile an audit report outlining lessons learned. The report may focus on the implementation experience with respect to critical success factors such as commitment displayed by both the user and the vendor, conflicts experienced, maintenance of time-frame integrity, costs incurred, quality achieved, extent of learning and skill upgrading, new knowledge generated and communication effectiveness.

Post-implementation stage

This stage is incorporated as part of the complete model for overall ERP system implementation methodology. This is largely outside the main activity of the ERP system implementation, where tasks are limited to system maintenance, system upgrades and database backups. Planning such activities can be incorporated into the only stage associated with this activity. Assessing the impact of an ERP project is difficult because it is a complex process with multiple outcomes that could emerge throughout the life of a project. Also, the intangible benefits of an ERP project are difficult to evaluate. It would be prudent to use a balanced scorecard approach to assess the impacts of an ERP project from financial, technological and organisational perspectives (Chand *et al.*, 2005).

The following activities may be carried out at this stage:

- assessing the actual outcomes of the ERP project from financial, technological and organisational perspectives;
- identifying variances (if applicable) between actual and expected outcomes and the reasons for the variances;
- evaluating the adequacy of corrective measures that were implemented to correct adverse variances;
- examining the feasibility of improving the ERP system functionality; and
- identifying new or complementary systems such as supply chain management (SCM) and customer relationship management (CRM) that could be incorporated into the current solution.

Completion of all of the above activities reaches the post-implementation gate. At this gate, important decisions have to be made as to whether to continue to use the ERP system by adding other functionalities incrementally or go for ERP system upgrades. A successful ERP project could lead to a strong relationship between the partners and new projects could be initiated. In such a situation, guidelines may be formulated by top management in consultation with the EISC for postimplementation activities such as global roll-out of the phase of implementation, adding complementary applications (SCM, CRM, etc.), improving the system through internal research and development, or using a mix of all in partnership with the ERP vendor.

Deployment of information technology in enterprise resource planning implementation

It was noted in the literature that most of ERP implementation failures were caused by treating ERP systems as IT systems and limiting the scope of IT PM (Peslak, 2006; Velcu, 2007). By contrast, ERP systems are much more than IT systems, and, therefore, successful implementation of an ERP system requires broader IT involvement (Robey *et al.*, 2006). This means that ERP system implementations require deployment of many IT tools and techniques. Because the proposed approach for ERP implementation is supported by a stage-gate model,

which is a technology transfer approach, IT deployment is considered to be core element of overall implementation project. Irrespective of the size (small or large ERP implementation), IT plays a major role in planning and executing the activities involved.

Earlier work by Davenport (2000) identified a number of opportunities for using IT in various projects within organisational contexts, including technology transfer. Many of those impacts can be used advantageously in planning and implementing an ERP system. A major concern in many ERP projects is the cost involved in implementing such a system across the entire organisation. Both software and hardware vendors, and users of ERP system, are interested in finding approaches to reduce the overall costs.

Another reason for the interest in IT deployment for ERP implementation is that many ERP projects take considerable time to complete. The shortening of life cycles and frequent changes in the marketplace have made it imperative for the user and the vendor to complete the implementation project as quickly as possible so that benefits can start flowing before the system is upgraded. The use of IT, especially the new communication and information exchange technologies, has the potential to reduce the time taken for selection, negotiation, transfer scheduling and implementation stages. The following section outlines the potential use of the various IT tools and systems at each stage, which can be effectively used in planning and implementing ERP systems, using stage-gate approach.

Partner selection, negotiation and finalising agreement

The frequent contact and communication between both parties are imperative to ensure an effective negotiation process (Huang *et al.*, 2004; Jagoda *et al.*, 2010). This can become problematic if the vendor and buyer or other parties are located in different countries or are geographically separated within the same country. While videoconferencing or other social media based systems can be used during the negotiation stage, currently, privately hosted electronic arbitration rooms are being established for the use of the legal and business community that can be used for negotiations and beyond (Ramanathan, 2001).

Lyytinen *et al.* (2006) have advocated the use of a variety of IT-enabled tools such as on-line search of patent databases, research web-sites, mega search engines, directories and on-line libraries, push technology (such as PointCast), web-based surveys, social media groups and trade mailing lists for identifying potential vendors and buyers of ERP systems. This will help the managers to reduce the cost of finding partners and time spent in negotiating with the potential partners.

Preparing and approving an enterprise resource planning system implementation plan

Adequate training is essential to upgrade the technological capabilities of the buyer. Traditional means of training require the physical movement of personnel between the vendor and buyer facilities, frequent travel and allocation of considerable time for training and travel. The time and cost outlay associated with all this often force buyers, especially those from developing countries, to rely more on learning-by-doing. While the scope and the content of the training has to be decided by experts, currently, the staggering developments in communications technologies and social media make it possible to deliver training through powerful formats very quickly (Burn and Ash, 2005; Ngai *et al.*, 2015; Trimi *et al.*, 2005; Ramanathan, 2001).

Internet-based conferencing tools such as Internet Relay Chat allow real-time conferencing between the transferor and the transferee in a global context at a much lower cost. This can help the parties to rectify problematic areas of the project and undertake corrective measures before proceeding to the next stage. At this stage, the parties may decide to initiate steps to establish a better Intranet, which can help to use EDI at the next stage.

Implementing the enterprise resource planning system and implementation audit

Development of a sound infrastructure should be carried out simultaneously during installation and start-up, and this may consist of developing a vendor network for components, a pool of trained workers and staff, logistics channels and other external aspects, in all of which modern telecommunications may be handy (Robey *et al.*, 2006). During implementation, as pointed out by Lyytinen *et al.* (2006), Extranet, teleconferencing, internet-based telephone services and mobile computing systems can all be utilised to gain quick access for assistance and advice from transferor experts to solve problems collaboratively. Integrated PM software with internet, extranet and mobile communication systems may also be used to estimate, schedule and organise day-to-day activities (Lyytinen *et al.*, 2006; Sommer, 2003) during the implementation stage.

At the gate the key role of IT interventions would be to use intranets, databases, e-mail, the internet and groupware to gather information expeditiously to measure actual performance against the expected results and finalise the audit. Monitoring of operations may be in the form of periodic intensive reviews. The findings can be disseminated widely through IT interventions that have already been discussed above.

IT interventions can be valuable in gathering information for impact assessment. Teleconferencing and video conferencing may be used to connect to remote experts (Lyytinen *et al.*, 2006) and ascertain their views. With regard to consolidating the gains of the transfer project, the transferor may deliver information on updates of the existing technology or new technologies via e-mail, video mail and computer-based conferencing.

If the transferor and transferee have come this far they may well decide to go for a new IT project or an extension of the existing agreement. It may be worthwhile for both parties to consider implementing a collaborative advanced IT infrastructure for supporting effective transfer. If the buyer decides to go for a new ERP system, they can use IT to exploit a variety of sources for opportunities.

Managerial implications

While ERP systems are expected to improve the organisational performance and operational capabilities, the complexity of the process integration often leads to difficulties and failures (Ram *et al.*, 2014; Beheshti and Beheshti, 2010). Effective implementation requires careful planning and execution of key processes. Recent literature suggests that training and education and system integration activities are critical to obtain the desired competitive advantage (Ram *et al.*, 2014; Chien *et al.*, 2014; Sudhaman and Thangavel, 2015) and should be integrated to implementation plans. We believe that the proposed stage-gate approach would assist managers to navigate the complex implementation in three ways. First, it will assist the managers to carefully plan the activities at each stage. The proposed approach will help to identify the critical activities needed to be completed at each stage before committing resources to the next stage. Second, it helps them to critically evaluate the activities at each stage before moving to the next stage. If they have not completed the activities to a satisfactory level, then they can make the necessary adjustments or corrections. To evaluate the performance at each stage the quantitative modelling approaches such as AHP can be used as shown in the earlier section. Third, it assists the managers to document and evaluate the overall project success and to identify any adjustments to be made for the future projects.

The outcomes of this research have the following major implications:

- The proposed stage-gate model addresses the need for integrated approach for ERP implementation. It brings together the three important phases of ERP implementation

Table I.
Deployment of IT in ERP implementation

Stage/gate	Potential activities with IT deployment	IT Systems and tools
Partner selection and negotiation/agreement finalisation	Agreeing on the value of the ERP system, terms of payment and intellectual property protection	Privately hosted electronic arbitration rooms with multipoint videoconferencing
	Developing a preferred vendor profile	On-line search engines, patent databases, research web-sites, meta-search engines, directories, on-line libraries, digital versatile discs (DVDs), push technology (such as PointCast)
	Developing a list of potential vendor firms	Internet telephony, videoconferencing and teleconferencing
Preparing implementation plan/approving implementation plan	Developing pragmatic training and education schedule for the workforce	Training modules using multimedia technology (CD-ROMs, DVD-ROMs, computer-based multimedia simulation software, multimedia extranet, e-mails and video mails, mobile communication, and teleconferencing etc.)
	Formulating measures to build good relationships between the ERP vendor and implementation partner	Internet-based conferencing tools, such as IRC (Internet Relay Chat)
Implementing the ERP system/implementation audit	Identifying configuration changes to be made to the ERP system to suit local conditions and making the necessary adaptations	Business process modelling tools for mapping the current practices with ERP system's blueprint
	Recruiting skilled personnel not already available within the organisation	Extranet, teleconferencing, internet-based telephone service and mobile computing systems for communications among implementation partners and users
	Formulating arrangements with hardware and DBMS vendors	Online recruitment through designated websites and video conferencing for interviewing potential candidates
		Email and video mail systems for scheduling and organising day-to-day activities during the implementation stage
ERP system impact assessment/developing guidelines for post ERP activities	Assessing the actual outcomes of the ERP project	Teleconferencing and video conferencing for connecting with remote experts and ascertaining their views
	Evaluating the adequacy of corrective measures	E-mail, video mail and computer-based conferencing for consolidating the ERP system implementation progress
	Identifying new or complementary technologies	Use of online market research firms such as @plan (www.webplan.net) for acquiring business intelligence

project: pre-implementation roadmap, implementation phase and the post implementation. It also established the linkages among each phase. This model is also useful to educate the managers of the ERP implementation process.

- Managers involved in ERP implementation process can use this model as the basis for planning the project with clear goals and the project charter. Each stage-gate consists of key activities and criteria for decision-making, especially at the pre-implementation stage where managers can develop a check list to make the process effective.
- This paper also discussed the use of a wide range of information and communication technologies available for the managers to address two main issues of any ERP projects: time and cost. We outlined various IT tools managers can use to reduce the time and cost of the ERP projects.

Conclusions

It is evident from broader discussion that the literature on ERP system implementation is often sparse when it comes to managerial issues, technical details or internal organisational processes that can influence the effectiveness of the implementation. The integrated model based on the stage-gate approach presented in this paper is a preliminary attempt to meet that need. The model is built on the concept of stage-gate, where each stage is identified with relevant activities. Essentially, the stage-gate model proposed is based on the premise that if managers of an ERP system implementation project use the proposed stage-gate sequence and carry out the recommended activities, then problems can be minimised, and, wherever needed, proactive action can be taken to avoid problems. This paper also made a preliminary attempt to examine the deployment of IT for enhancing the effectiveness of ERP system implementation. The deployment options have been examined in conjunction with the different stages and gates at the implementation cycle to enable a systematic examination of the various possibilities. However, such deployment has to be considered in the light of some important issues. This model was developed based on the existing literature. Therefore, case studies that assess the usefulness of this model are valuable. Future research will involve developing a detailed questionnaire to investigate the application of this model in ERP projects (Table I).

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