



Managing The Full Erp Life-Cycle: Considerations Of Maintenance And Support Requirements And It Governance Practice As Integral Elements Of The Formula For Successful Erp Adoption

By: Chuck C.H. Law, **Charlie C. Chen**, Bruce J.P. Wu

Abstract

Companies adopting enterprise resource planning (ERP) systems have often focused primarily on implementation-related factors while neglecting those of post-implementation. As a result, the usefulness and operation of the ERP systems, once installed, are compromised. This research adopted a case study approach to demonstrate that ERP adoption efforts that fail to pay attention to post-implementation requirements (especially those relevant to maintenance and support (M&S)) from an early stage in the project lifecycle will face dire consequences. It points out that poor planning and management of M&S services can imperil the normal operations of an ERP system and the daily activities of a business. With the life span of ERP systems getting shorter, sound M&S practices can extend their life and create a stable system platform to support efficient and effective business operations. M&S issues deserve to be considered as integral elements among the critical success factors (CSF) of ERP adoption projects. In other words, ERP success requires a full lifecycle perspective to be taken by adopting companies. With lessons having been learned from the mistakes in the first project, the company in this case study revamped its ERP implementation second time out, with due consideration being given to M&S strategies and practices from project initiation onward in order to realize a stable, usable, and maintainable system. The case study explores and identifies the critical success factors (CSF) of ERP adoption, and shows that M&S must be included as a key element from the outset and throughout the system lifecycle. Our findings capture a great deal of experience for any ERP adopting companies to follow in order to avoid learning costly lessons both in implementation and subsequent M&S throughout the lifespan of the system. A set of propositions is also presented for academic researcher to consider in future ERP research endeavors.

1. Introduction

The successful implementation of enterprise resource planning (ERP) systems can create competitive advantages for companies which adopt them. With product life span becoming increasingly shorter, the installation of an ERP system alone cannot sustain competitive advantage unless it is properly maintained and allowed to evolve to satisfy new business requirements. In other words, the perspectives and practices of project management must be extended to encompass post-implementation activities in the ERP lifecycle. Maintenance and support (M&S) services, as an intrinsic part of an ERP system, can improve its quality and extend its life span. High quality M&S can result in the system having a

profound and lasting impact on adopters' competitive advantage [17].

The extant academic and practitioner literature centers mostly on adoption and implementation issues, ranging from ERP-process fit, business process re-engineering (BPR), and implementation methodologies to organizational impacts [26]. Post-implementation issues are as important as matters concerning adoption, yet they are often under-researched [26]. Such issues encompass ongoing requirements, change management, user support, and maintenance and upgrade of ERP systems. As Glass and Vessey [14] point out, the total post-implementation cost, including maintenance, of a piece of software could be as high as 70% of the total cost, and annual M&S could amount to 25% of the cost of implementation. This shows how important M&S is to ERP as well as to other types of software systems. It is therefore critical for companies and other stakeholders to fully understand and manage maintenance issues so as to devise appropriate measures to

address problems, mitigate interruptions to daily operations, and extend the life and benefits of the enormous investment made in ERP systems [25].

This study set out to investigate, analyze, and report on the strategies, challenges, and practices of ERP adoption and maintenance in a multinational firm operating in the Greater China region, which comprises Taiwan, China, Macao, and Hong Kong. We consider the full ERP lifecycle of the projects with a focus on M&S issues, since we believe the requirements of the latter are of paramount importance [26] to the success of implementing as well as operating the system. Using ERP projects as examples, this study will explore the linkage between implementation and M&S, and highlight the impact of the latter on the success of implementation and operations. While ERP implementation issues have been discussed widely in the extant literature, M&S issues tend not to be. Therefore, the results of an extensive review of the literature are reported in section two. In this section, we attempt to summarize key conceptual and practical issues pertinent to the M&S of ERP, all of which made a significant contribution to defining the focus and objectives of the study. The methodology adopted to operationalize this study is discussed in the third section, followed by a detailed description of the ERP experience of the company studied in section four. Based on an analysis of the case study, section five identifies and discusses eight critical success factors (CSF) and their implications, so far as relevant, to the M&S of ERP. Along with the CSF, a set of propositions is also presented. The academic contributions and limitations of this study, and directions for future research, are presented in section six while section seven sets out our concluding remarks.

2. Review of relevant issues and framework of the study

2.1. Stages of the ERP lifecycle

ERP systems can be deployed in a big-bang or phased approach, either of which initiates the stages of a system's project lifecycle. According to the staged implementation model [20], the project lifecycle consists of four phases—adaptation, acceptance, routinization, and infusion. The last two phases – routinization and infusion – are the post-implementation stages that are most relevant to this study, though they cannot be examined without reference to the practices and decisions of previous phases.

Routinization is the stage where ERP is assimilated into the routine activities of an organization. The infusion phase is where the next innovation is sought or any disordered situations (such as bugs, outdated drivers, incompatible hardware and software, and unfamiliarity of new users with the system) are corrected. A substantial number of activities and players need to be actively involved throughout the lifecycle of an ERP system. The infusion stage must not be treated lightly since the maintenance and evolution of the installed system must be handled properly to

fulfill emerging business requirements. Other researchers have also expressed similar opinions. For instance, Markus and Tanis' [23] four-phase model consists of stages labeled chartering, project, shake-down, and onwards and upwards. The shake-down phase is the one in which corrective actions are taken to stabilize the system for routine operations [23]. The fourth (onwards and upwards) phase is aimed at providing ongoing maintenance, user support, and upgrades to the system [23]. Thus, the infusion process is one of the critical elements that deserve our attention [29].

2.2. Important issues in ERP adoption and maintenance

The ERP phenomenon has been considered a very important one, resulting in many studies in the last decade of the critical issues or success factors for adoption. Issues and CSF identified in these studies range from those relating to organizational and project management to implementation strategy and human resources [8,26,28]. However, it has been pointed out [26] that the volume of ERP studies concentrates mainly on the pre-implementation and implementation phases, with little discussion of post-implementation. While we expect that readers would have little problem accessing a comprehensive list of implementation issues and factors, we present below a discussion of the issues that are relevant to the M&S of ERP systems, with a summary displayed in Table 1.

Three major issues can arise very early in the ERP lifecycle: (1) the extent of customization; (2) the choice between in-house implementation, use of external consultants, or total outsourcing; and (3) the management of conflicts of interest between stakeholders. These issues often carry forward into the infusion stage in which the adopting company may need to decide on the degree of customization to be allowed in order to narrow functionality gaps, satisfy emerging user requirements, and strike a balance between competing demands from users in the post-implementation stage. It also has to decide whether to rely on expensive external expertise for implementation and M&S activities, or to develop its own in-house capacity. These decisions will have a substantial impact on the practices and costs of M&S, and the recruitment, development, and retention of the internal human resources essential for successful system operation. Failing to address these major issues will adversely affect normal business operations, possibly leading to dire consequences for the company.

2.2.1. Strategic decision about the extent of ERP customization

The extent of customization of the ERP system is a strategic decision that can affect the costs and risks of implementation, and the ongoing maintenance and upgrade of the system [11]. The rapidly changing business environment creates a need for frequent updates to the system to meet business needs. Customization of an ERP package means changing the software to fit business

Table 1
Key issues relevant to ERP maintenance and support.

Issues	Studies
• Customization refers to modifications made to the native features of an ERP product. They may include modifications to user interfaces, reports, messages and even program codes, and additions of bolt-on logic to the native system	[12]
• In contrast, a "vanilla" implementation of ERP system does not allow any modifications to the native systems. The system is to be set up to meet the needs of the adopting company using configuration tables and parameters supplied by the native system.	[28,33,40]
• Customization increases the risks and costs to the implementation and maintenance of an ERP project.	[5,11]
• Customization creates hurdles for on-going maintenance and support of an ERP system. For instance, it creates difficulty for the ERP system's migration to a newer release, and it is costly to retain customizations created in the past.	[5,19,22]
• Some researchers and consultants suggest to eliminate customizations before migrating to new releases.	[5]
• Unlike that of traditional proprietary systems developed in-house, ERP implementation and maintenance is in many circumstances vendor-driven. ERP vendors will continue to distribute software patches for "bug fixes", and new enhanced releases, which may be incompatible to any in-house customizations made to the older releases.	[24,25]
• ERP vendors will cease to support older versions of their ERP products after a period of time subsequent to the launch of new releases	[5]

requirements through the modification of output, user interfaces, and even program codes; or by the addition of bolt-on functionality to the native features [12]. Unfortunately, ERP packages are very complicated, and, therefore, difficult for MIS practitioners in organizations adopting them to comprehend. This characteristic renders any customization task an enormous challenge to the consultants and MIS practitioners of the adopting organization [12], not to mention the fact that many ERP vendors such as Oracle will not make source code available to clients.

Over the past years, many ERP consultants and researchers have pointed out that too much customization increases the costs and risks of implementation [11, 16]. According to Beatty and Williams [5], customization causes system developers and business analysts a great deal of time and effort, and can be considered a “ROI killer.” Moreover, modifications to the ERP functionality also pose difficulties for software upgrades and migration to future releases [7, 19]. Thus, it is wise to avoid making customizations in the first place, and to eliminate them before migrating and upgrading to a new release of the ERP product [5].

Consequently, the potential risks of customization have discouraged many companies from changing program code or adding bolt-on functionality to the native systems. Instead, many resort to configuring their ERP systems using the parameters and tables provided by, and reengineering their business processes to align with, the package’s native features. Unless customization is adequately justified at the strategic level, it is often the last choice for adopting companies.

2.2.2. ERP maintenance and the client–vendor relationship

The ongoing upgrade, maintenance, and support of ERP systems differ significantly from a traditional in-house software system, and many companies have underestimated the M&S efforts required to make the ERP system work. The difference between the maintenance of traditional in-house systems and that of ERP systems is obvious when the relevant activities and practices are compared. In maintaining the former, the internal MIS team can usually handle the activities independently. It can successfully deal with routine maintenance (such as correcting logic errors), but may find adaptive maintenance (such as revising or enhancing systems to satisfy user requirements) somewhat more challenging [38]. Important M&S issues arising from in-house software solutions include feature enhancement and extensions, competing demands for programmer time, quality of documentation [21], support interface, software properties, business rules [10], user support [1], and preventive maintenance [9, 36]. These activities are usually handled by MIS staff, except in circumstances in which the expertise of external consultants is sought. By and large, the adopting company has control over the key decisions about enhancements and the timing of producing newer versions of the software.

Unlike the implementation of in-house developed application systems, ERP package adoption and maintenance is not a task manageable by any client organization on its own. An anatomy of the activities of ERP M&S shows that it is not solely an internal matter. ERP activities are often affected by the vendor’s technical support services, distribution of software patches, and also minor and major software releases [25]. A study by Ng et al. [25] on ERP M&S classifies maintenance requests into nine categories. Some of these are purely in-house issues, and some are vendor-driven [24, 25]. In-house M&S comprise enhancement, adaptive, corrective, and user support activities. Vendor-driven M&S include “functional upgrade/minor enhancement,” “patch maintenance-standard,” “patch maintenance-adaptive,” “patch maintenance-corrective,” and “technical upgrade” activities [25]. The choice between outsourcing, relying totally on in-house resources, or adopting a hybrid arrangement depends very much on the complexity of the requirements and the availability of resources.

In any case, ERP vendors’ product plans and support policies may affect the M&S practices and outcomes of their clients. Consequently, establishing a close relationship between client and vendor is indispensable to the success of ERP implementation and subsequent M&S. As ERP consultants are often eager to point out, it is difficult to sever the tie between vendor and client since the former’s product releases have a significant bearing on the future of the latter’s installations. ERP-adopting companies often place a higher perceived value on vendors’ abilities to provide ongoing upgrade and maintenance of their products with a guaranteed level of service quality. Furthermore, the alternative, of incorporating incremental modifications and bolt-on modules to the existing ERP system, is beyond the internal capability of most non-IT companies [4].

2.2.3. Vendor’s role and implications for customization and maintenance of ERP

Companies often select an ERP vendor based on the location of its services and its abilities and policies towards providing implementation services and ongoing upgrades and product maintenance. The negative side of total outsourcing is the tremendous cost of obtaining the vendor’s services in implementation and M&S. Regardless of whether a total outsourcing solution is sought, most companies use some form of consulting services from the vendor or its partner organizations. In-house staff are often assigned to a joint project team to work side by side with external consultants [18].

In general, many ERP adopting organizations subscribe to the vendor’s M&S service. The rationale behind this is twofold. Firstly, ERP expertise is precious to many client organizations, and a subscription to the vendor’s M&S program is an important means for client organizations to secure such expertise when needed. Secondly, it entitles a company to support services, software patches, and new releases in the future. ERP products are “continuously evolving in terms of technology and functionality” [19], and therefore, new releases are continually launched to the market. In recent years, researchers have noticed a trend for ERP vendors to launch new software releases more frequently. In the 1990s, the interval between ERP releases was approximately 3 years, but this has recently declined to 1.5–2 years [5]. That means a release will be removed from the support list sooner than before. Meanwhile, ERP adopting companies have to face pressure from vendors who are only too eager to convince users to migrate to a newer release of the software [34]. Needless to say, these vendor-provided services do not come cheap, with related charges rising by 15–22% in recent years [34]. Despite the cost, many clients continue to subscribe to such services since the saving obtained from severing the tie with the vendor may not justify the risk and cost of doing so.

The implications of the vendor’s services and product offerings for the client are profound when viewed from the perspectives of cost, expertise, and the technical feasibility of ERP customization and maintenance. Firstly, it must be noted that the decision about customization must be handled cautiously since too much in either the implementation or post-implementation stages can jeopardize the whole ERP system [11]. With the scarcity and high turnover rate of ERP skills, in-house customizations can pose many threats to the quality of the system implemented, and to the success of M&S at the infusion stage. Therefore, these companies have intentionally kept any types of modifications to their ERP systems to the minimum (a “vanilla” approach), and instead rely on enhancements made by the vendor in future releases [28, 40].

2.2.4. Infrastructure and organizational issues

Organizational and contextual factors must be observed and managed in any information technology and systems adoption

project, and their importance must not be underestimated in the post-implementation period. A successful ERP M&S practice needs to actively engage IS staff, vendors, users, and executives to work together throughout the project lifecycle, and particularly at the infusion stage. The need for close co-operation among many stakeholders carries forward from the implementation to the post-implementation stage, and a high level of coordination and sharing of information and knowledge is vital. However, differences between stakeholders in terms of knowledge, interest, expectations [32], and problem-solving approaches [2] may, unsurprisingly, result in conflict from time to time. These differences lead to more uncertainty in the infusion stage of the ERP project, and increase the challenge of managing the M&S process. The management of ERP adopting companies must be sensitive to these issues and establish mechanisms to resolve any political and business issues arising from stakeholder conflicts.

Other resource issues may further aggravate ERP M&S problems. For instance, any changes (such as patches and enhancements) to the systems must be tested thoroughly so that their impact in the test instance can be assessed before they are applied to the production instance [40]. Therefore, it is critical for ERP adopters to invest in additional hardware and software platforms to support M&S practices. On the other hand, the high turnover rate of ERP skills has seriously jeopardized many projects. The development and retention of a balanced set of ERP skills will remain an important challenge in post-implementation.

The quality and availability of training is another critical factor to the success of post-implementation activities. User training, tailored specifically to the company’s business processes and practices, and the quality of training materials and user manuals, can make a significant contribution to the development of in-house skills for operating and maintaining the ERP system. The usability dimensions of such training manuals (such as task support, learnability, navigation, and presentation format) deserve a great deal of attention [31]. In summary, the presence of a combination of these factors may profoundly affect the success of ERP M&S.

2.3. Research objectives and framework

The literature review presented above sheds light on the important issues that must be carefully considered and managed in the implementation and maintenance of ERP systems. Obviously,

some of the issues or CSF reviewed here are not unique to a single phase of the ERP lifecycle, but are common to more than one. For instance, issues regarding business process changes and ERP customization need to be considered from the earliest initiation of an ERP project, and similar issues may resurface throughout the lifecycle of the system. The decisions and practices implemented earlier concerning such matters may have a profound impact on M&S activities. Thus, a study of ERP M&S issues and factors must examine those arising in post-implementation as well as in earlier phases of the system lifecycle.

Although our review has not resulted in an exhaustive list of issues, what is highlighted and discussed above has, to a significant extent, affected the focus and objectives of this study. In summary, its primary objectives are threefold. Firstly, it examines the strategies and practices of ERP M&S in an ERP adopting company, and the impact of the strategies and practices implemented at earlier stages on the M&S of the system in the remainder of its lifecycle. Secondly, based on a comparison of the experience of the two ERP projects in the company, we attempt to identify a set of CSF relevant to M&S that emerge across the various phases. Thirdly, a set of propositions for future research is presented. The research framework of this study is presented in Fig. 1 below.

3. Research methodology

This research project is aimed at understanding the “what” and “how” aspects of M&S as integral parts of the whole ERP lifecycle. Because of the nature of this type of study, we believe a case study approach has the potential to provide insight into these issues in a real-life context [6] and allows us to explore topics that are not yet well understood [41].

For this research, we chose an American-based multinational company which is one of the major world producers of process control systems. It provides a total solution (including hardware, software, and consulting services) for the automation needs of customers in the industrial and building management sectors in North America, Europe, and Asia/Pacific. In recent years, it has established a strong presence in the Greater China region, comprising China, Hong Kong, Macao, and Taiwan.

The company was chosen because it met the following important criteria. Firstly, it employs a sizeable workforce (with more than 1000 employees in Greater China) and has implemented

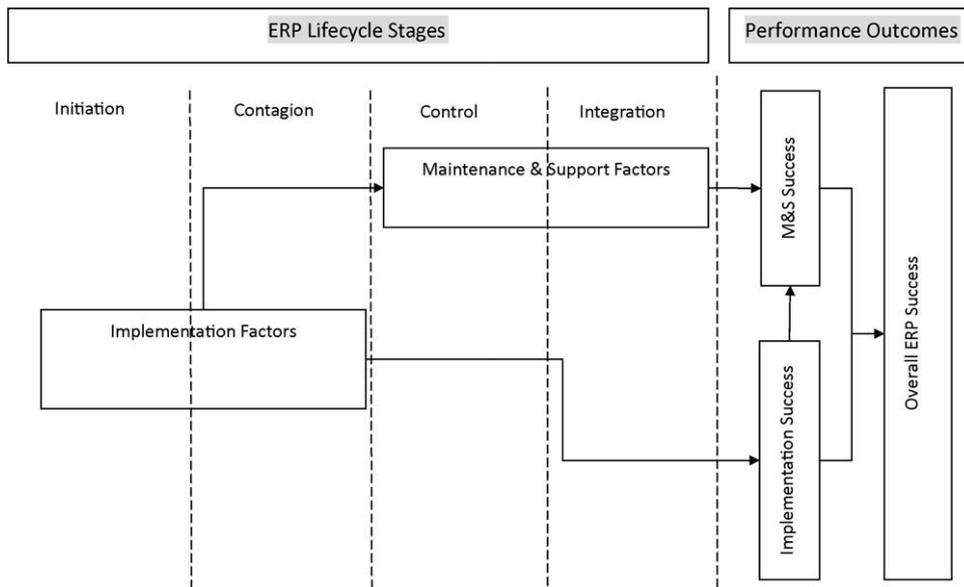


Fig. 1. Research framework.

multiple modules of a well-known international ERP product. We tend to think that smaller firms lack sophistication and complexity in terms of their organizational environment, business processes and practices, and ERP installations. A larger firm is more endowed with these complexities and thus is better positioned to provide a realistic picture of ERP M&S practices. Secondly, the executives of the company were supportive of our research after hearing our description of the primary objectives of the study. We wish to stress that the interviewees' positive attitude and support for academic research has greatly reduced the challenge of collecting accurate and reliable information critical to the success of the study.

Generally speaking, multiple case studies (about four to six) are preferred in order to generalize research findings [41]. Admittedly, a single case study is limited in terms of the external validity of its findings. However, considering that the primary objective of this study is not to produce generalizations, but to uncover the ERP M&S practices of a company, we decided to adopt the single case study approach as our research method. We are confident that this contributes to the success of the study by allowing us to focus on the critical issues within a single setting. It is hoped that this has yielded an in-depth understanding of the ERP M&S experience of this company which may be shared by other adopters in future. The international company selected has operations across countries and can, to some extent, provide a broader picture of ERP implementation and M&S practices not only in the Greater China region but also in other locations. The company also provides us with a research context and an important opportunity to compare its experience in two consecutive ERP projects [28]. The findings of this study can therefore yield insights into major ERP M&S issues and how they were managed in one real world situation. Based on the analysis of the information gathered, we shall highlight the CSF relevant to successful ERP maintenance, and the intertwining relationships between them.

3.1. Research design

According to the staged model of ERP implementation [27], design and implementation decisions made at the early stages of the project life cycle have an impact on M&S at the infusion stage. For instance, a firm's strategic decision on ERP customization or business process adaptation in the planning phase can have a profound impact on M&S practices later. A time-variant view of the entire ERP project life cycle (including adaptation, acceptance, routinization, and infusion stages) from different stakeholders can help enhance our understanding of the complexity of ERP M&S implementation.

CSF can narrow executives' focus on an enterprise's limited and precious resources in order to ensure effective competitive performance [30]. It is a widely accepted methodology in the field of IS to address the resource constraints present within most organizations [8]. We have adopted the CSF methodology to discuss the critical elements of M&S based on this real-life case study.

When conducting interviews, the researchers selected interviewees with different backgrounds, and used consistent procedures, including semi-structured and open-ended questionnaires, follow-up phone calls, and email exchanges, to collect and validate information. The data captured in these activities was triangulated using documentation released by the company. We used semi-structured and open-ended questions to capture the complexity of ERP implementation and operations with the emphasis on M&S practices at the infusion stage. Open-ended questions are a more suitable approach for exploring issues that are less well understood, and to minimize social desirability effects. This approach provided opportunities to engage participants with the researchers during in-depth discussions on subject matter well beyond the

expected level. Other benefits may include mitigating interviewer bias, justifying the logical flow between interviewee statements and CSF findings, and validating CSFs with the interviewees.

3.2. Sources of data

We first contacted the Director of MIS of the company (Greater China region), who later actively assisted us in soliciting support from other participants. In addition to the Director of MIS, the Director of Supply and Customer Services and six employees from MIS and other departments (namely, one business application manager, one senior systems analyst, one procurement manager, one sales and marketing manager, one salesman, and one warehouse supervisor) were interviewed. All interviewees had extensive experience in the use of ERP systems in their daily jobs.

We also interviewed non-MIS executives and staff as a means to validate the information collected from their MIS counterparts. We considered the interviewees from the supply chain department as very important because their functional unit spanned a wide range of operational responsibilities critical to the performance of the company. Since the Greater China strategic business units (SBU) and staff functions reported to the American corporate and SBU headquarters through a matrix reporting relationship, business and IT strategies and decisions made in headquarters affected international operations. While our focus was on the ERP projects of the Greater China operation, we also captured information in the interviews about similar issues in headquarters and other locations. However, we did not interview any executives or professionals outside the Greater China region. Such information is still valuable since it helps us understand the background and challenges faced by the leaders of MIS and the other units in Greater China.

The interviews were conducted in two rounds of site visits. The first was brief, lasting less than an hour, and was done in order to collect basic company information in advance of the actual interviews. It also provided an opportunity for the researchers and interviewees to begin to get to know each other and establish rapport, which might be conducive to subsequent meetings. Documentation collected in this visit included IT strategies, ERP project plans, user request samples, procedures and guidelines, and internal customer satisfaction surveys. Project financial information, considered sensitive by the company, was not released to the researchers.

The second site visit occurred one week later. The researchers interviewed participants using the semi-structured questionnaire with open-ended questions. Interview notes were prepared by the researchers and reviewed by the interviewees. Additional issues were followed up through telephone discussions and electronic mail communications. The information collected from the interviews was then triangulated with the documents.

4. The ERP M&S practices of the international company

With its headquarters located in Hong Kong, the business units of the company in the Greater China region provide to its customers industrial and building control systems, spare parts, and consulting services via its sales forces, joint ventures, and distributors. Its revenue in this region amounts approximately to US\$ 250 million annually.

In this study, we analyzed the evolution of two ERP implementations with the emphasis on M&S issues, based on Nolan's Stage Model of Organizational Computing [27]. At the initiation stage, champions initiate a technological project with the financial and resource support of sponsors. Anxieties, problems, and sometimes crises emerge to slow the progress of the project at the contagion stage. Disordered situations are solved at the control

stage. The adopting organization then accepts the technology and integrates it into normal operations.

4.1. *The experiences of the first ERP project*

The management of the Asia/Pacific headquarters had recognized an urgent need to replace legacy sales and distribution systems with an ERP system to enhance the visibility of its business operations in the region. In Greater China, the responsibility for managing the ERP implementation project was assigned to the MIS department, which had to deploy the systems for the business units in Hong Kong, Taiwan, and China, following the IT strategies and ERP standards established by the corporate IT team. With insufficient IT resources and limited knowledge of ERP, the MIS department needed to rely on expensive external expertise. Consultants were hired from the consulting division of the Hong Kong office of the ERP vendor on a time and materials basis. The corporate headquarters decided to adopt the vanilla ERP approach, by which modifications to the purchased system are kept to a minimum to reduce risks [33]. Therefore, the Greater China region followed this approach.

Many problems arose when the American SBUs deployed their ERP systems, and similar issues appeared also in the Greater China project. Though vanilla implementation was intended, the management also understood that it was politically difficult to enforce the strategy fully. Users within SBUs in the United States and other countries often demanded specific functionality beyond the core features. The vanilla approach was soon compromised when corporate management allowed SBUs to customize their ERP systems through adding bolt-on functionality. The process of incorporating add-on features was loosely defined and not systematic. A flood of user requests came in and were often poorly prioritized. Similar problems also mushroomed in the Greater China region. Because of the matrix reporting relationships between international operations and the American SBUs, any decisions by the latter to adopt a bolt-on module would gradually trickle down to the Greater China SBUs.

4.1.1. *Initiation stage*

SBUs in the United States contracted a consulting partner of the ERP vendor to develop two bolt-on modules to meet their specific needs for customization. The first was a back-to-back ordering system. Some American SBUs installed it only to find that the module was plagued by problems of data consistency and integration with the native ERP systems. The second module was an interface for a third party project management system which had been selected as the corporate standard. Poor project management practices hindered the interface from delivering on time and within budget.

Such problems encountered by SBUs in the United States led the Greater China management team to suspend its installation plan for these two bolt-on modules. However, the Greater China MIS team had to cope with another challenge. Taxation requirements in Taiwan are greatly different from those in Hong Kong and China. The original ERP package was not able to fulfill country-specific requirements. Mandatory requirements to do business in Taiwan called for customization by adding bolt-on taxation features. Consultants provided advice and customization solutions with respect to the functionalities required in this taxation module. These resulted in some structural changes to the database schema of the original system to support the bolt-on logic, including the additions of new columns to tables of the existing database and the creation of new tables.

4.1.2. *Contagion stage*

The SBUs and the MIS team in the Greater China region lacked experience in ERP implementations, so unanticipated problems

continued to rise. There was too little involvement from senior management, and from the users of business and functional areas, in different tasks of the project; especially in business process analysis and redesign. Poor project management practices, as seen in the United States SBUs, continued in this region. The steering committee in this region, chaired by the MIS Director, had limited authority to decide on the systems requirements and business process changes. Senior executives were reluctant to participate. When they did join the meetings, they expressed no interest and showed little involvement in implementation and post-implementation issues. Resistance from the SBUs and functional areas was high. The BPR required to accommodate the new ERP module did not succeed without user cooperation. Consequently, business processes were not improved or redesigned before setting up the ERP systems. Business processes within the Greater China region were not standardized across the individual territories. All locations retained legacy localized business practices and processes, which were often inefficient. Heavy reliance on printed reports, as in the pre-ERP era, further aggravated the localization issue. The plan to replace legacy practices and processes with an ERP system to integrate operations and information across functions and SBUs was not realized. These limitations also increased difficulties in maintaining and supporting systems and users. For instance, it took MIS staff more time and effort to learn to support the different business processes and the ERP instances, which were configured differently. They struggled to develop three sets of reports to meet the requirements of users across Greater China. Worse still, the highly customized Taiwan taxation module was very unstable. Although the company had subscribed to the ERP vendor's global technical support program, the technical support center refused to offer any support services since the taxation module had been customized. The mistakes made in ERP implementation sowed the seeds for more problems in the post-implementation stage.

4.1.3. *Control stage*

The first ERP implementation was a disaster, and created serious resentment among the MIS department and other stakeholders. Severe criticisms from management and users resulted in the resignation of the MIS Director and several system analysts. The crisis worsened at this point. The company recruited a new MIS director nine months later in order to resolve this crisis and rebuild the MIS function within the organization. In response to the limited availability of well qualified MIS staff, the new director established a prioritization committee to manage the very large backlog of user requests. It was facilitated by either the MIS Director or the Business Application Manager. Each of the functional areas or SBUs assigned a representative (who was either an experienced operational staff member or a middle manager) to help establish priorities for the user requests. The establishment of the committee benefited the company in two important ways. Firstly, it institutionalized a scope management control policy to deal with user problems and M&S needs, which had stakeholder support. Under this arrangement, user requests with lower urgency would be resolved when the system was redeployed and the MIS team would focus only on urgent requests, such as bug corrections or those having a high business impact, which needed to be resolved immediately. Secondly, it provided an organizational structure to improve the relationship between the MIS function and its clients, and a mechanism to allocate resources fairly and facilitate communications across the various functional and business units. With this committee, the crises that had occurred earlier were contained and controlled. The Business Application Manager's comments on the contribution of the committee may be paraphrased as follows:

MIS must assume a leadership role and avoid being seen as shirking its responsibility in managing these difficult situations. We offered our clients any assistance needed as much as possible, and facilitated the process of user request prioritization and resources allocation. In this committee, the needs, difficulties and opinions of all representatives are heard.

4.1.4. Integration

After the chaotic situation had subsided and the situation was under control, redeployment of the ERP modules was a high priority. The MIS Director recommended that the systems be re-implemented since the business processes and systems had been so poorly designed and implemented in the past. Redeployment would also mean losing all customizations that had been done so far. The MIS Director and the steering committee officially ended the first, ill-defined, vanilla ERP implementation, and embarked on a second.

4.2. Experiences of the second ERP project

4.2.1. Initiation stage

The MIS Director and the prioritization committee defined three milestones for the second ERP project. This strategy won the full support of the IT steering committee (chaired by the Managing Director, with members drawn from the top management team). The first milestone was to redeploy and replace the poorly installed modules and customizations (like the Taiwan taxation module) within ten to twelve months. The second called for the implementation of the native project accounting module to support the businesses in the region; while the third was to add in native manufacturing modules. In order to avoid or mitigate the problems encountered in the first ERP installation, the MIS Director decided to adopt a stricter and better defined vanilla implementation strategy. The second project involved two critical strategies. Firstly, the system was to be deployed following a more rigid vanilla ERP approach by which customizations would be minimized to the greatest possible extent and would be permitted only in exceptional circumstances. The rationale behind this approach was to make use of native ERP features and to align the system with the ERP vendor's product and upgrade plans and support services as much as possible. Secondly, the Greater China region needed to redesign its business processes. The drivers for this were not only to narrow the gap between business processes and the native functionality of the ERP package, but also to establish a set of core processes common to the company's business across Hong Kong, Taiwan, and the Chinese mainland. This would improve operational efficiency and ease the task of supporting the various processes. Consequently, at least 85% of the business processes of SBUs of Taiwan, Hong Kong, and China became common. This arrangement made it easier to set up and support the ERP instances for the three sub-regions.

4.2.2. Contagion stage

A strictly enforced vanilla implementation approach resulted in an ERP installation with no or minimal customizations. This made it easier to apply software patches and upgrades released by the vendor, and so made the job of upgrade and maintenance more manageable.

In comparison to the first project, the vanilla ERP approach was highly enforced in the second implementation. The company practiced scope management to control the extent of customization. Such requests would be approved only when the core ERP functionality failed to satisfy critical business requirements. For any customization request raised, the prioritization committee would conduct an assessment of the business impact and risks. On the basis of this it would then either reject the request or agree to submit it (with justifications) to the IT steering committee for final

approval by senior executives. After these rounds of assessments and debate, the MIS team, with the support of the prioritization committee, recommended that the plan to add bolt-on modules of back-to-back ordering and project management systems to the native ERP system be abandoned. It also rejected an offer from an Australian SBU to share its consultant-developed project accounting system. The Greater China region preferred the native project accounting module for reasons of seamless integration and easy maintenance.

4.2.3. Control stage

The MIS Director reached an agreement with the Taiwan office of the ERP vendor to produce a localized version of the native taxation module to replace the previous, highly customized, functionality. According to the agreement, the company paid only a proportion of the development cost. As the resulting module was a legitimate product produced by the vendor's Taiwan office, the vendor was willing to actively provide M&S services to the company. The resolution of this matter allowed the company to be entitled to technical support and new releases as long as it subscribed to the global support program.

The above was a good example of how the company was able to avoid or control the proliferation of customization requests while still considering the needs and risks associated with ongoing M&S, and the roles of the ERP vendor. On the other hand, the MIS Director improved the company's control over the selection and management of external expertise. Unlike the first, the second ERP project no longer relied on a single source of external expertise. External consultants were selected and recruited by matching their specific skills and experience against the requirements of the ERP modules. While some consultants were hired from the vendor's consulting division, many were recruited (at a lower hourly rate) from a smaller consulting firm which had been established by former principal consultants of the vendor. Consultants' responsibilities were clearly defined by work schedules and estimates against which actual deliverables were measured. Hours reported on time sheets would be questioned if they deviated significantly from the amount of work completed.

The prioritization committee continued to exist as a formal organizational structure to manage user requests for M&S services to the ERP system. In comparison with previous arrangements, procedures and criteria for the prioritization and management of user requests were systematized and clearly defined in the second project. User requests could be submitted either online or offline. The helpdesk would review them to determine their level of criticality. Requests at the highest level of severity/urgency were resolved immediately so as not to jeopardize the operations of the system and the business. Urgent requests included bugs in the ERP software, any problems relating to "stuck" or incomplete transactions, and problems with the technical infrastructure. Other types of user requests were forwarded to the prioritization committee, which scheduled them within other priorities. Examples of such requests included changes to messages and user interfaces, development of online and batch reports, enhancements to existing modules as a result of changing business requirements, and implementation of new modules. The Business Application Manager's comments can be paraphrased as below:

We established a set of clearly defined procedures and guidelines for the prioritization committee and helpdesk activities. The documentation not only helped us ensure that M&S activities were handled consistently, but also to educate MIS and non-MIS staff about the processes of handling customer support and of prioritization and resources allocation. Doubtlessly, it was very important to carefully assess the risks and business impacts associated with the user requests, and the

reviews might find that some of the required activities would also call for other related activities. For example, a complaint about an ERP feature from the user might indicate that there was a need for informal or formal training for the user, or improvement to user documentation. A patch or version upgrade might also result in a need to upgrade the network, operating systems, or servers.

4.2.4. Integration

ERP M&S practices were successfully incorporated into the daily operations of the firm to support business activities. For instance, the helpdesk systems tracked the status of M&S activities and problem-solving history. Training courses for managers, users, and IT staff were organized on a regular basis by the MIS department to meet the needs arising from different phases of the project. Knowledge transfer was one of the critical issues for the MIS team in order to avoid the mistakes of the first project. Therefore, MIS personnel worked closely with external consultants to learn to support the system in the post-implementation period. The MIS Director also signed a contract with the small independent consulting firm referred to above to retain its services for a minimal number of work hours per week. This allowed the MIS team to make use of external expertise while minimizing expenditure on consulting services. In case of emergency or when implementing new modules, work hours would be increased at a discounted rate.

During the implementation and post-implementation periods, monthly and quarterly performance analysis reports relating to user requests were generated for review by the users and middle managers of all functional areas. The prioritization committee in the second ERP project differed significantly from before. It now played an increasingly proactive role in identifying and managing both the strategic and operational issues regarding changing business requirements and ERP features. The positive comments of the Director of Supply and Customer Services can be paraphrased below:

We are working in a very dynamic business environment, in which changing business requirements often require new systems functionality. Our team was disconnected from MIS and other functional areas in the past and lacked an understanding of what we can and cannot do. The prioritization committee provides a mechanism for critical operational and strategic issues to be reviewed and addressed by all stakeholders. It allows us to consider our local requirements in the light of the overall picture of the firm.

In summary, the more satisfactory experience of deploying and supporting the second ERP installation was very much due to the approach and practices which had been implemented, as reflected by the comments of the MIS Director:

Success in the deployment, and M&S, of an ERP system requires a lot of preparation in many areas. For instance, you need a new thinking and approach, ERP expertise, and supporting infrastructure. A proper infrastructure must encompass clearly defined procedures, helpdesk systems, and the methods for prioritizing user requests and allocating resources. In the second project, our success has much to do with the fact that ERP M&S is viewed as an integral element of TQM (total quality management). We consider that sound change management practice is fundamental to success in maintaining the business processes and ERP system. Using the prioritization committee and the IT steering committee, we manage to make sure that our resources are not overly absorbed by mundane day-to-day support activities at the expenses of strategic requirements. It provides a means for us to look beyond our current needs and prepare for the future.

Fifteen months after the redeployed ERP system became operational, the interviewees told the researchers that they considered the system a great improvement over the previous installation in terms of stability and usability. They were also satisfied with the improved business processes, and with how user requests were managed. Technical support for this ERP installation was much simpler than for the first. As in other ERP projects, the MIS department usually had to handle a large number of M&S requests in the early months of system operations. It was estimated that M&S requests from end users alone consumed 70–80% of the resources of the application systems team in the first seven to eight months of operations. The proper prioritization and scope management processes implemented by the MIS team helped gradually reduce the number of user requests. By eliminating customizations, the process of tracing system bugs and seeking support from the ERP vendor's global technical support center became much easier and more effective. The MIS team could apply software patches or upgrade to a newer software release without having to worry about causing new errors or losing the customized features.

The prioritization process of user requests was now incorporated as a critical part of change management practice. The expanded scope of ERP M&S, to include both strategic and operational aspects, is tantamount to an admission that M&S has been repositioned to a higher status. The M&S practice and mechanisms implemented have made possible multi-directional communications between senior management, operational staff, and middle managers in various organizational units. The experience of the first and second implementations of ERP in the Greater China units of this multinational company can be summarized as in [Table 2](#) below.

5. Analysis and findings

An analysis of the experience of the two ERP projects clearly points to a set of factors or issues that must be managed properly in order for the implementation and maintenance of the ERP system to be successful. It is obvious that many of the CSF are not exclusive to only one stage of the lifecycle. Some issues or factors appeared early, and the decisions made about them would have a profound impact on the whole project. Although the list of factors we have identified is not exhaustive, we believe our findings capture a subset of very important factors critical for the successful M&S of an ERP system. These should be interpreted as additions to the CSF that have already been reported in the ERP adoption literature [8,26]. The second ERP project has also demonstrated that the proper planning and management of M&S is as critical as that of implementation requirements in order to achieve the goal of a stable and usable ERP system. Consequently, our understanding of ERP M&S, derived from this case study, has led to a set of propositions for consideration by ERP researchers.

5.1. Summary of findings and CSF identified

The experience of the first and second implementations of ERP in this international company was summarized in [Table 2](#) above. By comparing the experiences of both projects, a framework of eight CSF for ERP M&S may be developed as shown in [Fig. 2](#).

The CSF included in the framework are: "M&S CSF 1: Implementation Strategy," "M&S CSF 2: Organization & Infrastructure," "M&S CSF 3: Client-Vendor Alignment & Co-operation," "M&S CSF 4: Support & Participation," "M&S CSF 5: Ability to Leverage ERP Expertise from Multiple Sources," "M&S CSF 6: Communication & Co-ordination," "M&S CSF 7: M&S Strategy and Focuses," and "M&S CSF 8: Quality of ERP Implementation."

Table 2

Evolution of ERP implementations at the international firm.

Stages	Phase I: Loosely Controlled “Vanilla” ERP (2000–2002)	Phase II: Strictly Controlled “Vanilla” ERP (2003–2005)
Initiation	<ul style="list-style-type: none"> • Champion: MIS leader. (Senior management assigned responsibility to MIS, but provided limited support.) • Strategy: Loosely enforced with customization allowed • Drivers <ul style="list-style-type: none"> ◦ Retire legacy system ◦ Local business requirements 	<ul style="list-style-type: none"> • Champion: Managing director. (MD played critical role to ensure active involvement of stakeholders.) • Strategy: More rigidly enforced to minimize customization • Drivers <ul style="list-style-type: none"> ◦ Failure of the first ERP implementation project. ◦ System ineffectiveness
Contagion	<p><i>Strategic Level</i></p> <ul style="list-style-type: none"> • Vanilla ERP strategy compromised <p><i>Operational Level</i></p> <p><i>United States</i></p> <ul style="list-style-type: none"> • Data incompatibility between bolt-on modules and the native system • Poor project management practices to deliver bolt-on modules <p><i>The Greater China Region</i></p> <ul style="list-style-type: none"> • Local requirements for the taxation module for Taiwan. • Underestimate the extent of corresponding changes brought by the customized taxation module • Poor user support • Little support from the senior management 	<p><i>Strategic Level</i></p> <ul style="list-style-type: none"> • Redesign of operational business process • Minimize the extent of customizations <p><i>Operational Level</i></p> <p><i>United States</i></p> <ul style="list-style-type: none"> • Extent of customization • Disagreement on priority of adding adds-on modules <p><i>The Greater China Region</i></p> <ul style="list-style-type: none"> • Seeking the co-operation of the ERP vendor’s local branch to localize the ERP package to comply with taxation requirements in Taiwan, and provide on-going support to the legitimate localized taxation module.
Control	<ul style="list-style-type: none"> • Hire a new MIS director • Form a committee • Involve users from all functional areas into the M&S activities • Priority control with scope management policy and practices 	<ul style="list-style-type: none"> • Prioritization committee formed • Strict screening process • Closely work with external consultants and ERP vendor.
Integration	<ul style="list-style-type: none"> • Attempt to fix problems of the installed ERP system. • Redeployment of the ERP modules 	<ul style="list-style-type: none"> • Integrated with daily operational processes, which were simplified and improved.

The company’s vanilla approach to ERP implementation was only loosely enforced in the first project, which led not only to implementation issues but also to difficulty with M&S. The Taiwan taxation module was highly customized, causing many support problems and obstacles to utilizing the support services and software patches available, even though the company had subscribed to the vendor’s expensive M&S programme. Learning from the difficulties encountered in the first implementation, the company changed its approach in the second. That resulted in a more rigidly enforced vanilla approach (M&S CSF 1). Minimal customizations were allowed and then only with strong justification and senior management approval (M&S CSF 1). An explicit M&S strategy (M&S CSF 7), which aligned better with the vendor’s services and its product strategies and practice (M&S CSF 3), were

conceived and established. By minimizing customizations, implementation risks were also reduced. An important implication for other ERP adopting organizations is that before customization is approved and implemented, an organization must assess the associated risks and business benefits, and the potential impact on future maintenance [22].

Learning from the first ERP project improved the company’s second project through process redesign and standardization, improved project management practice, rigorous quality assurance, and increased support and involvement from all levels of personnel. This has resulted in a stable and highly usable ERP system. This positive project outcome is critical for the effective performance of M&S activities in the later stages (M&S CSF 8). The above-mentioned strategies were also supported by the use of

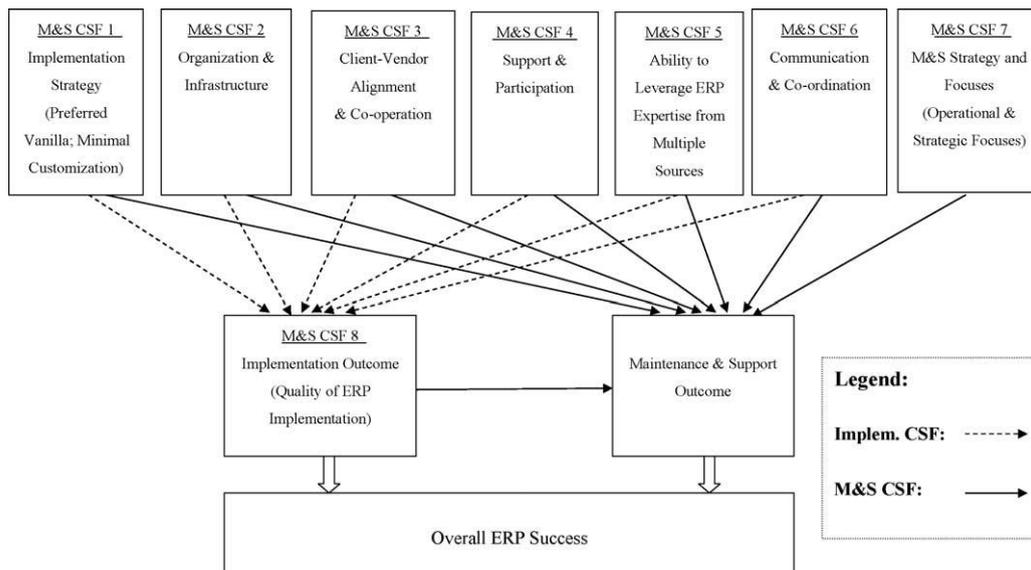


Fig. 2. A framework of critical success factors for ERP implementation and M&S.

multiple sources of ERP expertise to safeguard against turnover of MIS employees (M&S CSF 5). In the first ERP project, external expertise and skill transfer were not properly managed, while such mistakes were corrected in the second project. In preparation for the post-implementation phase of the ERP lifecycle, emphasis was placed on the training of in-house MIS staff and skill transfer from external consultants (M&S CSF 5). In spite of such measures, the company decided to retain the consulting firm to offer a limited number of service hours after ERP roll-out, while trying to minimize the costs of external consultants. The implication is that the company would have an ongoing and co-operative relationship with the consultancy, which could offer help in emergency situations or when a particular skill requirement arose. An ERP is a suite of complicated systems involving a wide range of knowledge and skills that would pose a great challenge to most companies. The company's practice of not relying only on a single source of ERP expertise, but in the meantime curtailing consulting expenses, could be a valuable experience for other adopters.

Most companies have limited resources and it is therefore important to set priorities so as to maximize business impact and minimize risks. One of the insurmountable challenges facing MIS departments is the huge backlog of user requests from various business and functional areas. It is impossible, and indeed sometimes dangerous, to try to satisfy all these requests. Resources possessed by any company are precious, limited in supply, and must be devoted to productive use to yield the greatest benefits. Honoring requests from some users but rejecting others often leads to customer relationship problems. While a true consensus among the requesters of services is next to impossible, it is essential to have senior executives or a committee set the priorities which will achieve maximum benefits for the company rather than individual departments [39]. The roles assumed by the company's prioritization and steering committees are good examples of successful customer relationship management for other MIS departments, while allocating resources only to urgent user requests or those with the greatest business impact. The formalization of M&S practice, as manifested in the organizational structures (prioritization and steering committees), and clearly defined roles and responsibilities (such as those of the process owners), contributed to the operation and execution of M&S activities (M&S CSF 2). On the other hand, the documented procedures, guidelines, and automated helpdesk systems, working in conjunction with the organizational structural elements, provided a well-managed environment in which stakeholders were empowered to perform their jobs (M&S CSF 2). In fact, these organizational structures were also conducive to the improvement in communication and coordination (M&S CSF 6) among MIS, functional units, and all levels of personnel. These measures led to an increased level of support and participation by the stakeholders (M&S CSF 4). As demonstrated by this case study, support and participation from personnel at all levels is necessary, both in the implementation and post-implementation phases. As one IT executive puts it, adopting an ERP is indeed a "lifelong journey" for a company [3], so ongoing M&S with the participation and support of various stakeholders is necessary if the system is to contribute to company performance over the long term.

5.2. Propositions for future research

The company's M&S experience has affirmed our beliefs about ERP customization. It has demonstrated that a greater degree of customization leads to more difficulties in operating the ERP, and compromises the success of M&S practices. The Greater China MIS team underestimated the potential effects of adding bolt-on functionality to the native enterprise system in the first project in order to meet the local taxation requirements in Taiwan. Technical

problems (including data incompatibility and system instability), and difficulties in supporting the system, were painful experiences. Added to these problems was the refusal by the ERP vendor's support center to provide assistance with a customized module. In the second project, the MIS department worked with the Taiwan office of the vendor to implement a legitimate localized module, aiming to avoid the undesirable fallout of customization and reduce subsequent difficulties in M&S.

The company's success with its second ERP project indicates that an adopting company cannot ignore its ongoing relationship with the vendor if it is to be successful in later M&S practices. Attempts by any company to plan, implement, and maintain an ERP installation in isolation would likely result in adverse outcomes as this case study has shown.

Proposition 1. A higher degree of customization in the implementation or post-implementation stages would be likely to compromise the success of M&S services, and increase the difficulty of operating the ERP system.

Proposition 2. An ERP-adopting company's M&S practices are less likely to succeed if it ignores issues surrounding the ERP vendor, such as policies and advice in system deployment and support, product plans, and the availability of software patches and new releases.

ERP project management should be regarded as an organizational endeavor, rather a purely technical one. The undesirable outcomes (such as resistance to business process changes, high turnover rate, competition for MIS resources, and so on) of ERP implementation and M&S in the first project were the results of internal and external conflicts among stakeholders. The case study once again supported the proposition that conflicts of interest among stakeholders would compromise the success of the ERP implementation and M&S. A successful M&S practice requires an institutionalized mechanism for managing relationships among stakeholders, prioritizing user requests, and allocating resources appropriately.

Proposition 3. A higher level of conflicts of interest among stakeholders would compromise the success of the M&S of ERP systems, so it is critical for companies to have a mechanism for managing the interests of various stakeholders and resource allocation. Managing the competing interests of various parties properly may help garner the support and participation of all levels of the organization in M&S activities.

A policy and mechanism for managing the interests of, and allocating resources to, various stakeholders is undoubtedly one of the important organizational factors in ERP M&S. The project and business leaders of ERP-adopting companies must be encouraged to focus attention and effort towards the establishment of an organizational structure that is conducive to arbitrating and balancing the political and business interests of various parties. Based on the experience of the two ERP projects studied, we would like to highlight the need to consider a broader range of organizational and contextual issues in order to provide a healthy organizational environment for successful M&S. In addition to technical facilities and other project resources, issues regarding the acquisition, development, and retention of expertise and the development of standards and procedures for the execution and management of project and business processes should be considered high priority items within the overall infrastructure supporting M&S activities. In short, the above-mentioned elements form the infrastructure, or foundation, which will enable and support effective M&S on an ongoing basis. The second ERP project studied here indicates that a successful M&S strategy must not treat it as a lowly positioned endeavor isolated from other management activities. Instead, M&S must be positioned high in

the organization (here, it was seen as an integral element of the company's total quality management program) and be fully supported by the above-mentioned elements of organizational infrastructure.

Proposition 4. A comprehensive foundation or infrastructure must be established to support the strategy and practices of M&S, which must be treated as an integral part of the organization's total quality management program. The foundation includes not only technical resources but also other elements such as standards and procedures, training programmes, and the various types of expertise required by the ERP.

6. Implications

This case study has offered us an important opportunity to closely examine and compare the experience of an international firm in two consecutive ERP projects. Much has been learned by the company as it accumulated these experiences. Its lessons on ERP implementation and maintenance have been learnt the hard way, and such findings would surely benefit both academics and practitioners involved in ERP systems. The lessons learnt are highlighted below, followed by our suggestions for future research.

6.1. Experiences and learning

This case study has illustrated that ERP M&S not only comprises a set of lower-level operational activities, but also those aimed at maximizing long-term strategic benefits for the company. The company studied here repositioned its M&S program by emphasizing its strategic focus in addition to the operational dimension (M&S CSF 7), in the second ERP project. This is consistent with the findings of other studies in IT investment, which empirically demonstrate that companies using IT for strategic purposes (strategic focus) enjoy better payoff than operationally focused companies. Dual focused companies benefit the most from IT in comparison to single focused ones or those without any clear focus [37]. The measures taken by the company studied here ensured that the strategic needs of the company were being assessed together with the ERP features.

A dual focused M&S programme ensures that the company does not lose sight of important opportunities, since it is, and will continue to be, overwhelmed by the requests of mundane day-to-day services. While both the operational and strategic impact of ERP has been recognized in the literature [35], such recognition is mostly highlighted in relation to the selection and adoption of ERP software. The company studied here reminds us that the strategic perspective should be extended to cover the whole lifespan of the ERP system [13].

This international firm faced a strategic decision about the extent of customization in the implementation and post-implementation stages. Its experience with two ERP projects shows that a higher degree of customization of the native modules creates a multitude of problems including data inconsistency, system instability, and M&S issues. Unanticipated technical, communication, and human resistance issues are sources of complexity that this company failed to address in the first implementation. Vanilla implementations often involve a leaner coordination pattern, while rich coordination patterns are needed for ERP implementations with a higher degree of customization [15]. The fewer modifications and bolt-on features made to the native modules, the more likely the M&S services are to succeed.

System implementations are not a core competence of this international firm, which therefore has limited manpower and expertise in ERP and IT. The ability to leverage ERP expertise from multiple sources helps ERP-adopting companies fulfill their

expertise requirements in both the implementation and M&S of their ERP systems.

Managerial issues are as prominent as technical ones in ERP implementation and M&S. Technical and managerial challenges can create conflict among stakeholders including systems developers, vendors, MIS staff, and users. A proper management control mechanism such as the prioritization committee can mitigate such conflicts and direct scarce resources to the most important issues. A mechanism to manage conflict, rather than to seek full consensus, allows an ERP-adopting company to achieve both technical and business goals [39]. Most importantly, some aspects of operational success obtained by proper managerial control measures like those identified in this study may result in (1) improved quality of ERP implementation and (2) better communication and co-ordination throughout the ERP lifecycle.

6.2. Future research directions

This case study clearly demonstrates that ERP success hinges not only on proper planning and implementation, but also on post-implementation activities. That is, while we suggest that a full lifecycle perspective must be taken by ERP practitioners, the same perspective is highly applicable to academics in their assessment of CSF. Although ERP studies have mushroomed in the recent decade, there is still a dearth of research into post-implementation issues and the strategies and methods required to address them.

Accordingly, we would suggest that there is a need to step up research efforts on post-implementation issues, especially on M&S support, the inter-relationships among the implementation and post-implementation CSF, and the impact of post-implementation issues on the overall success of the ERP lifecycle. Specifically, the propositions presented in the previous section may serve as pointers to the focus of future studies.

7. Conclusion

This study has shown that M&S are important to the ERP lifecycle, and so must be handled properly in order for investment in ERP to yield benefits to the organization. Using an in-depth case study comparing two ERP implementation projects within the same international company, a framework of CSF for successful M&S, and a set of propositions for future research, have been presented. It is anticipated that the results of this study will benefit the ERP-using communities and MIS researchers alike.

References

- [1] A. Abran, H. Nguyenkim, Analysis of maintenance work categories through measurement, in: Conference on Software Maintenance, Sorrento, Italy, IEEE Computer Society, Los Alamos, CA, 1991, pp. 104–111.
- [2] C. Argyris, Management information systems: the challenge to rationality and emotionality, *Management Science* 17 (6) (1971) 275–292.
- [3] M. Avital, B. Vandenbosch, SAP implementation at Metalice: an organizational drama in two acts, *Journal of Information Technology* 15 (3) (2000) 183–194.
- [4] J. Beard, M. Sumner, Seeking strategic advantage in the post-net era: viewing ERP systems from the resource-based perspective, *Journal of Strategic Information Systems* 13 (2004) 129–150.
- [5] R. Beatty, C. Williams, ERP II: best practices for successfully implementing an ERP upgrade, *Communications of the ACM* 49 (3) (2006) 105–109.
- [6] I. Benbasat, D. Goldstein, M. Mead, The case research strategies in studies of information systems, *MIS Quarterly* 11 (3) (1987) 369–386.
- [7] V. Botta-Genoulaz, V. Millet, B. Grabot, A survey on the recent research on ERP systems, *Computers in Industry* 56 (2005) 510–512.
- [8] C. Bullen, J. Rockart, A primer on critical success factors, in: C. Bullen, J. Rockart (Eds.), *The Rise of Managerial Computing: The Best of the Center for Information System Research*, Dow Jones-Irwin, Homewood, IL, 1986, pp. 383–423.
- [9] J. Burch, F. Grupe, Improved software maintenance management, *Information Systems Management* 10 (1) (1993) 24–33.
- [10] N. Chapin, Software maintenance types—a fresh view, in: International Conference on Software Maintenance, San Jose, CA, IEEE Computer Society, Los Alamitos, CA, 2000, pp. 247–252.

- [11] T. Daveport, Putting the enterprise into the enterprise systems, *Harvard Business Review* 76 (4) (1988) 121–131.
- [12] Y. Dittrich, S. Vancouleur, Practices around customization of standard systems, in: *Proceedings of the 2008 International Workshop on Co-operation and Human Aspects of Software Engineering*, 2008, pp. 37–40.
- [13] G. Gable, T. Chan, W. Tan, Large packaged application software maintenance: a research framework, *Journal of Software Maintenance and Evolution: Research and Practice* 13 (6) (2001) 351–371.
- [14] R. Glass, I. Vessey, Enterprise resource planning systems: can they handle the enhancement changes most enterprises require? *The Software Practitioner* 9 (5) (1999) 1–12.
- [15] S. Gosain, Z. Lee, Y. Kim, The management of cross-functional inter-dependencies in ERP implementations: emergent coordination patterns, *European Journal of Information Systems* 14 (4) (2005) 371–387.
- [16] J. Harris, The road to ERP optimization, *Government Finance Review* 20 (6) (2004) 18–22.
- [17] S. Hirt, E. Swanson, Emergent maintenance of ERP: new roles and relationships, *Journal of Software Maintenance and Evolution: Research and Practice* 13 (6) (2001) 373–387.
- [18] W. King, Ensuring ERP implementation success, *Information Systems Management* 22 (3) (2005) 83–84.
- [19] K. Kumar, J. van Hillegersberg, ERP experiences and evolution, *Communications of the ACM* 43 (4) (2000) 23–26.
- [20] T. Kwon, R. Zmud, Unifying the fragmented models of information systems implementation, in: R.J. Boland, R.A. Hirschheim (Eds.), *Critical Issues in Information Systems Research*, Wiley, Chichester, 1987, pp. 227–252.
- [21] B. Lientz, E. Swanson, Problems in application software maintenance, *Communications of the ACM* 24 (11) (1981) 763–769.
- [22] B. Light, The maintenance implications of the customization of ERP software, *Journal of Software Maintenance and Evolution: Research and Practice* 13 (6) (2001) 415–429.
- [23] M. Markus, C. Tanis, The enterprise systems experience—from adoption to success, in: R.W. Zmud (Ed.), *Framing the Domains of IT Research: Glimpsing the Future Through the Past*, Pinnaflex Education Resources, Inc., Cincinnati, OH, 2000, pp. 173–207.
- [24] C. Ng, A decision framework for enterprise resource planning maintenance and upgrade: a client perspective, *Journal of Software Maintenance and Evolution: Research and Practice* 13 (6) (2001) 431–468.
- [25] C. Ng, G. Gable, T. Chan, An ERP-client benefit-oriented maintenance taxonomy, *The Journal of Systems and Software* 64 (2002) 87–109.
- [26] E. Ngai, C. Law, F. Wat, Examining the critical success factors in the adoption of enterprise resource planning, *Computers in Industry* 59 (2008) 548–564.
- [27] R. Nolan, Managing the computer resource: a stage hypothesis, *Communications of the ACM* 16 (7) (1973) 399–405.
- [28] A. Parr, G. Shanks, A model of ERP project implementation, *Journal of Information Technology* 15 (2000) 289–303.
- [29] P. Rajagopal, An innovation-diffusion view of implementation of enterprise resource planning (ERP) systems and development of a research model, *Information and Management* 40 (2) (2002) 87–114.
- [30] J. Rockart, Chief executives define their own information needs, *Harvard Business Review* 57 (2) (1979) 81–93.
- [31] J. Scott, Post-implementation usability of ERP training manuals: the user's perspective, *Information Systems Management* 22 (2) (2005) 67–77.
- [32] H. Smith, J. McKeen, Computerization, management: a study of conflict and change, *Information & Management* 22 (1) (1992) 53–64.
- [33] C. Soh, S. Sia, The challenges of implementing “vanilla” versions of enterprise systems, *MIS Quarterly Executive* 4 (1) (2005).
- [34] M. Songini, ERP users bristle at upgrade pressure, maintenance costs, *Computerworld* (February 16, 2004) (journal on-line); available from <http://www.computerworld.com/softwaretopics/software/apps/story/0,10801,90221,00.html>.
- [35] C. Stefanou, A framework for the ex-ante evaluation of ERP software, *European Journal of Information Systems* 10 (2001) 204–215.
- [36] E. Swanson, The dimensions of maintenance, in: *International Conference on Software Engineering*, San Francisco, IEEE Computer Society, Long Beach, CA, 1976, pp. 492–495.
- [37] P. Tallon, K. Kraemer, V. Gurbaxani, Executives' perceptions of the business value of information technology: A process-oriented approach, *Journal of Management Information Systems* 16 (4) (2000) 145–173.
- [38] I. Vessey, R. Weber, Some factors affecting program repair maintenance: an empirical study, *Communications of the ACM* 26 (2) (1983) 128–134.
- [39] E. Wagner, S. Newell, Repairing ERP: producing social order to create a working information system, *The Journal of Applied Behavioral Science* 42 (1) (2006) 40–57.
- [40] I. Yakovlev, M. Anderson, Lessons from an ERP implementation, *IT Pro* 3 (4) (2001) 24–29.
- [41] R. Yin, *Case Study Research: Design and Methods*, Sage Publications, Newbury Park, 1990.