An empirical investigation of the impacts of internal/external facilitators on the project success of ERP: A structural equation model

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A B S T R A C T

In recent years many companies have improved their business performance and competitive position by implementation of enterprise resource planning (ERP) systems. This study goes beyond the boundaries of an individual organization to develop an integrated framework for successful implementation of ERP systems. We also discuss the internal/external facilitators which make this possible. Meanwhile, the authors utilize the SERVQUAL instrument, project management and information systems success theory in our empirically investigation of the roles and interdependent relationships of system vendors, consultants, project management and system performance, based on existing measures suitable for this study. The results reveal a significant causal relationship between system providers, implementation consultants and project management, and project to system performance, except directly from SERVQUAL to system performance. It is believed that an understanding of the relationships between the relevant factors for ERP success is necessary to satisfy the adopter's requirement, both practically and theoretically.

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1. Introduction

Over the past decade, enterprise resource planning (ERP) systems have been implemented in many organizations worldwide [28]. However, there are various obstacles that must be overcome in the process of the successful implementation of an ERP system by an organization [32,59,67]. In fact, ERP implementation is a difficult and risky task. Executing an ERP project not only tends to be large and complex but also involves a broad range of organizational transformation processes during the whole implementation process. There are many internal and external entities involved in this type of high-risk project besides the executive steering committee for project management (PM) which require expertise that is not typically found within the organization, such as system vendors and implementation consultants [25].

The system vendors and implementation consultants represent external sources of expertise and the executive steering committee of project management (PM) stand for an internal transformation mechanism facilitating fundamental changes in the organizational structure. The organization goes through tremendous changes through PM efforts during ERP project implementation, creating environments where systems could be modified or embedded and systems of services are delivered in the process of the transformation. System vendors, implementation consultants and the executive steering committee of PM are the three key participants to achieve success in driving the system performance of ERP.

It should be noted well that if an ERP system cannot be embedded, system services cannot be delivered and system performance not carried out by the efforts of the system vendor, implementation consultant and PM. Given this, it is believed that a more comprehensive and integrated ERP success model should incorporate such factors as the Vendor/Consultant quality and PM dimensions. More importantly, study of ERP systems success is limited if these three important dimensions are not considered.

A review of the previous literature on ERP success reveals that researchers have either used narrowly defined measures [73] or examined ERP success at individual stages [40]. However, few go beyond the boundaries of the organization to discuss the internal/external contextual factors that lead to success, looking at the whole process of what drives successful ERP implementation from a wider perspective. Although Gable and colleagues [22,52] have stepped up to this challenge on ERP assessment of systems success issues and discussed the impact of external contextual factors, overall, there is a shortage in the literature of an integrated model dealing with the internal/external contextual factors as antecedents of ERP success. It goes without saying that no one has examined the relationships...
between dimensions leading to ERP systems and the PM dimension as a moderator (intermediary) of ERP system performance in the later stages. This study aims, therefore, to fill this gap by examining the effects of the afore-mentioned two external and one internal contextual factors, i.e., system vendor, implementation consultant and PM on ERP success assessment, simultaneously.

The rest of this paper is organized into six sections. Section 1 briefly describes the research problem and the goals of this study. In Section 2, we discuss the influence on ERP system quality from two perspectives, internal and external facilitators, to better understand the participants involved in the process of ERP implementation. In Section 3, we consolidate these streams of research and propose a modified research framework and six propositions. In Section 4, methodology (sample, data arrangement and model testing) and the discussion of management implications are introduced. Limitations and suggestions for future research are discussed in Section 5. Finally, we present our conclusions in Section 6.

2. Literature review

The deployment of any complex system has always faced barriers [21]. Barriers are high when striving to accomplish anything involving a large network of internal and external stakeholders, applying untried technology and utilizing best-practice models that may not be a good match to the organization [55]. Wang et al. [64] has stated that such barriers can arise from the adaptability of the system or procedural transformation of behavioral concerns and can be addressed by looking at system performance as perceived by clients during later stages of implementation. Each step in the deployment process requires analysis to determine what factors will promote effective deployment [12,33].

The internal and external facilitators have an influence on ERP system quality. Examination of these two perspectives is needed to better understand the participants involved in the process of ERP implementation. One also needs to investigate the relationships between service quality from the system vendor and the implementation consultant and the level of achievement level by project management for successful ERP project implementation.

2.1. External facilitators

2.1.1. Effect of system providers and implementation consultants

According to Yen and Sheu [75], successful implementation of an ERP system requires a strategic fit between the product and the organization. Xu and Ma [74] also mentioned that the benefits of ERP depend on the client’s operations, maintenance, and upgrading skills and knowledge, which can be learned, acquired and transferred from a consultant. Without external help, few organizations can implement ERP successfully. External support, therefore, is usually obtained from software vendors and implementation consultants.

Ko et al. [34] first underscored the crucial role that system vendors play in ERP implementation. It is recognized that the service quality of the ERP provider is crucial throughout the life span of any ERP process [34,40,56]. Janson and Subramanian [29], therefore, concluded that a close fit between the software vendor and the user organization is positively associated with successful implementation.

Furthermore, according to Dong-Gil [20], ERP implementation also requires knowledge of activities associated with configuring and testing ERP modules, installing software, and training employees in preparation for ongoing operation, maintenance and support of customized a vendor-supplied system. Few firms, however, by themselves have sufficient in-house skill or a comprehensive enough knowledge base to implement a complex ERP system [64]. The consultant who possesses experience in system implementation, however, can effectively support clients with the necessary knowledge to help with project management and implementation methods.

The client possesses detailed knowledge of the firm’s business processes, organizational context, and competitive situation. Consequently, high-quality consultants not only will have a positive effect on ERP system quality but they will also be able to provide valuable service to alleviate the misfit problem [65].

Markus and Tanis [40] further highlighted “dependence on vendors and consultants” as the two key issues in ERP implementation. They differentiate these systems from other IT implementations since they represent an external source of expertise to the firm. These two types of external entities play a critical role in ERP implementation. Clearly, the service quality provided by system vendor and implementation consultants needs to be effectively articulated, gathered and analyzed to determine what factors will promote effective deployment. Most importantly, the analysis of the service quality of system vendors and implementation consultants for ERP implementation will enable subsequently assist project management to facilitate communication and mutual understanding as well as increase coordination between the service quality and system performance through the PM’s activities during the implementation process. The knowledge and service from both sides could then be integrated into the implementation and measured by the application of the service quality (SERVQUAL).

2.1.2. Service quality of external facilitators

Over the past decade, commonly used measures of information system (IS) effectiveness have focused on the products, rather than the services, of the IS function. However, organizations have struggled with traditional measures to improve the service performance of the system provider and their largely intangible benefits. There is a danger that IS researchers will inaccurately measure IS effectiveness if they do not include in their assessment package a measure for service quality. Consequently, there has been an urgent call for new types of IT performance indicators [30]. One alternative measure that has recently has become quite popular in the IT setting is service quality as perceived by the customers of IT services [66]. The IS function includes a significant service component. System providers, like other service firms, have realized the significance of customer-centered philosophies, and are turning to quality management approaches to help manage their business. Similarly, since ERP implementation consultation is a professional service, the service quality should be assessed from a client’s perspective.

Service quality is a concept that has aroused considerable interest and debate in the literature, because of the difficulties in defining and measuring it, with no overall consensus emerging on either [71]. Caruana et al. [11] pointed out that definitions of service quality revolve around the idea that it is the result of comparisons made by customers make between their expectations about a service and their perception of the way the service has been performed [44,50]. Pitt et al. [46] offered SERVQUAL, an instrument developed by the marketing area, as a possible measure of IS service quality. The majority of the work to date has attempted to use the SERVQUAL methodology in an effort to measure service quality [6,37,44].

Certainly, the SERVQUAL instrument has been the predominant method used to measure the degree of satisfaction associated with consumer perception of service quality especially related to the IS function. In order to examine the applicability in the IT setting and the quality of service inputs from system providers and implementation consultants during the process of ERP implementation, the authors have adapted the concept of service quality and SERVQUAL to measure the performance of IT service. The main five generic dimensions of SERVQUAL are outlined as follows [62]:

(1) Tangibles: physical facilities, equipment and appearance of personnel.
(2) Reliability: ability to perform the promised service dependably and accurately.
(3) Responsiveness: willingness to help customers and provide prompt services to meet customers’ needs.
(4) Assurance: professional knowledge and courtesy of employees and their ability to inspire trust and confidence.
(5) Empathy: caring and individualized attention that the firm provides to its customers.

2.2. Internal facilitators

2.2.1. Effectiveness of the ERP steering committee for project management

Project management of ERP implementation is considered one of the most important institutional factors that influence technology adoption in an organization. Specifically, the role of project management in successful ERP implementation is critical [35,65,69]. There is a lot of evidence, however, that the success rate of ERP implementation is not high in relation to the sums invested by firms in its application. The main reason for this could be the lack of a vigorous executive mechanism capable of ensuring availability of resources and their most effective and efficient use to deliver and transfer desired developing system performance into the organization.

Williams and Edge [68] stated that ERP systems can be characterized as configuration technology, which conducts a wide range of business activities and can rarely be obtained in the form of standard solutions. Adopting an ERP system might also require customizing certain solutions to fit the firm’s specific markets, structure, and operational requirements [26,68]. An executive steering committee is needed for the process of adaption between the organization and the package throughout the implementation process. The steering committee is responsible for facilitating the harmonization and integration of organizational functions and system, and must be involved throughout the project [8]. This committee plays a critical intermediary role. It is not only responsible for execution but also for the delivery and transformation of the ERP project into effective system performance.

Adam and Twomey [1] pointed out that ERP projects are often treated as normal IS projects, even though they often involve aspects that make them different from traditional information systems development projects. This is because an ERP system is constituted of many subsystems, requiring the collaboration, cooperation and interaction of different departments and at the level of company operation [15]. Furthermore, because of the scale and integrative nature of an ERP system, the effort required by the client to fit the system’s model and functionality can be extensive, require difficult and costly reengineering tasks, and may sometimes encounter strong organizational resistance. The complete implementation of an ERP system is a very difficult and important task and includes the optimal adaptation and installation of all the subsystems in the respective departments of the enterprise.

Owing to the involvement of so many people, systems, the organization and consultants in this process of transformation, a steering committee can help clearly define the goals of the system, frame the required changes properly, assist in the resolution of disputes and minimize the risk of project failure. If the steering committee can recognize the nature and magnitude of the risks they face in implementing ERP systems, organizations can minimize these risks by employing project management and control strategies suggested by steering committees to address the challenges they face.

Given the various constraints and barriers imposed on the implementation process, Myers et al. [42], thus, emphasized the importance of a steering committee for project management, propounding it as playing a key transforming role in terms of influencing ERP system performance. They argued that any IS success model should incorporate PM impact in light of the contributions made by a steering committee toward system performances, and these should be considered in the ERP performances evaluation model.

2.2.2. Measurement of the achievement level of internal facilitators

There are numerous factors related to project management while implementing ERP systems, such as a clear understanding of strategic goals, commitment by top management, system selection, and organizational change management, that have been widely explored [60,63]. Before investigating risk causes and effects, we have to define what is meant by ERP project success.

Lyytinen and Hirschheim [38] categorized IT project success by assessing the resulting system against the planned objectives, user expectations, projected budget and goals. Cleland and Ireland [13] emphasized that a vital procedure in project management is risk management which helps to avoid problems such as deviation from project goals, timetables and construction estimates. Risk management is thus very crucial for the success of a project, especially in the implementation of an ERP system [76].

In addition, Linberg [36] observed that the success of a completed project was linked to the quality of the product. Agarwal and Rathod [2] identified two different perspectives for success: internal factors linked to time, cost and scope that underlined the value of project monitoring and control processes, and external factors such as customer satisfaction and system quality. The application of project management principles allows the steering committee to establish and use more appropriate measures of success, to quantify value commensurate with cost and to optimize the use of organizational resources.

In contrast with the traditional definition of project success [45], Procaccino and Verner [49] emphasize the achievement level of project management in the delivery of a system that will meet customer/user requirements at work (effective deployment of resources resulting in improved quality and organizational performance). In the IS project management literature, therefore, project success is linked to the achievement level of project management and the quality of the system [16,72].

Similarly, we define ERP project success as the utilization of such a project to promote effective deployment and enhance organizational effectiveness to which the project management efforts of the steering committee are crucial. We describe the activities identified as assisting in the achievement level of project management in the following sections. They are categorized into seven areas including: (1) fulfilling business implementation goals; (2) full top management support; (3) meeting scheduled goals; (4) meeting budget objectives; (5) effective communication; (6) solving problems; (7) system integration. These seven areas, although presented as distinct features are usually totally integrated, as are their component processes.

2.3. Information system success model

Information system success is widely recognized by practitioners and academics as a difficult concept to define. A great many past studies have endeavored to describe as well as to justify the evaluation of IS success [17,18]. DeLone and McLean [18] and Gable and colleagues [22] provided perhaps the most comprehensive system success measurement model, to date, which has often been used by others (e.g., [7,54]).

A widely adopted model of IS success depends on its multi-dimensional and interdependent nature, in this case, DeLone and McLean’s (D&M) IS success model. The purpose of the original model was to synthesize work involving individual measures into a single coherent model. Six interrelated dimensions of IS success were identified. It is suggested that success can be represented by the system quality, the output information quality, consumption of the output, the user’s response, the effect of the IS on the behavior of the user and the effect of the IS on organizational performance. DeLone and McLean later proposed an updated model based on a review of the literature. The categories in the updated taxonomy were system, information, service quality, intention to use, use, user satisfaction, and net benefits.
Next, Gable and colleagues developed an additive model that redefined the dimensions in the original D&M IS success model. Measurement of ERP success criteria in the early stages, however, does not reflect the entire scope of ERP related success during use and later periods. Recently, Ifinedo [28] has extended the model, incorporating two relevant dimensions not included in Gable et al.’s model, namely, Vendor/Consultant Quality (VQ) and Workgroup Impact (WI) dimensions. He recognized the relevance measures relating to the cooperative role and system providers as success measures, grouping both together into the Gable et al.’s ERP success measurement model.

It is appropriate to use a multi-dimensional approach with suitable perspectives to investigate the impact on system performance of both internal and external entities and explore the relationship among the SERVQUAL, achievement of PM and system performances. Important social actors in this stage are included in a successful D&M (updated version) IS model. These actors include end users, technical administrators, and business and IT management personnel. More importantly, the purpose of our study is to evaluate ERP success during the usage stage after its implementation. A series of concrete measurement constructs for the D&M IS model are applied to evaluate performance during implementation. The model includes six IS success factors, their description and examples of the measures taken for these six dimensions, summarized as follows:

1. System quality denotes system performance like data accuracy, database contents, data currency, system accuracy, responses, etc.
2. Information quality refers to the quality of the IS product, such as believability of output, timeliness of output, usefulness of output, understandability of output, and relevance of output.
3. Use of ERP system refers to the frequency at which an information system is used. Items like the rate of using ERP to assist in making decision, charge for ERP system use, and amount of connecting time are examined.
4. User satisfaction records the satisfaction level as reported by system users, including information, software, interface, overall satisfaction, ERP project satisfaction, etc.
5. Individual impact refers to measuring the impact of the information system on individual users, reflected by job performance, individual productivity, decision quality, information awareness, inventory etc.
6. Organizational impact requires the evaluation of changes caused by the information system to the organization, such as decrease in operating cost, savings in labor costs, and growth in profits. Authors also use the Balanced Scorecard (BSC) approach as financial measures to evaluate the ERP performance of organizational impact dimension. The four categories of BSC are financial, customer, internal business process, and learning and growth [31].

3. Proposed framework and hypothesis development

3.1. Simplified research framework

From the literature review in the previous section we are not only able to identify factors of potential interest for each dimension but also to formulate a possible research framework for the four parts. The simplified research framework without PM is shown in Fig. 1. There appears to be direct correlations between SERVQUAL and system performance. However, the relation between cause and effect from internal/external facilitators driving the system performance of ERP seems to be oversimplified. Such a simplistic research framework also tends to cause confusion because of ambiguous causal relationship.

As indicated above, project management by the steering committee likely plays a critical role throughout the process of implementation. It can also offer a vigorous executive mechanism capable of ensuring that the available resources are used in the most effective and efficient way to deliver the desired developing system performance into the organization. Therefore, in this study, project management is incorporated into the research model. It is believed that such a research framework with involvement of PM will provide insight into the causal relationship among SERVQUAL, project management and system performance.

3.2. Modified framework

The proposed modified model integrating internal/external facilitators during the implementation of ERP is shown in Fig. 2. This is a multi-dimensional model, and the dimensions are interrelated. There are three dimensions driving ERP system performance considered in the modified model including the SERVQUAL of system providers, SERVQUAL of implementation consultants, and the achievement level of project management.

In the questionnaire, these concepts are to be translated into concrete items as described above. The dependent variables shown on the chart indicate the degree of achievement in terms of project management and the degree of the improvement of system performance including system quality (SP1), information quality (SP2), system use (SP3), user satisfaction (SP4), individual impact (SP5), organizational impact (SP6) after implementation of the ERP systems. These six dimensions come from the Information System Success model proposed by DeLone and McLean [17].

Meanwhile, the achievement level of project management is not only an intervening (moderating) variable but also includes the seven areas of knowledge described in Section 2.1. These include: (1) fulfilling business implementation goals (PM1); (2) full top management support (PM2); (3) meeting budget objectives (PM3); (4) meeting scheduling goals (PM4); (5) triggering effective communication (PM5); (6) solving problems (PM6); (7) system integration (PM7).

Finally, the independent variables are the SERVQUAL of system providers and implementation consultants. The list of SERVQUAL measures include Tangibles (SS1 and SC1), Reliability (SS2 and SC2), Responsiveness (SS3 and SC3), Assurance (SS4 and SC4) and Empathy (SS5 and SC5), respectively.

Utilizing this method and tools, the authors expect that this proposed framework will benefit to understand whether traditional project management techniques are, in fact, suitable for ERP projects and whether some of the problems encountered by implementing firms could be solved by using specific ERP approaches.

3.3. Hypothesis development

With this model and definitions, we explore the relationships among the degree of satisfaction with service quality, the achievement level of project management and the degree of improvement in performance after implementation of ERP. Moreover we also propose the following hypotheses and investigate how project management by the steering committee can assist in transferring the service quality of system providers and consultants into system performance during the implementation of ERP systems. In the subsequent data analysis, we use structural equation modeling techniques to test these hypotheses. The questionnaire design and the collected data more readily permit the testing of variance analysis using that approach. The set of hypotheses with a more comprehensive introduction and individual motivations are articulated below.

3.3.1. Impact or effects of the selected external contextual factors on ERP system success

Alonini et al. [3] stated that the service quality of the system vendor must be evaluated before implementation and their impact on system success questioned. These factors are pivotal to ERP project success. Essential system aspects include all necessary functionalities, user
friendliness, portability, scalability, modularity, version management, simple upgradeability, flexibility, security, presence of a complete guide, procedure manual to help users, and data accuracy. Furthermore, Dolmetsch et al. [19] stated that the use of outside consultants is common for an ERP project. Their experience, knowledge of the modules, technical and organizational acumen, experience with familiar software applications [47] and management implementation [58] play a major role in promoting successful ERP implementation and performance.

More importantly, because of the integrated nature of ERP software, if some of these elements are absent or ineffective this can have a negative effect throughout the enterprise. Implementation of an improper system or the involvement of an inappropriate consultant could cause implementation to fail or weaken it sufficiently to affect the company’s performance [9,70]. Therefore, a deep analysis of the service quality provided by the system vendor and implementation consultants is necessary. It is important to effectively determine, articulate and analyze what factors will promote effective deployment. The better the service quality of the system and implementation consultant support for the ERP implementation, the greater the chance of success. Therefore, we propose the following two hypotheses.

**H1.** There is a positive relationship between the degree of satisfaction of the SERVQUAL of system providers and the degree of the improvement in system performance.

**H2.** There is a positive relationship between the degree of satisfaction of the SERVQUAL of implementation consultants and the degree of improvement in system performance.

### 3.3.2. Impact or effect of the selected external contextual factors on PM success

Successful implementation of an ERP system is the result of knowledgeable and dedicated people working together. It entails company-wide commitment, openness to change, good planning and experienced guidance. In their discussion of implementation strategy, Wu and Wang [73] recognized the relevance of system providers and consultants as measures of success for ERP implementation. In addition, Umble and Umble [61] also stated that an organization must decide why an ERP system should be implemented and what critical business goals the system will address. Hence, identifying business goals, determining strategic business issues and identification of strategic requirements, especially external sources of expertise and consultant services, are essential elements of the ERP planning process. More importantly, the analysis of service quality by system vendors and implementation consultants will facilitate subsequent project management, communication and mutual understanding as well as increase accuracy between service quality and system performance through PM activities during the implementation process.

It is risky to neglect the impact of the service quality of the system vendor and implementation consultants. The better the system service quality and implementation consultant support for the project management of a steering committee, the greater the chance of successful implementation. Along this similar line of reasoning, therefore, we propose the following two hypotheses:

**H3.** There is a positive relationship between the degree of satisfaction of the SERVQUAL of system providers and the achievement level of project management.

**H4.** There is a positive relationship between the degree of satisfaction of the SERVQUAL of implementation consultants and the achievement level of project management.
3.3.3. Impact or effect of the PM factors on ERP system success

Clemons [14] underlines the importance of the involvement of project management in planning and implementing ERP system. Project management activities span the first four stages of the ERP life cycle, from initiating the project to its closing [56]. Participation of a steering committee to drive change and employment of project management and control strategies are expected to influence the success of ERP throughout the project [43]. The inadequate use of project management techniques significantly affects ERP project success [48]. Risk management in particular is a vital procedure of advanced (goal-directed) project management [13].

Similarly, Bingi et al. [8] also place emphasis on the importance of a steering committee, responsible for facilitating the harmonization and integration of organizational functions and systems, involved throughout the project. The steering committee plays a critical moderating (intermediary) role. They are not only responsible for the execution but also the delivery and transformation of the ERP project into effective system performance.

The steering committee can help clearly define the goals of the system, properly frame the required changes properly, help with the resolution of disputes and even minimize the risk of project failure owing to the involvement of people, systems, the organization, and consultants in this process of transition. Therefore, we define success as the utilization of such an ERP project as the effective deployment and enhanced organizational effectiveness by the efforts the steering committee for project management. Meanwhile, we also describe the activities identified for the achievement of project management, categorized under seven areas. Similarly, the PM support for ERP implementation is positively related to perceived ERP system quality after implementation. Therefore, we can formulate the following hypotheses:

H5. There is a positive relationship between achievement level of project management and the degree of improvement on system performance.

4. Methodology

4.1. Sample and measurement

We explore the relationship among SERVQUAL, project management and system performance of ERP implementation. This study uses data on the ERP implementation experience of the Top 5000 Largest Corporations in Taiwan including manufacturing, non-manufacturing, banking and financing and government enterprises, as well as foreign-businesses and consolidated companies. To avoid repetitions, a stratified and disproportional set of subgroups was selected, based on annual revenue. The total sample consisted of 4300 firms from a comprehensive database containing annual revenue of over US$ 9 million from manufacturers and US$ 6 million for the service industry. All of the corporations were registered with the Ministry of Economic Affairs. This source of data ensured that the sampling procedure was repeatable. In all, 4300 questionnaires were sent out in the year 2006 to these companies.

Of the 4300 questionnaires mailed, 620 (14.41% of 4300) usable responses were returned. However of the 620 data sets, 249 (40.16% of 620) were not concerned with ERP and 71 (11.45% of 620) were implementing the ERP system while there were no modules going into these, 51 (17.00% of 300) employed custom-built IS and 249 (83.00% of 300) applied ERP software packages. The empirical analysis was consequently based on 249 observations. In terms of usage success and incomplete data, the number of eligible data sets was further reduced to 207. The firm size and branch distribution of the data can be seen in Table 1.

Of the 207 usable responses, the participating companies employed either ERP solutions provided by domestic vendors or ERP solutions provided by international software vendors. Among these, 45 (37.6%) of the 207 ERP implementation clients were international software vendors (international, such as SAP, Oracle or J.D. Edwards) and 110 (11.8%) were domestic software vendors (promising local system vendors, such as Data Systems, Yongyou and IE). Total sources of ERP solutions are shown in Table 2.

Consulting firms were divided into three groups according to their partners, management consulting firm and individual software vendors (consulting with firms such as IBM, Accenture and HP) and individual consultancy such as promising local consulting corporations or unknown local consultants. Many local ERP vendors provided only a few technicians to help in implementing the system. In contrast, international ERP vendors had numerous implementation partners (consultants) to help their clients. The distribution of the three groups is 53:25:14. Total sources of ERP consulting services are shown in Table 3.

The mean project size was 22.4 persons, and the standard derivation was 12.6. The majority of the projects were in charge of a designated steering committee for project management; only a small minority of ERP projects were in charge of specific IS departments, as shown in Table 4.

Finally, 207 companies will be examined in the paper. The Likert Scale was used to measure relevant variables. Sample data were obtained with a certain level of reliability and validity. With such constructive information, we were able to explore the relationships among SERVQUAL, project management and Information System Success.

4.2. Data arrangement and operation

In order to evaluate their importance level and compute the degree of satisfaction of SERVQUAL or the degree of the improvement on system performance measure, this study adopted a two-stage approach to design the questionnaires and collect data. The respondents were asked to evaluate the degree of satisfaction, performance improvement, and importance level for each of the SERVQUAL and the 37 chosen ERP performance measures by using 7-point Likert-type scales ranging from 1 (substantial deterioration) to 7 (substantial improvement) and from 1 (extremely unimportant) to 7 (extremely important), respectively. The data of importance levels are used to calculate the relative weights of measures. We used these data and the following equations not only to determine each SERVQUAL of system providers and consultants but also to determine the degree of performance improvement of the six dimensions and composite performance after having implemented ERP systems. Then the importance of these ERP performance measures (83 measures in total) is evaluated by companies that have implemented ERP systems by using 7-point Likert-type scales. The two-stage approach in this study described as follows:

Stage 1: Firstly, in order to obtain the relative weight of the $i^{th}$ measure of the $j^{th}$ dimension relative to the measures within the $j^{th}$ dimension, the important level of SERVQUAL and the degree of performance improvement were calculated as following equation:

$$W_{jk} = \left( \frac{\sum_{i=1}^{N} W_{ijk}}{N} \right), i = 1 \text{ to } N$$

In Eq. (1), $W_{ijk}$ is the importance level score (1 to 7) of the $i^{th}$ measure of the $j^{th}$ dimension as perceived by the $j^{th}$ respondent, and $W_{jk}$ is the average importance level score of the $i^{th}$ measure of the $j^{th}$ dimension as perceived by N respondents.

Stage 2: According to the average importance score rankings obtained from Stage 1, the satisfaction score and the degree of
4.3. Data analysis and model testing

To assess the degree of performance improvement of enterprises in the post-implementation stage, we conducted a normality test on 207 usable responses. The Kolmogorov–Smirnov test results were non-significant, which indicated the collected data to be normally distributed. The reliability coefficients and Cronbach’s alpha for the dimensions of ERP performance, service quality and project management’s measures, were equal or larger than 0.8, as indicated in Table 5. This means that there was good consistency for the subjects of the questionnaire. Path analysis was adopted to test our model as well as to check the relationships among these dimensions. The hypothesized paths in the modified model described above were tested using STATISTICA 6.0 with maximum likelihood (ML) estimation. STATISTICA is appropriate for testing well-developed theories.

The structural models were evaluated on the basis of five goodness-of-fit measures. The statistical significance of the chi-square statistic indicates whether the model has a good fit with the data or not. The drawback of the chi-square test is that significance is sensitive to sample size and the number of parameters in the model [6], and as a result, the test may provide an inappropriate indication of good fit. The fit of the models is accordingly evaluated in terms of three alternative measures that are less sensitive to sample size or model complexity. These are (a) the goodness-of-fit index (GFI) which outperformed other alternative indices in a study by Marsh el. al. [41]; (b) the adjusted goodness-of-fit index (AGFI) which regulates the GFI for degrees of freedom; (c, d) the Normalized Fit Index and Non-Normalized Fit Index as recommended by Bentler and Bonett [6] respectively; and (e) Steiger’s [57] root mean square error of approximation (RMSEA) as recommended by Browne and Gudeck [10].

The fit statistics and estimated path coefficients for the modified structural model are listed in Table 6. The fit estimates provide mixed signals concerning the goodness-of-fit of the modified structural model. The thresholds for GFI and AGFI are a matter of dispute in IS research but are above 0.90 and above 0.80, respectively [53]. A less restrictive 0.80 threshold for AGFI is also cited [23]. Both NFI and NNFI approached the threshold of 0.90 recommended by Bentler and Bonett [6] for a good fit and the RMSEA was below the 0.05 level set by

Table 1
Demographic information of respondents (N = 207).

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<tr>
<th>Industry (N = 207)</th>
<th>Frequency</th>
<th>Valid (%)</th>
<th>Annual revenue (US$ million) (N = 207)</th>
<th>Frequency</th>
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<tbody>
<tr>
<td>Food</td>
<td>13</td>
<td>6.3</td>
<td>&lt;15</td>
<td>29</td>
<td>14.0</td>
</tr>
<tr>
<td>Mechanical/steel/metal</td>
<td>21</td>
<td>10.2</td>
<td>15 to 30</td>
<td>58</td>
<td>28.0</td>
</tr>
<tr>
<td>Plastics and rubber</td>
<td>7</td>
<td>3.4</td>
<td>31 to 150</td>
<td>83</td>
<td>40.1</td>
</tr>
<tr>
<td>Chemical</td>
<td>9</td>
<td>4.3</td>
<td>150 to 310</td>
<td>18</td>
<td>8.7</td>
</tr>
<tr>
<td>Electronic and Generator</td>
<td>40</td>
<td>19.3</td>
<td>&gt;310</td>
<td>19</td>
<td>9.2</td>
</tr>
<tr>
<td>Information</td>
<td>19</td>
<td>9.2</td>
<td>Employee numbers (N = 207)</td>
<td>Frequency</td>
<td>Valid (%)</td>
</tr>
<tr>
<td>Conveyance</td>
<td>11</td>
<td>5.3</td>
<td>&lt;100</td>
<td>42</td>
<td>20.3</td>
</tr>
<tr>
<td>Trade</td>
<td>13</td>
<td>6.3</td>
<td>100 to 500</td>
<td>115</td>
<td>55.6</td>
</tr>
<tr>
<td>Building/real estate</td>
<td>6</td>
<td>2.9</td>
<td>500 to 1000</td>
<td>24</td>
<td>11.6</td>
</tr>
<tr>
<td>Other manufacturing</td>
<td>23</td>
<td>11.1</td>
<td>&gt;1000</td>
<td>26</td>
<td>12.5</td>
</tr>
<tr>
<td>Other services</td>
<td>45</td>
<td>21.7</td>
<td>Industry sector (N = 207)</td>
<td>138</td>
<td>66.67</td>
</tr>
<tr>
<td>Total</td>
<td>207</td>
<td>100%</td>
<td>Services</td>
<td>69</td>
<td>33.33</td>
</tr>
</tbody>
</table>

Table 2
ERP software package (N = 207).

<table>
<thead>
<tr>
<th>Implemented ERP software package (N=207)</th>
<th>Frequency</th>
<th>Valid (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAP</td>
<td>17</td>
<td>8.2</td>
</tr>
<tr>
<td>Oracle</td>
<td>23</td>
<td>11.1</td>
</tr>
<tr>
<td>J.D. Edwards</td>
<td>5</td>
<td>2.4</td>
</tr>
<tr>
<td>Data Systems (Taiwan)</td>
<td>94</td>
<td>45.4</td>
</tr>
<tr>
<td>Proyoung (Taiwan)</td>
<td>10</td>
<td>4.8</td>
</tr>
<tr>
<td>IE (Taiwan)</td>
<td>6</td>
<td>2.9</td>
</tr>
<tr>
<td>Others</td>
<td>52</td>
<td>25.2</td>
</tr>
<tr>
<td>Total</td>
<td>207</td>
<td>100%</td>
</tr>
</tbody>
</table>

Table 3
ERP implementation consulting alternatives (N = 207).

<table>
<thead>
<tr>
<th>ERP implementation consulting alternatives (N = 207)</th>
<th>Frequency</th>
<th>Valid (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consulting services provided by ERP system vendor</td>
<td>110</td>
<td>53.1</td>
</tr>
<tr>
<td>Consulting service provided by mgmt consulting firm</td>
<td>52</td>
<td>25.2</td>
</tr>
<tr>
<td>Individual Implementation consultants</td>
<td>30</td>
<td>14.5</td>
</tr>
<tr>
<td>Others</td>
<td>15</td>
<td>7.2</td>
</tr>
<tr>
<td>Total</td>
<td>207</td>
<td>100%</td>
</tr>
</tbody>
</table>
Browne and Sandy [10] as the maximum allowable for an acceptable model.

The results show that the value of GFI approached the recommended 0.80 threshold for good fit. The chi-squares estimate (658.52) obtained in this study was significant (p < 0.001), suggesting a good fit. The value of AGFI approached the threshold of 0.80, but did not meet the more restrictive 0.90 threshold level. Overall, the fitting statistics indicate that the modified model provides a fit to the data (χ²/df = 2.94, p < 0.00001; GFI = 0.78; AGFI = 0.72; NFI = 0.87; NNFI = 0.89 and RMR = 0.05). The χ² value was significant; all other fit statistics remained within the range suggestive of a good model fit.

4.4. Results and management implications

Table 5–7 show the results, the parameters and the p-values of the assumed paths for the structural model. It can be seen in Table 8 that there are high correlations from one to another for multi-dimensional model. Synthesis of the achievement level of project management and the degree of the improvement on system performance is highly associated with the SERVQUAL no matter whether it was provided by system providers or implementation consultants. However, on the statistically significant level, the construct from SERVQUAL to system performance is not significant but to project management. That is, the significant path coefficients were as hypothesized from SERVQUAL to project management at a 0.01 significance level except from SERVQUAL to system performance as indicated in Table 7.

First, as indicated by the correlation in Table 8, the path of the perceived SERVQUAL of the system provider and implementation consultant shows a high correlation to each other, as perceived by clients. Meanwhile, both of the satisfactions of SERVQUAL in terms of external factors might also have main and moderating effects on the achievement of project management at 10% and 5% significance, respectively, without considering the joint effects; see Table 7. Such results might indicate that a higher degree of satisfaction of SERVQUAL of system providers and implementation consultants can benefit ERP implementation, leading to higher perceived SERVQUAL provided by external facilitators. The value of higher ERP project success also increases as an ERP project is fulfilled. Thus, the degree of satisfactions of perceived SERVQUAL of system providers and implementation consultants is not only important in facilitating effective ERP project management but also critical in accommodating a firm’s operational needs and driving value from an ERP package.

Next, the achievement level of project management and the degree of improvement in system performance are closely associated with the SERVQUAL regardless of whether provided by the system providers and implementation consultants. The construct from SERVQUAL to system performance is not statistically significant but to project management. The results reveal that the relationship of the SERVQUAL (whether to the system providers or consultants) with performance improvement is not obvious prior to the involvement of project management. However, it is interesting to note that this relationship becomes significant after the involvement and operation of project management. The significant path coefficients were as hypothesized from SERVQUAL to project management at a 0.01 significance level except from SERVQUAL to system performance. This might mean that SERVQUAL should be delivered and transferred through the mechanism of project management. It is thus clear that organization perceived SERVQUAL might not be completely equal to the ERP system performance improvement gained by the company. In other words, SERVQUAL does not naturally produce performance improvement by itself. Project management acts as a moderating (intermediary) mechanism for the SERVQUAL during the process of ERP implementation. Therefore, the path from SERVQUAL, whether provided by system providers or consultants to performance improvement, is indirect — not

<table>
<thead>
<tr>
<th>Inventory</th>
<th>Cronbach’s α</th>
<th>Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>The inventory of project management</td>
<td>0.927713</td>
<td>7</td>
</tr>
<tr>
<td>The inventory of SERVQUAL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SERVQUAL of system provider</td>
<td>Importance level</td>
<td>0.848893</td>
</tr>
<tr>
<td>SERVQUAL of system provider</td>
<td>Degree of satisfaction</td>
<td>0.891197</td>
</tr>
<tr>
<td>SERVQUAL of consultants</td>
<td>Importance level</td>
<td>0.901304</td>
</tr>
<tr>
<td>SERVQUAL of consultants</td>
<td>Degree of satisfaction</td>
<td>0.909673</td>
</tr>
<tr>
<td>The inventory of system performance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>System quality</td>
<td>Importance level</td>
<td>0.880925701</td>
</tr>
<tr>
<td>System quality</td>
<td>Degree of satisfaction</td>
<td>0.907037895</td>
</tr>
<tr>
<td>Information quality</td>
<td>Importance level</td>
<td>0.918133547</td>
</tr>
<tr>
<td>Information quality</td>
<td>Degree of satisfaction</td>
<td>0.909688571</td>
</tr>
<tr>
<td>System use</td>
<td>Degree of satisfaction</td>
<td>0.840503954</td>
</tr>
<tr>
<td>System use</td>
<td>Importance level</td>
<td>0.942193148</td>
</tr>
<tr>
<td>User satisfaction</td>
<td>Importance level</td>
<td>0.934826468</td>
</tr>
<tr>
<td>User satisfaction</td>
<td>Degree of satisfaction</td>
<td>0.956314206</td>
</tr>
<tr>
<td>Individual impact</td>
<td>Importance level</td>
<td>0.95806456</td>
</tr>
<tr>
<td>Individual impact</td>
<td>Degree of satisfaction</td>
<td>0.937559755</td>
</tr>
<tr>
<td>Organizational impact</td>
<td>Importance level</td>
<td>0.940387705</td>
</tr>
<tr>
<td>Organizational impact</td>
<td>Degree of satisfaction</td>
<td>0.942596526</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fit indices</th>
<th>Threshold</th>
<th>Recommended by</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>χ²</td>
<td>–</td>
<td>–</td>
<td>658.52</td>
</tr>
<tr>
<td>df</td>
<td>–</td>
<td>–</td>
<td>224</td>
</tr>
<tr>
<td>χ²/df</td>
<td>&lt; 3</td>
<td>Hayduk [24]</td>
<td>2.94</td>
</tr>
<tr>
<td>GFI</td>
<td>&gt; 0.80</td>
<td>Scott [51]</td>
<td>0.78 (approached)</td>
</tr>
<tr>
<td>AGFI</td>
<td>&gt; 0.80</td>
<td>Scott [51]</td>
<td>0.72 (approached)</td>
</tr>
<tr>
<td>NFI</td>
<td>&gt; 0.80</td>
<td>Bentler &amp; Bonett [5]</td>
<td>0.87</td>
</tr>
<tr>
<td>NNFI</td>
<td>&gt; 0.80</td>
<td>Bentler &amp; Bonett [5]</td>
<td>0.89</td>
</tr>
<tr>
<td>CFI</td>
<td>&gt; 0.8</td>
<td>Bagozzi &amp; Yi [4]</td>
<td>0.89</td>
</tr>
<tr>
<td>RMR</td>
<td>&lt; 0.1</td>
<td>Hu &amp; Bentler [27]</td>
<td>0.05</td>
</tr>
</tbody>
</table>

Notes: GFI = goodness-of-fit index NFI = normed fit index AGFI = adjusted goodness-of-fit index NNFI = non-normed fit index RMR = standardized root mean square residual
direct. On the other hand, the relationship of project management to performance improvement is quite direct.

Last but not least, the results also indicate that project management is positively related to ERP value delivery, that is, perceived ERP improvement of system performance. We find that a high level of project management is always associated with successful ERP performance. Carrying out an ERP project under the direction of project management is beneficial to facilitate effective delivery and innovation of system performance as known by identifying implementation goals, determining the strategic implementation issues and strategic requirement identification. Meanwhile, effective communication, solving problems, system integration and so on are essential elements in achieving successful ERP project management. Hence, a steering committee, responsible for system selection, the delivery and transformation of the ERP project into effective system performance, must be involved throughout the project [8].

The evidence and explanations are confirmed by the evidence.

5. Limitations and suggestions for future research

Several limitations of this study should be addressed. The first limitation is that SERVQUAL project management and system performance is measured using perceptions of functional managers. The authors follow Mabert et al. [39] in the use of subjective measures for IT research. The satisfaction, achievement and perceptive improvement level of functional managers are proxies for organizational satisfaction, achievement and perceptive improvement level, respectively. This level of analysis was chosen because managers are usually responsible for integrating ERP into their respective departmental units. Objective measures would add further support to this model and would be a fertile area of future inquiry. In addition, the sample used does enable us to measure the level of satisfaction, achievement and perceptive improvement performance of ERP implementation model, thereby achieving a significant advantage. Future studies should examine the forms of reactions between MIS department and users. Differences in goals and their importance might also be studied as a measure of managerial effectiveness.

The second potential limitation is that treating the concept of “the integrated model of internal/external contextual factors” as an independent construct of individual respectively may result in interpretational problems due to incompleteness. It is not only because some factors should work simultaneously in order to function effectively but also because the effects of multi-dimensional constructs on our research model can result in a formation of joint effects or complementarity. That is, the strength of the relationships among the constructs might be somewhat inflated and the existence of multiple factors accounting for system performance might be the primary reason driving overall system success. The significance of internal/external facilitators in driving ERP system performance needs more research. In future we could take a process approach to further analysis of the interactions between external facilitators, or between external and internal facilitators and the stakeholders of the client in the implementation process and their implications for system implantation.

Future research could also be done to examine and refine these relationships using an instrument design and hypothesis development that would enable researchers to explore causal relationship among constructs.

Moreover, subsequent study may need to be done to enhance the response rate of the questionnaire or use SEM with the partial least squares (PLS) method to provide a more comprehensive empirical evaluation. PLS is neither contingent upon data having multivariate normal distributions nor does it require the large sample sizes of other methods. Such work will help evaluate the ERP implementation model more accurately and precisely.

6. Conclusions

This paper went beyond the boundaries of the organization to discuss the internal/external contextual factors that lead to ERP system success. It provided a wider perspective to look at the whole process driving successful ERP implementation. Meanwhile, the results indicate significant causal relationship of the SERVQUAL of system providers and implementation consultants to the project management and then from the project to the system performance except from SERVQUAL to the system performance directly.

We survey the current ERP literature and identify the present state of ERP theory. We formulate propositions for three strategic factors related to ERP system performance. The propositions are in turn delineated and evaluated in terms of specific subfactors associated with each factor. On the generalizability of the study, this study has been successfully used as a comprehensive model that integrates literature streams from different fields such as SERVQUAL and project management as antecedents of on ERP success. The results provided interesting insights into ERP implementation with broad organizational impact to deal with the study of ERP system success.

In addition, based on the integrated model, we draw upon the SERVQUAL instrument, project management and information systems success theory to empirically investigate the roles of different factors that could affect ERP success. The results also indicate that SERVQUAL is thus the cause, not the consequence, of progress in system performance research and that project management forms a moderating (intermediary) mechanism for the delivery and transformation of SERVQUAL during the process of ERP implementation. Internal/external contextual factors for ERP implementation, therefore, will enable researchers to facilitate communication and mutual understanding as well as increase probability of successful ERP implementation through such integrated model.

Last but not least, this study further illustrates that higher satisfactions of SERVQUAL of system providers and implementation consultants can benefit ERP implementation, leading to higher perceived SERVQUAL provided by external facilitators delivered, and that the value of higher ERP project success also increases as fulfilling ERP project. The results illustrated the need of MIS practitioners to pay greater attention to the role of PM as well as the system and technology itself. An understanding of the relationships to the factors of ERP success theory to empirically investigate the roles of different factors could affect ERP success. The results also indicate that SERVQUAL is thus the cause, not the consequence, of progress in system performance research and that project management forms a moderating (intermediary) mechanism for the delivery and transformation of SERVQUAL during the process of ERP implementation. Internal/external contextual factors for ERP implementation, therefore, will enable researchers to facilitate communication and mutual understanding as well as increase probability of successful ERP implementation through such integrated model.

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