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Assessing ERP post-implementation success at the individual level: Revisiting the role of service quality

Pei-Fang Hsu [a,*], HsiuJu Rebecca Yen [a,1], Jung-Ching Chung [b]

[a] Institute of Service Science, College of Technology Management, National Tsing Hua University, Taiwan
[b] UPS Supply Chain Solutions

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ABSTRACT

Whereas previous studies have devoted great attention to the success of Enterprise Resource Planning (ERP) system implementation, this study aims to investigate how the different qualities of an ERP system affect its post-implementation success from the user's perspective. We refined DeLone and McLean's IS success model to examine the relative importance of ERP system quality, information quality, and service quality to post-implementation success, with users' satisfaction, users' individual benefits, and a very critical yet seldom investigated variable, users' extended use of ERP systems, as the outcome variables. Our research model was empirically examined with data from 151 ERP users. We found that service quality, in conjunction with system quality and information quality, significantly affects ERP post-implementation success in terms of user satisfaction. More importantly, service quality was found to significantly interact with information quality and system quality to promote an ERP system's post-implementation success by increasing employees' extended use.

1. Introduction

Over the past few decades, organizations have made significant investments in Enterprise Resource Planning (ERP) systems that enable them to synergize the 4M resources (man, money, material, and machines), integrate business data throughout organizations, and support critical business functions such as manufacturing, inventory management, human resources, sales, delivery, customer service, and finance [1]. An ERP system is generally considered an expensive investment, with costs ranging from half a million to $300 million, with an average cost of $15 million [2]. Despite huge investments in ERP systems, benefits after implementation are not guaranteed [3]. A recent survey finds that 57 percent of organizations suffered operation stoppages after ERP implementation [4] and that 67.5 percent failed to realize half of their projected benefits after implementation [3]. Companies often encounter great difficulties in using, maintaining, or enhancing ERP systems after implementation. These challenges may turn the costly investment into a post-implementation failure or even lead to a business disaster [5]. Therefore, the "ERP post-implementation" phase, also called the "post go-live" stage, is viewed as being critical [6–10].

However, the extant literature on ERP applications tends to focus on issues related to their adoption and implementation, with limited attention devoted to the post-implementation stage. For example, Esteves and Bohorquez [11] review study indicates that the number of ERP publications geared toward the implementation phase is 47 percent vs. 15 percent on post-implementation usage. Other meta-analytic studies (e.g., [12,13]) also report the paucity of research on ERP systems after implementation. Some scholars have acknowledged this gap and consider it a focus for the second wave of ERP research [9,10,14]. Additionally, while the majority of research has investigated ERP success at the organizational level, focusing on consequences such as profits, costs, or market share, etc. [5,10], few studies have concentrated on users' perspectives. Assessing the post-implementation success of ERP systems from the perspective of individual users is crucial because the underachievement of the implemented ERP systems may be due in part to the underutilization of the systems by the users [15,16]. In line with this argument, research also suggests that

* Corresponding author. Tel.: +886 3 5742221.
E-mail addresses: pfhsu@mx.nthu.edu.tw (P.-F. Hsu), hjyen@mx.nthu.edu.tw (H.R. Yen), jungching.chung@gmail.com (J.-C. Chung).
[1] Tel.: +886 3 5162146.

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positive impacts for the organization result from accumulated benefits that individuals obtain from their use of the ERP packages (e.g., [17,18]).

Thus, in this article, we extend the current ERP literature by revisiting DeLone and McLean's information systems success model (D&M IS success model; [19,20]) and proposing a framework that explains the success of an ERP system at the post-implementation phase from individual users' perspectives. Specifically, this study addresses two research issues that deserve further attention. The first gap is the need for understanding users' "extended use" of an ERP system and its relationship with the other components of the D&M IS success model when evaluating the success of the implemented ERP systems. Compared with other success constructs in the D&M model (e.g., system use, user satisfaction, and net benefits), extended use is a success construct that is often overlooked, and its relationship with other success constructs is not well understood [21]. Petter et al. [21] conclude that the inadequate understanding of "system use" seems to be largely caused by oversimplified or unspecified measures of this construct. When using an implemented ERP system, employees are required to use the system to perform their routine, which makes use/nonuse or frequency of use an insensitive indicator of individual impact. However, employees have discretion or flexibility in deciding the extent of their system usage. Firms that intend to further realize the benefits promised by mandatory systems must shift their employees from simple and shallow use during initial adoption to "extended use" because the full utilization of the system constitutes the basis of the system's success [15,20]. Hence, apart from previous studies that focused on the simple dichotomous use decision or amount of usage (e.g., frequency, time, etc.), this study turns to the notion of extended use, which refers to using a wider range of system functionalities for work productivity [15]. In this manner, we can better capture the important aspect of an ERP system as a complex IS that permits employees to use the system at different levels of sophistication [22]. Because the system of investigation has important implications in explaining extended use [15], by aligning the notion of extended use with the mandatory nature of ERP systems, this study complements the literature on assessing an ERP system's success after implementation.

The second gap that needs to be addressed is the lack of understanding of the interrelationships among information quality (IQ), system quality (SQ), and service quality (ServQ) after ERP systems are implemented. In an effort to re-specify their original model, DeLone and McLean [20] incorporate ServQ to complement the other quality dimensions because evaluating the success of an IS would be incomplete if the services provided by IS personnel were not properly considered. Despite increasing attention to the effects of ServQ in IS research, our knowledge regarding its roles in facilitating the success of an IS remains fragmented. Petter and McLean [23] meta-analytical study reports that only a few empirical tests of the D&M model have examined ServQ and that none of those studies found significant relationships between ServQ and other IS success constructs. Although researchers have urged the need to explicate the interactions among the IS success constructs [19–21,24], existing investigations of the updated D&M model assume that the three types of quality do not affect each other. While the exceptional studies that have examined the interrelationships among the three quality dimensions have proposed a mediation model [25,26], the relationships of the constructs within the D&M model can vary across contexts [20].

ERP systems are complex in nature, and their deployment is typically in conjunction with the continuous reengineering of business processes. Thus, despite their initial acceptance of the systems, users' utilization of such complex systems and realization of anticipated benefits at the post-implementation stage may rely even more on IS personnel support and services, such as user training and bridging communication between users and the vendor [11]. Arguably, the impacts of an implemented ERP system's quality on use are, in part, a consequence of the interplay between the ServQ of the IS staff and the system's IQ and SQ. To that end, this study is designed to contribute to the IS literature by extending the D&M model and refining previous assumptions on the interdependency among IQ, SQ, and ServQ. Specifically, we illuminate the missing role of ServQ (i.e., its moderation on the influences of an adopted ERP system's IQ and SQ in evaluating the system's success). By highlighting the role of in-house IS staff as a complementary asset to the ERP system's IQ and SQ at the post-implementation stage, this study advances knowledge in the area of ERP post-implementation performance, which has predominantly focused on services provided by vendors or external consultants (e.g., [18,27]).

2. Literature review and theoretical foundation

We first review existing studies that focus on ERP post-implementation performance. As summarized in the review table (see Appendix A), most prior studies have examined ERP post-implementation performance at the firm level (i.e., the first nine articles in the table). Typical outcome variables include firms' profits, product quality, market value, productivity, process efficiency, shareholder return, etc. Few works have studied ERP post-implementation at the individual level. Notably, these studies tend to focus on one or two outcome variables, such as user satisfaction, user performance, or users' intention to use ERP systems. For example, Sykes et al. [28] investigate how employees' ERP post-implementation job performance is predicted by workflow and software advice. Through the lens of the social network structure, Sasidharan et al. [29] find that an individual's post-implementation performance is a function of his/her in-degree and betweenness centralities. In other studies, researchers employ satisfaction (e.g., job satisfaction; satisfaction with the system) to measure individual-level post-implementation success (e.g., [30,31]). Lastly, others consider an individual's use of the system as a proxy for the success of an implemented ERP and how such use is associated with job design [32] and learning [33]. There is no doubt that these studies have advanced our understanding of ERP post-implementation success at the individual level; however, that each of them focuses on only one or two "success" constructs has resulted in fragmented knowledge regarding an ERP system's post-implementation success.

Noting this gap in the literature, researchers (i.e., [34,35]) argue that the need to re-conceptualize IS success. Specifically, Gable et al. [34] model the success of ERP systems based on the assumptions that IS success is multi-dimensional and that the positive impacts of the IS are the ultimate outcomes sought by organizations. Their IS impact model suggests that four dimensions, including IQ, SQ, individual impact, and organizational impact, can effectively define the system's success. Despite their notable contributions in re-conceptualizing IS success, Gable et al.'s IS impact model remains limited in explaining an implemented ERP system's success at the individual level. First, their model does not consider ServQ, which has been proposed as an important factor when studying IS success [20]. Second, the IS impact model, which intends to measure success at the organizational level, has excluded success measures (i.e., extended use, satisfaction) that are critical to individual users who have adopted the ERP systems. Finally, the relationships among the success measures of an implemented ERP system remain unknown.

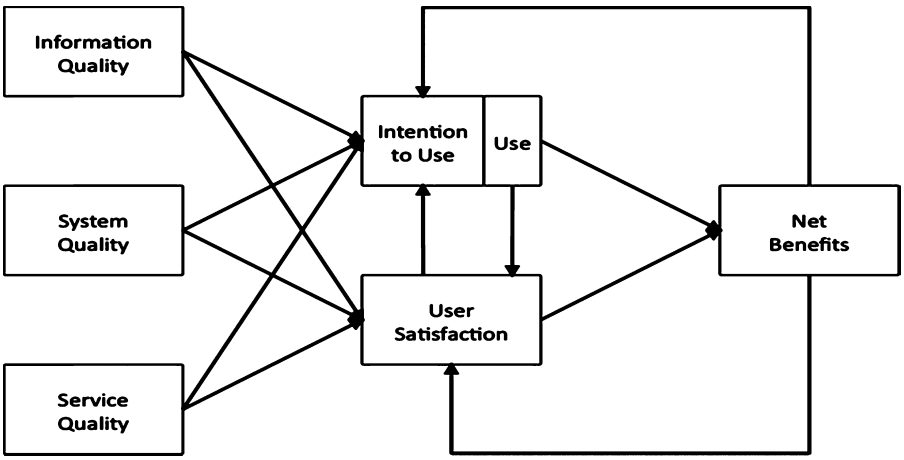


Fig. 1. DeLone & McLean updated is success model (2003).

DeLone and McLean [19], DeLone and McLean [20] IS success (D&M IS Success) model provides a useful lens through which we can understand ERP post-implementation success in a more integrative manner. By reviewing over 100 measures used in 180 studies for definitions of IS success and their antecedents, DeLone and McLean [20] have developed an IS success model (see Fig. 1) that systematically combines previously reported measures. The IS success model can be interpreted as follows: an IS system can be evaluated based on three quality dimensions: IQ, SQ, and ServQ. In the context of ERP, IQ and SQ indicate the resources, which are technically oriented, derived from the ERP system itself that impact users, whereas ServQ could signal the resources, which are human-oriented, controlled by the IS staff to affect users. These quality factors affect users' use/intention to use and satisfaction. Through use or intention to use, certain net benefits are achieved. The D&M IS Success model is the most widely cited and has made valuable contributions to our understanding of IS success [34]. In addition to many studies that have tested the D&M IS Success Model, DeLone and McLean [36] have validated their own model in the context of e-commerce.

Building on DeLone and McLean [20] and Gable et al. [34], we model ERP post-implementation success as multi-dimensional, with the aim to contribute to the literature in two aspects. First, this study examines the direct and indirect effects of ServQ on individual impact. A recent meta-analysis indicates that ServQ has received scant research attention [23]. Indeed, research on ERP systems has rarely examined human-based ServQ in the presence of IQ and SQ (e.g., [8,10,37]). Among the few studies that have examined human-based ServQ, they focus on services provided by the ERP system vendor or ERP consultants [27,38]. Taken together, these findings suggest much work is needed to learn how the ServQ of internal IS personnel, together with IQ and SQ, determines the success of implemented ERP systems. Second, this research contextualizes the measures of individual impact. DeLone and McLean [20] note that the selection of IS success dimensions and constructs should be contingent on the objectives and context of the empirical investigation. Given that this study is interested in the employee's use of an implemented mandatory system, "extended IS use" would more accurately reflect the success of the ERP system than constructs such as frequency of use. More importantly, we delineate the interrelationships between these success measures. We describe our model in more detail in the following section.

3. Research model and hypotheses

To address the two identified research gaps, we have modified the D&M IS success model to elucidate how individual users assess the success of an implemented ERP system (Fig. 2). The research model consists of six constructs that are categorized into two groups, one group for the three types of quality and another group for the impacts on users (i.e., user satisfaction, extended use, and individual benefits). By taking into account the characteristics of implemented ERP systems, the framework explicates how the three quality constructs, independently and through their interactions, affect user satisfaction and extended use. In addition, the

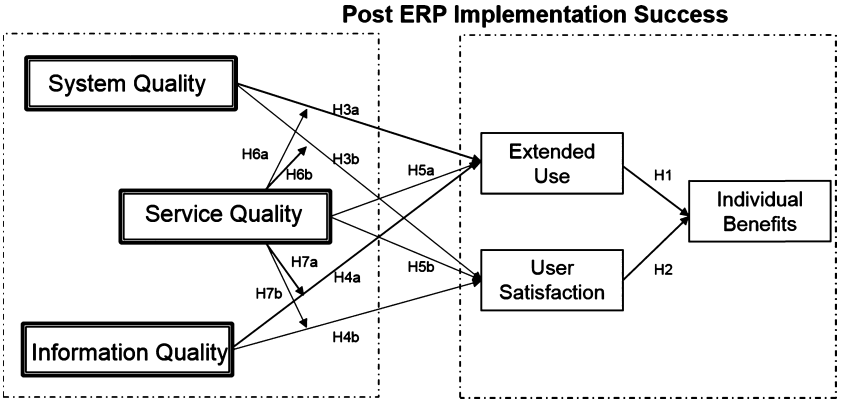


Fig. 2. Research framework.

framework posits that extended use and satisfaction will influence individual benefits.

3.1. Relationships among measures of individual-level impacts

3.1.1. Individual benefits

Individual benefits refer to "the effect of information on the behavior of the recipient" [19] or "the extent to which the IS has influenced users' capabilities and effectiveness" [34]. While the major objective of a firm is to maximize profits, it is essential to recognize that profits are generated from productive employees. When the effect arising from an information system is high for an individual, it is likely that the impact for the organization to which the individual belongs will also be high [18]. The organization will experience a positive outcome only when its constitutive entities are positively impacted [18]. Therefore, this study investigates an individual's (i.e., an employee's) benefits rather than the firms' profits. The post-evaluation of an ERP system on an individual's benefits is necessary because it not only justifies the investments but also provides insights concerning how to better manage employee behavior [39]. In this study, we define individual benefits as users' perceptions of the importance and usefulness of the ERP system that affect their capabilities and effectiveness.

3.1.2. Extended use

In the original D&M IS success model, system use refers to the "recipient consumption of the output of an information system" [19], and use is often measured as the number of times visiting an IS and transaction execution [19,20]. However, many researchers suggest that use/nonuse or amount of use (e.g., time, frequency) may not adequately explain IS success in some contexts. For example, measuring the presence of system usage only makes sense for voluntary users [18,34,40], in contrast to situations in which using ERP is mandated in an organization because users have to use ERP systems to perform their routine tasks. Given that no single measure of system use is applicable across contexts, a research call has been made for better conceptualizations and operationalizations of this construct based on the study context [41,42]. According to Burton-Jones and Straub [41,42], the definition of individual-level system use should specify "an individual user's employment of one or more features of a system to perform a task." To that end, a meaningful measure of an ERP system's use needs to consider the characteristics of the system, the individual/user using the system, and the task performed with the system.

Based on this view, conceptualizing the system use of the ERP system must recognize that it is a rich, highly contextualized behavior. Given that system use typically involves the system, the users, and the task, a rich measure of system use should attempt to capture more or less of these elements [41,42]. In this vein, we contend that extended use is an appropriate measure because it considers the elements of system context (i.e., breadth of use) and task context (i.e., variety of use in different tasks) in conceptualizing system use. For an implemented ERP system, although the use is mandated, a content-valid and contextualized measure in this context must reflect the discretion of such usage and the critical use behaviors that can contribute to the system's post-implementation success. Thus, extended use, defined as the extent to which employees are willing to use more functionalities of the system and apply the ERP system to execute more tasks, is considered an effective measure for assessing the success of an ERP system [20,33,40,43,44].

Extended use is critical to the post-implementation success of the ERP systems because most firms implementing an ERP rarely use their system to its fullest potential and realize the promised return on investment [16]. Research finds that, in the early stage of implementation, users often struggled to understand how to use ERP systems to support their jobs and only use a small number of functions. This simple and shallow usage of ERP systems is frequently observed when users initially accept ERP systems [15]. Over time, if users can find additional useful features and apply them to their jobs, then they may consequently receive the full benefits of the ERP system [44]. That is, by going beyond the routine usage of the system, employees have the opportunity to exploit the richest potential assumed by the system to support their work, resulting in higher productivity and performance [15,45]. Accordingly, we hypothesize the following:

H1. Users' extended use of ERP systems is positively associated with users' individual benefits.

3.1.3. User satisfaction

User satisfaction refers to the "recipient response to the use of the output of an information system" or the degree to which users feel that the IS meets their requirements [19]. Satisfaction is the consequence of users' experiences during the stages of need arousal, information search, alternatives evaluation, purchase decision, and post-purchase behavior [46]. An ERP is a complicated information system because it involves almost all business processes, while users' requirements for an ERP also cover all business processes, across vertical levels or horizontal sectors [47]. Accordingly, the definition of user satisfaction in the present study is the extent to which users perceive a match between their requirements and ERP functionality. Evidence in the literature indicates that system use, though mandatory, is not sufficient to receive system benefits [40,48]. Instead, satisfied ERP employees are more likely to be productive, especially in situations in which the use of such systems is mandatory [48]. Therefore, we hypothesize the following:

H2. User satisfaction is positively associated with users' individual benefits.

3.2. Qualities and individual-level impacts

3.2.1. System quality

System quality refers to the measures of the information processing system itself (i.e., the quality of the performance of the IS from a technical perspective; [19,34,49]). System quality is generally classified as (1) system-related dimensions and (2) task-related dimensions. System-related dimensions measure the characteristics that are unvaried across different uses and independent of task, context, or application, such as accessibility and reliability. Task-related dimensions measure the characteristics that depend on specific tasks and settings, such as flexibility, response time, and integration [49]. If users experience a stable system, with accessibility and reliability, and perceive that the ERP system helps them better complete their jobs, then they are more inclined to extend their use of the system's functions and features. Furthermore, both the D&M IS success model [20] and prior research (e.g., [50–52]) suggest a positive relationship between system quality and user satisfaction, and this relationship has been examined by numerous empirical studies. Therefore, we hypothesize the following:

H3a. Higher system quality is associated with a higher level of extended use.

H3b. Higher system quality is associated with a higher level of user satisfaction.

3.2.2. Information quality

IQ refers to the measures of information system output (i.e., the quality of information the system produces, primarily in the form of reports or screens; [19,34]). IQ is generally classified as (1) contextual and (2) representational dimensions [49,53]. The *contextual* dimension values the quality of information that ERP systems produce for users. The main measurement is the accuracy of information (whether information is accurate, updated, and consistent). The degree to which the information is helpful, relevant, complete, and current is also included in this dimension. The *representational* dimension reflects the degree to which information presentation is clear and interpretable; therefore, the key measurement is the format [49]. It is reasonable to assume that, when users perceive that information is accurate, updated, consistent, relevant, complete, and the format is easy to understand, it would lead them to higher levels of extended use and satisfaction. Accordingly, we hypothesize the following:

H4a. Higher information quality is associated with a higher level of extended use.

H4b. Higher information quality is associated with a higher level of user satisfaction.

3.2.3. Service quality

ServQ refers to the overall support offered by the service provider [20]. Many scholars, such as Pitt et al. [54], have observed a drawback in that "commonly" used measures of IS success focus on the systems rather than the services provided by IS departments or vendors. In response, DeLone and McLean [20] include ServQ in the model and specifically indicate that, to measure the success of a single information technology (IT), information or system quality may be a very important factor but, to measure the overall success of an information system, ServQ may become the most important factor. Thus, DeLone and McLean [20] adapt SERVQUAL, an instrument developed by Parauraman et al. [55] for assessing ServQ, into the IS domain. To measure ServQ, it includes the following five dimensions: *tangibility, reliability, responsiveness, assurance*, and *empathy*. In this study, ServQ refers to the quality of services delivered by the IS department to users within the organization, evaluated based on the five dimensions listed above.

However, in a meta-analysis of 52 empirical studies based on or related to the D&M model, Petter and McLean [23] find that only four of these studies tested the relationship between ServQ and use, while another three tested the relationship between ServQ and user satisfaction. More surprisingly, none of these studies empirically demonstrates significant relationships between ServQ and use or user satisfaction. By contrast, SQ and IQ consistently show significant relationships with use and user satisfaction in many of these prior empirical studies. The meta-analysis shows not only that ServQ has received much less research attention but also that its relationship with other IS success constructs is not well understood. Petter and McLean suggest that a possible reason for these unexpected findings is the lack of appropriate measures and that the "use" construct needs to be carefully measured in different contexts. To this end, Hsieh et al. [56] find that "extended use," in the context of using the customer relationship management (CRM) system, had a significant relationship with the ServQ that was assessed by their customers. While services provided by IS personnel do not directly signify the quality of the ERP system itself, by having IS personnel provide good ServQ through courteous interactions with users (assurance), bearing users' interests in mind and being understanding of their needs (empathy), and by solving users' problems in a timely manner (responsiveness), users may feel encouraged to learn and attempt more of the available functions of the implemented system. The positive interactions with IS personnel may also promote more satisfactory experiences when using the mandatory system [27,57]. Based on this reasoning, we propose the following hypotheses:

H5a. Higher service quality is associated with a higher level of extended use.

H5b. Higher service quality is associated with a higher level of user satisfaction.

DeLone and McLean [20] and other researchers (e.g., [40]) strongly express the need to examine the interrelationships among the constructs in the D&M model; however, research is generally silent on the interaction effects among the three quality dimensions. Among the few studies that illuminate this issue, Gorla et al. [57] test the relationship between SQ and IQ, while Wang and Chen [27] examine the relationship between ServQ and SQ. Thus, our study goes a step further to examine whether ServQ can enhance the impact of SQ and/or IQ in determining post-implementation success. In a mandated use situation, a system with high information quality and system quality is essential but not sufficient for promoting the extended use of more available functions. Support from IS personnel can contribute by increasing employees' confidence in attempting new functions. Thus, with equivalent levels of IQ and SQ, we predict that employees who experience high ServQ should feel more comfortable attempting more ERP functions and feel more satisfied with the systems than those who receive low ServQ. Accordingly, we hypothesize the following interaction effects:

H6a. Service quality enhances the relationship between system quality and extended use.

H6b. Service quality enhances the relationship between system quality and user satisfaction.

H7a. Service quality enhances the relationship between information quality and extended use

H7b. Service quality enhances the relationship between information quality and user satisfaction.

3.3. Control variable: ERP vendor

To determine whether the ERP vendor affects ERP post-implementation success, all ERP vendors investigated in this study are divided into two groups. The first group consists of first-tier ERP vendors (i.e., the top players in the industry, such as SAP and Oracle), whereas the second group is composed of medium-sized and smaller vendors.

4. Methodology

4.1. Data collection

To test our research model, a questionnaire was designed to collect data on each of the variables in the model. Each of the items on the questionnaire was reviewed for content validity by an expert panel composed of faculty whose work focuses on ERP systems and some practitioners and consultants from industry. The initial questionnaires were piloted on ten respondents randomly selected from the sample frame; based on their responses, some items were revised for clarity. Q-sorting was also conducted to evaluate whether the measures could be categorized based on theoretical predictions [58].

Given that our data are collected from a single source, we took a number of steps suggested by Podsakoff et al. [59] to reduce the

possibility of common method bias, including appropriate instrument design and data collection procedures. First, we used multiple items for each construct and ensured the neutral wording of the items. Second, following the "protecting respondent anonymity and reducing evaluation apprehension" strategy [59], we assured respondents of the anonymity of their responses and emphasized that there were no right or wrong answers; each of these actions enabled them to answer questions as honestly as possible. Third, we used Podsakoff et al. [59] "separation of measurement" strategy and separated the measurement of predictors and criterion variables in the questionnaire. Doing so diminishes the respondent's ability and motivation to use his/her prior responses to answer subsequent questions.[2]

To collect data, the questionnaire and a cover letter were sent by email or postal mail to ERP users in medium and large high-tech manufacturing companies in Taiwan. We chose the high-tech manufacturing industry because ERP systems are popularly adopted in this industry and because medium and large high-tech manufacturing companies are considered to be the most experienced and mature firms in using ERP systems [60]. The qualified respondents for the survey were ERP users (i.e., employees who have to use ERP systems to conduct their daily business tasks). In total, we collected 151 valid responses from 16 firms. The sample characteristics are shown in Table 1. We found that the respondents work in different departments in the high-tech manufacturing companies, ranging from sales and marketing to technology and administration. Up to 97 percent of our respondents used ERP systems at least once a week, 68 percent were frequent users who use ERP system every day, which indicates that our respondents have sufficient knowledge and experience to answer our questionnaire. In addition, approximately 81 percent of the respondents were non-managers, whereas 19 percent were in managerial positions, and approximately 58 percent of our sample used systems from first-tier ERP vendors. Nearly 70 percent of our respondents had more than two years of experience using an ERP system, whereas the remaining respondents had less than two years of experience. It seems interesting to further investigate whether the novice ERP users may respond differently from experienced ERP users. We performed some between-group tests regarding their response value to each variable used in our model. We used *t*-tests to compare the means and further computed the Kolmogorov–Smirnov test statistics to examine the sample distribution of the two groups [61]. Responses from the two groups did not differ significantly in terms of either sample means or sample distributions.[3]

4.2. Measures

All research constructs included in this study had multi-item scales derived from the relevant literature. Each item in the survey employed a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree), and a not applicable (NA) option was available for the respondents to choose. We now elaborate our measures for the constructs, which are shown in Table 2 and Appendix B.

4.2.1. System quality

SQ was measured with 8 items adapted from Gable et al. [34]. Following the suggestion of Nelson et al. [49] to consider the

[2] We also conducted two statistical tests to examine common method bias (Harman one-factor test and common method factor test). Results are discussed in data analysis section and in Appendix C.

[3] The two groups have significantly different responses in two research constructs — *Assurance* and *Extended use*. We further discuss this finding in Section 5.

Table 1
Sample characteristics ($N = 151$).

Category	Percentage
Department	
Administration	27.81
Sales and Marketing	31.13
Technical	25.83
Manufacturing	12.58
Top Management	1.32
Others	0.14
Education	
High School	2.65
College and University-Bachelor	80.79
University-Master	16.55
Job level	
Non-Manager	80.79
Manager	19.20
ERP vendor	
First Tier	57.62
Second Tier	42.38
Have used this ERP for	
Under 2 years	30.46
2 (including)–5 years	46.36
6 (including)–8 years	17.88
Over 8 years	5.30
Frequency of use	
Every day	68.21
Three times a week	14.57
Once a week	14.57
Others	2.65

Table 2
Reliability and convergent validity of reflective constructs.

Construct	Indicator	Loading	AVE	Composite reliability
System quality				
System-related	SQ1	0.789***	0.560	0.835
	SQ2	0.716***		
	SQ3	0.659***		
	SQ4	0.819***		
Task-related	SQ5	0.798***	0.597	0.855
	SQ6	0.806***		
	SQ7	0.800***		
	SQ9	0.690***		
Information quality				
Contextual	IQ1	0.814***	0.600	0.857
	IQ2	0.812***		
	IQ3	0.782***		
Representational			0.844	0.916
	IQ5	0.910***		
	IQ6	0.920***		
Service quality				
Tangibility	SRQ1	0.746***	0.566	0.838
	SRQ2	0.848***		
	SRQ3	0.644***		
	SRQ4	0.758***		
Reliability	SRQ5	0.895***	0.767	0.943
	SRQ6	0.875***		
	SRQ7	0.904***		
	SRQ8	0.860***		
	SRQ9	0.844***		
Responsiveness	SRQ10	0.891***	0.838	0.912
	SRQ11	0.899***		
	SRQ12	0.905***		
Assurance	SRQ13	0.948***	0.847	0.957
	SRQ14	0.941***		
	SRQ15	0.866***		
	SRQ16	0.926***		
Empathy	SRQ17	0.880***	0.797	0.940
	SRQ18	0.882***		
	SRQ19	0.897***		
	SRQ20	0.911***		
Extended use	EXT1	0.850***	0.512	0.802
	EXT2	0.781***		
	EXT3	0.769***		
	EXT4	0.707***		

*** $p < .001$.

dimensions of SQ using a spectrum that ranges from *system* to *task*, we categorized the measuring items *into system-related* or *task-related*. Items for *system-related* quality assessed the characteristics of a system that are unvarying across different uses and independent of task, context, or application (e.g., ease of use, ease of learning system accuracy). *Task-related* quality comprised items that measure the characteristics that are best evaluated in the context of a specific task and setting (e.g., flexibility, integration, customization, user requirements). While system-related and task-related qualities of the system were modeled as reflective latent constructs, SQ was conceptualized as a second-order formative construct in this study. This conceptualization was used for two reasons. First, the causality directions move from the two dimensions to the overall assessment of SQ, rather than from the SQ to the two dimensions [62]. Second, as indicators of the higher-order construct, SQ, the two dimensions are not interchangeable [63].

4.2.2. Information quality

We measured IQ using a 5-item scale adapted from Gable et al. [34] that captures the two information system dimensions (i.e., *contextual* and *representational*) proposed by Nelson et al. [49]. Items for the *contextual* dimension of information system assessed the degree to which the ERP system is helpful in performing particular tasks (e.g., relevance, availability), whereas items for the *representational* dimension measured the extent to which information presentation effectively facilitates interpretations and understanding (e.g., format and conciseness). Based on the same reasoning for SQ, IQ was also modeled as a second-order formative construct composed of the two dimensions because changes in the contextual and representational quality of the system output will influence users' perceptions of the IQ of the ERP.

4.2.3. Service quality

We refined prior ServQ measures [54,55] to represent the quality of the support that system users receive from the IS department and IT support staff. In line with prior studies, a 22-item scale was used to capture the five dimensions of ServQ: *tangibility, reliability, responsiveness, assurance*, and *empathy*. Researchers suggest that ServQ should be a formative, higher-order construct (e.g., [64–66]) because the dimensions generate the overall perception of ServQ. Thus, we modeled ServQ as a second-order formative construct composed of the five first-order dimensions, whereas the first-order dimensions are operationalized as reflective constructs.

4.2.4. Extended use

To measure extended use, we adapted four items from Bhattacherjee [67] and Hsieh and Wang [15]. The items were rephrased to correspond to assessing the extent to which the users intend to continue use and expand their use of the system, including using more functions and using the system when performing different tasks. One item that was worded negatively to control for potential common-method bias assessed respondents' discontinuance intention (i.e., recommending that the firm use an alternative information system).

4.2.5. User satisfaction

Satisfaction with the ERP system was measured with a 4-item scale based on Wixom and Todd [68] and Sedera and Tan [31]. The four items assessed the extent to which respondents feel satisfied with the information received from the ERP system, their interaction with the system, the service provided by the IS staff, and the global satisfaction with the ERP system. We modeled user satisfaction as a formative construct here because overall satisfaction with an implemented ERP system is a composite of multiple measures; each measure captures different aspects of satisfaction in the moment [69]. In this instance, the combination of these measures defined an individual employee's satisfaction with the system.

4.2.6. Individual benefits

A 4-item scale developed by Gable et al. [34] was adopted to measure individual benefits. According to Gable et al. [34], individual benefits refer to the degree to which the focal system has affected the users' capabilities and effectiveness on behalf of the organization. Specifically, the respondents were asked whether ERP systems influenced their learning, awareness/recall of job-related information, decision effectiveness, and individual productivity. Following the same logic we used for modeling user satisfaction, we conceived individual benefits as a formative construct. As Jarvis et al. [63] have stated, changes in the formative measures cause changes in the underlying construct. Changes in each measure of individual benefits cause changes in one's perceived benefits of using the ERP system; as a result, the measures of individual benefits were operationalized as formative.

5. Data analysis and results

5.1. Measurement model

We estimate the reliability, convergent validity, and discriminant validity of each measurement scale to assess the measurement model. *Construct reliability* measures the stability of the scale based on an assessment of the internal consistency of the items measuring the construct. All the reflective constructs in our model shown in Table 2 have a composite reliability (CR) over the cutoff of 0.70, as suggested by Fornell and Larcker [70], implying high internal consistency. *Convergent validity* is verified through the *t*-statistic for each factor loading. Table 2 shows that all factor loadings are greater than the typical cutoff value of 0.5 [71] and significant at the $p < .001$ level. Cross-factor loadings are reported in Appendix D. Next, we perform tests to validate the formative constructs contained in our research model. Regarding formative constructs, it is suggested that the items of well-specified formative constructs should have significant weights [69,72]. Multicollinearity among indicators should also be avoided; it can be checked by determining whether each construct's variance inflation factor (VIF) is less than the cutoff value of 3.33 [62]. Table 3 shows that the weights for the indicators of "user satisfaction" and "individual benefits" are all significant ($p < .001$), which, in addition to the low VIF values, indicates acceptable construct validity. Furthermore, our model includes three second-order formative constructs (i.e., SQ, IQ, and ServQ) that each represent a broader contextual factor that covaries with several underlying first-order factors [73]. Second-order constructs are modeled at a higher or more abstract level, and their use is common [73]. Table 4 shows that the weights of each dimension to its designated constructs are significant ($p < .001$) and that the VIF values are low. Hence, a formative model seems to be suitable.

Discriminant validity measures the extent to which different constructs diverge from one another. In Table 5, the diagonal elements represent the square root of Average Variance Extracted (AVE), providing a measure of the variance shared between a construct and its indicators. The square root of AVE is required to be larger than the correlations between constructs (i.e., the off-diagonal elements) to meet the criteria for discriminant validity [70]. The constructs used in the model meet the criteria.

To address any possible common method effect, we conducted two tests to determine the extent of method variance in the data. First, we performed Harman's single-factor test and found that one general factor cannot account for the data variance. Second, we

Table 3
Validity of first-order constructs (formative).

First-order formative constructs	Indicators	Weight	VIF
User satisfaction	SAT1	0.441***	1.023
	SAT2	0.302***	2.208
	SAT3	0.178***	1.000
	SAT4	0.244***	2.209
Individual benefits	IND1	0.217***	2.085
	IND2	0.294***	1.132
	IND3	0.323***	1.089
	IND4	0.309***	1.057

*** $p < .001$.

Table 4
Validity of second-order constructs (formative).

Second-order constructs	First-order constructs	Weight	VIF
System quality	Task-related	0.517***	1.534
	System-related	0.596***	1.534
Information quality	Contextual	0.603***	1.504
	Representational	0.509***	1.504
Service quality	Tangibility	0.137***	3.126
	Reliability	0.252***	3.286
	Responsiveness	0.195***	3.077
	Assurance	0.271***	3.315
	Empathy	0.267***	1.427

*** $p < .001$.

followed Podsakoff et al. [59] and Liang et al. [74] to perform a "common method factor test," which is a more sensitive statistical test of common method bias. Appendix C shows that the average substantively explained by the variance of the indicators is 0.733 and the average method based variance is 0.009. None of the method factor loadings is significant. These results suggest that there is less concern for common method bias in this study.

5.2. Results of hypotheses testing

We used SmartPLS 2.0 (SmartPLS GmbH, Hamburg, Germany) as the analytical software to evaluate the research model and for hypotheses testing. The results of the structural model are shown in Fig. 3. Our model offers adequate explanatory power, with *R*-square values ranging from 41.4–63.2%. We provide the standardized path coefficient of each link suggested by our model, which allows for comparisons of the effects of different quality factors. First, we find that users' extended use is significantly related to users' individual benefits ($\beta = 0.491$, $p < .001$), which indicates that, when individuals go beyond simple and routine use but can extensively apply more ERP system features to support their work, their task performance may be significantly enhanced. Thus, H1 is supported. For a complex information system such as an ERP system, it is frequently observed that users may only use limited features or seldom apply task-related features to relevant operations [1,15]. Therefore, our study provides a more sophisticated concept, extended use, which is a valuable perspective for achieving the full potential of a complex information system. Second, user satisfaction is also positively associated with individual benefits ($\beta = 0.297$, $p < .001$), and therefore, H2 is supported. The result empirically confirms previous studies' observations that, although system use is mandatory, it is not sufficient to receive ERP benefits [40,48]. Instead, satisfied ERP employees are more likely to be productive, especially in situations in which the use of such systems is mandatory [48].

After we understand the importance of extended use and satisfaction, we go a step further to investigate the antecedents that may drive individuals' extended use of ERP and their satisfaction levels. Our results show that all the quality dimensions (system, information, and service) have a significant impact on user satisfaction; thus, H3b, H4b, and H5b are supported by our data. However, extended use is significantly affected by SQ and IQ ($\beta = 0.301$, $p < .001$ and $\beta = 0.258$, $p < .001$, respectively), whereas ServQ shows only a marginal impact ($\beta = 0.157$, $p < .1$). Thus, H3a and H4a are supported, whereas H5a is not. However, we note that ServQ has a dominant impact on users' satisfaction ($\beta = 0.507$, $p < .001$).

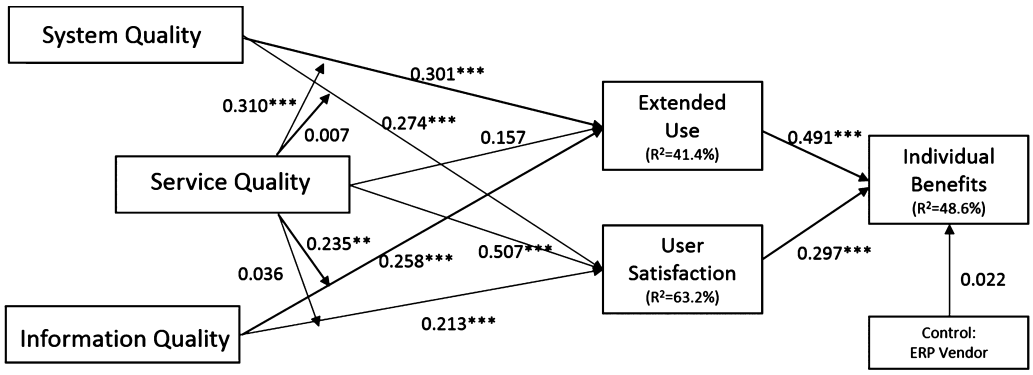
H6 and H7 predict that ServQ will enhance the effects of IQ and SQ on user satisfaction and extended use. We found significant effects for ServQ in moderating the relationship between SQ and extended use ($\beta = 0.310$, $p < .001$) and the relationship between IQ and extended use ($\beta = 0.235$, $p < .01$), thus supporting H6a and H7a. In contrast to the predictions of H6b and H7b, ServQ is not a significant moderator for the effects of information quality and system quality on satisfaction ($\beta = 0.007$, n.s. and $\beta = 0.036$, n.s., respectively). We must note that ServQ's main effect on satisfaction is already very significant ($\beta = 0.507$, $p < .001$). These results imply that the effect of ServQ not only is exerted directly on *satisfaction* but also significantly increases the other two quality dimensions' impacts on extended use and eventually increases individual benefits.

The above results show that ServQ plays a contingency role that we cannot overlook. To further explore the interaction effects, we plot the relationship of SQ and extended use for high and low ServQ. Fig. 4a shows that the relationship between SQ and extended use is stronger (i.e., steeper slope) for users who received better ServQ. In other words, for users who perceived similarly high IQ, the extent of their use of the ERP system is much higher when ServQ is high, in comparison with those who received low ServQ. The plot on the interaction effect of ServQ with IQ reveals a similar pattern (see Fig. 4b). Thus, firms should anticipate the uphill task they face with users who are not predisposed to ERP extended use—they will likely require a stronger pitch (i.e., ServQ)

Table 5
Results of the measurement model (correlation matrix).

	Mean	SD	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(1) System-related	3.52	0.60	**0.75**											
(2) Task-related	3.30	0.65	0.59	**0.77**										
(3) Contextual	3.58	0.53	0.57	0.57	**0.77**									
(4) Representational	3.47	0.63	0.55	0.42	0.64	**0.92**								
(5) Tangibility	3.15	0.59	0.48	0.34	0.39	0.31	**0.75**							
(6) Reliability	3.67	0.69	0.31	0.18	0.30	0.11	0.53	**0.88**						
(7) Responsiveness	3.51	0.78	0.29	0.14	0.28	0.17	0.49	0.83	**0.92**					
(8) Assurance	3.63	0.75	0.32	0.26	0.29	0.17	0.48	0.81	0.80	**0.92**				
(9) Empathy	3.44	0.77	0.33	0.27	0.31	0.16	0.48	0.85	0.80	0.84	**0.89**			
(10) Extended use	3.40	0.55	0.40	0.49	0.53	0.35	0.26	0.29	0.23	0.37	0.32	**0.72**		
(11) Satisfaction	3.38	0.54	0.57	0.57	0.62	0.44	0.52	0.48	0.43	0.49	0.56	0.54	**0.84**	
(12) Individual benefits	3.59	0.64	0.53	0.57	0.64	0.41	0.30	0.23	0.19	0.33	0.30	0.57	0.56	**0.87**

Note: Diagonal elements are the square root of AVE. SD means standard deviation.



Note: *p<.05; **p<.01; ***p<.001;

Fig. 3. Results of our proposed model. *Note*: $^{*}p < .05$; $^{**}p < .01$; $^{***}p < .001$.

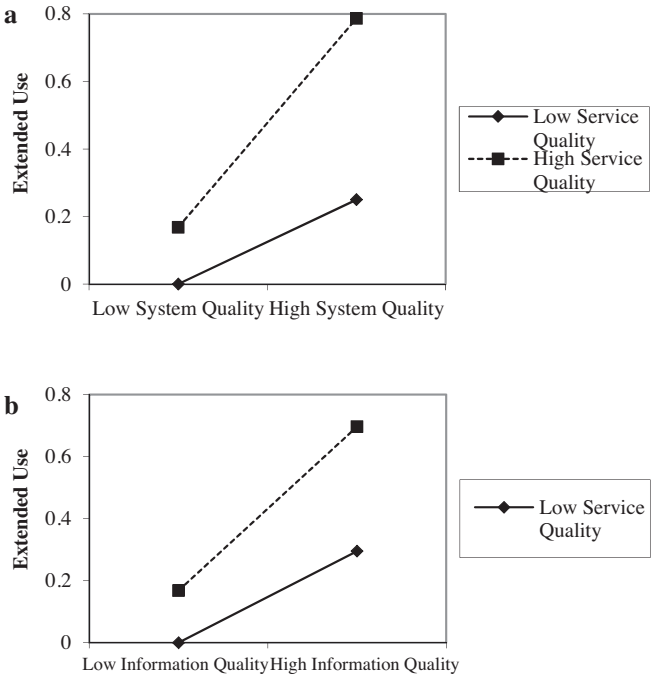


Fig. 4. (a) Interaction effect of service quality with system quality on ERP extended use. (b) Interaction effect of service quality with information quality on ERP extended use.

that goes beyond mere good system quality or good information quality.

5.3. Alternative model

To further understand how our proposed model may increase explanatory power in an ERP context, we test the original D&M IS success model using our data. In other words, we replace extended use with "use," which refers to users' ERP system use frequency,[4] and remove the interaction effects triggered by ServQ. Fig. 5 shows the results, and we note three different findings. First, ServQ is not significantly associated with use, and its relationship with extended use is marginally significant. Second, although system quality's and information quality's impacts on use and user satisfaction remain almost the same (in terms of magnitudes and significance), they only explain 3.8% of the variance of use, whereas our proposed model explains 41.3% of the variance of extended use. Third, while use is positively associated with individual benefits, in conjunction with user satisfaction, their explanatory power on individual benefits is only 31.2%, and a large portion of that is actually explained by satisfaction; however, in our proposed model, 48.6% of the variance in individual benefits is explained. The results obtained from the two models support our argument that "extended use" is a rich and meaningful measure of system use for an implemented ERP system. Furthermore, the results also provide evidence for our proposed ServQ interaction effect, which can enhance system quality's and information quality's impact on extended use and which is a much more valuable perspective for achieving the full potential benefits of ERP systems.

To further verify the above findings, we followed the procedure suggested by Burton-Jones and Straub [41,42] to compare the effects of "extended use" and use. We constructed a model with "extended use," use, and user satisfaction as the predictors of individual benefits, and we tested the R^2 change while one of the two usage measures was excluded from the model. Table 6 shows that excluding "extended use" from the full model (Cell A vs. Cell B) led to a much larger reduction in R^2 but that the R^2 change caused by the exclusion of "use" was non-significant (Cell A vs. Cell C). The results provide additional support for employing "extended use" in explaining an ERP system's post-implementation success.

Lastly, Table 1 shows that approximately 30 percent of our respondents have less than two years' experience using ERP, while the remaining respondents have more than two years' experience. When conducting between-group tests (i.e., t-tests to compare the means and Kolmogorov–Smirnov tests to examine the sample distributions of the two groups), we find that these inexperienced ERP users have significantly lower intentions for extended ERP use and that they have lower assurance from the service team. It seems that inexperienced ERP users remain in their routinized use rather than extended use of ERP systems, and this finding confirms an earlier report that it takes 6–18 months to routinely use ERP [28,30]. The results imply that it takes time to build trust and rapport between ERP users and the IS department (i.e., the assurance dimension) and that, if the IS department can build assurance and improve the perception of service quality for users, then it might be possible for an individual to become an extended ERP user. Given that we understand the importance of extended use in achieving ERP post-implementation success, firms and IS departments should make more efforts to trigger these inexperienced ERP users.[5]

[4] Use is measured by a self-reported ERP use frequency indicator, as shown in Table 1 for sample characteristics.

[5] We thank the reviewers for suggesting that we conduct the tests and provide an insightful explanation of the phenomenon.

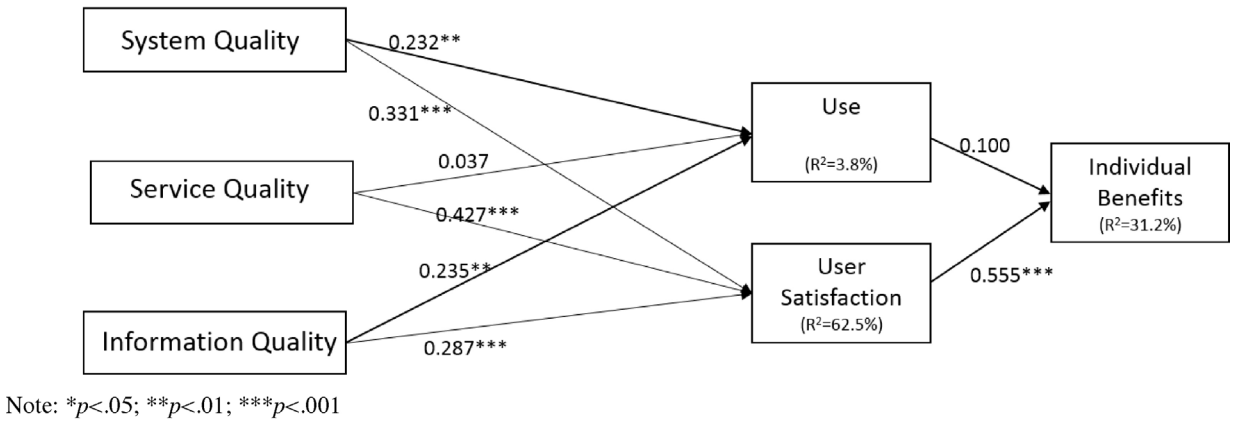


Fig. 5. Results of D&M IS success model. *Note*: $^{*}p < .05$; $^{**}p < .01$; $^{***}p < .001$.

Table 6
PLS structure models comparison.

Full model	Partial (nested) model	Change in R^2	Effective size
A Extended Use Use User Satisfaction 0.494*** 0.007 0.395*** Individual Benefits (R^2=49.4%)	**B** (Drop Extended use construct) Use User Satisfaction 0.100 0.555*** Individual Benefits (R^2=31.2%)	0.162**	f^2 = 0.359 Large
	C (Drop Use construct) Extended Use User Satisfaction 0.491*** 0.297*** Individual Benefits (R^2=48.6%)	0.008	f^2 = 0.01 Small

Each construct's effect size (f^2) can be calculated by the formula $f^2 = [R^2 \text{ (full model)} - R^2 \text{ (partial model)}]/[1 - R^2 \text{ (full model)}]$. An effect size of 0.02 is small, 0.15 is medium, and 0.35 is large (Chin [82]).

** $p < .01$.

6. Discussion and conclusions

6.1. Implications for research

Building on the D&M model, this study proposes and tests a model that explicates how ServQ, together with SQ and IQ, directly and interactively affect ERP post-implementation success from users' perspectives. In addition, this study departs from extant studies that focus on simple use behavior and goes a step further to investigate users' extended use of the ERP systems. The results of this study offer important research implications for extending the D&M model and the assessment of a successful ERP system at its post-implementation stage.

This study contributes to the literature by bringing together the three quality dimensions of the D&M model and demonstrating that all of them have significant impacts on ERP post-implementation success. Although ServQ has been added to the updated D&M model since 2003, most ERP studies still focus on the rational aspects of user decision making (i.e., good ERP SQ leads to ERP success), failing to consider that satisfying the hedonic needs of ERP users with human-delivered service could engender the extended use of a mandated system. Moreover, a recent meta-analysis on the D&M model (Petter et al. [23]) has discovered that the relationships between ServQ and the other impact constructs within the model (i.e., intention to use, user satisfaction, use) were either not significant or were not tested. This study not only replicates previous findings on the positive effects of IQ and SQ but also shows that ServQ is a crucial determinant of user satisfaction. The confirmed relationship between ServQ and satisfaction is consistent with the argument maintained by marketing researchers that cognitive appraisal normally precedes emotional response [75,76,84]. This finding also implies that, while users need good system quality and information quality to meet their utilitarian needs, their affective attitude (i.e., satisfaction) toward the ERP system is largely decided by the human-delivered services of the IS staff. Our findings complement previous studies on ERP systems by demonstrating that the usage of the systems is bounded both rationally and emotionally.

With regard to the antecedents of extended use, we find significant effects of IQ and SQ, whereas the influence of ServQ is relatively weak and only marginally significant ($p < 0.1$). This result might stem from how ServQ is operationalized in this study.

Unlike the studies that have conceptualized ServQ as one's attitude toward a specific system (e.g., [26,77]), which represents an object-based attitude, in this study, ServQ captures employees' general assessment of the IS staff's services. Employees accumulate this holistic view of service quality throughout multiple encounters with IS staff on a variety of occasions related to the use of different information technologies. Conceptualizing ServQ as a holistic attitude is advantageous because it maps closely with real-life scenarios in which employees' interactions with IS staff are not restricted to the use of only one specific system. In this light, one's assessment of ERP-based services is logically part of his or her general attitude regarding the IS staff's ServQ. Predicting object-based behaviors (i.e., extended use of the ERP system) with a general, holistic attitude (ServQ of IS staff), however, may underestimate the real relationship between attitudes and behaviors. As Ajzen and Fishbein [78] state, general belief and attitude are normally not a good basis for predicting object-based behavior. While the low correspondence between our measure of ServQ as a general view and the system-specific behavior (extended use of ERP system) justifies the weak effect of ServQ in this study, whether good ServQ in general is more or less influential than good ServQ for specific systems on the extended use of the system remains unanswered and requires further investigation.

A key finding of this study is that ServQ can indirectly influence the success of an ERP system at the post-implementation phase; it fortifies the effects of IQ and SQ on extended use and, eventually, improves employees' individual benefits. This attempt answers the call by DeLone and McLean [20] to continuously explore the interrelationships among the constructs in the D&M model. To the best of our knowledge, very few studies (e.g., [25,26]) have empirically tested the interrelationships among IQ, SQ, and ServQ within the D&M model. These exceptional studies have conceived of ServQ as a mediator for the effects of IQ and SQ on users' satisfaction or intention to use the system in the context of Web-based services. This argument is reasonable because services are typically conducted by or through information technologies in the Web-based context, making IQ and SQ the prerequisites for the delivery of quality services. Thus, it is logical to theorize that IQ and SQ exert their effects on users by influencing SerQ. Nevertheless, this may not equitably apply to the case of using the ERP system in some respects. For example, employees often receive offline human-based services from the IS staff rather than via technologies for the use of the ERP system. Even when they interact with IS staff through IT-based interfaces, the ERP system is not the technology used by employees for communication. Additionally, employees may interact with IS staff on occasions that are not related to the ERP system. To that end, it is unlikely that the IQ and SQ of the ERP system exert their influences on extended use through the ServQ of the IS staff. Alternatively, we find that ServQ may complement IQ and SQ in the condition when service is primarily delivered by IS staff and not by the system itself. Our investigation into the interaction effects of ServQ with IQ and SQ is a compelling extension of the updated D&M model, which has been limited in speculating about the interrelationships among the quality dimensions. Although the moderating effect of ServQ on user satisfaction is not significant, contrary to our prediction, it is explicable when the strong direct effect of ServQ on user satisfaction is taken into consideration. In summary, this study is the first of which we are aware that examines both the main effects and the moderating effects of ServQ. These results, together with the previous findings on the mediation effects of ServQ, highlight the need to consider the context of use when defining the interrelationships among the three qualities.

Our findings on the different effects of "extended use" and "use" in the D&M model contribute to IS research by answering the call to investigate system use beyond simple and lean measures and the call to conceptualize use based on the research context [41,15,40,42]. As Burton-Jones and Straub [41,42] state, system use is a complex activity that involves three elements: a user as the subject using the system, a system that is used by the user, and a task that constitutes a function performed by the user. Thus, it is essential to choose measures that are rich enough to capture the complex nature of system use in the specific context so that the roles of system use in determining a system's success can be accurately estimated. In this vein, "extended use" is a more appropriate measure of system use than a simple measure of use behavior (i.e., frequency of use) because the former assesses users' attitudes toward continued use, the extent to which the ERP system is used and the variety of the use (i.e., in different tasks). That is, "extended use" is a rich measure because it captures the complexity of intended use behaviors in the specific context. Our findings support this view by showing that, compared with "use," "extended use" is a more powerful predictor of individual benefits and can be explained by IQ, SQ, and ServQ to a much greater extent as an outcome variable. Such findings help explain why previous tests of the D&M model have reported mixed results when system usage is investigated [23]. Another important implication for research on the success of an ERP system is the need to carefully choose the measure of system use, which should be conceptualized based on the lifecycle of the system.

6.2. Implications for practice

These findings offer useful implications for managers as well. First, our revised D&M model can be used by managers who intend to realize the operational and strategic effectiveness of an implemented ERP system through strengthening employees' individual benefits. The findings suggest that managers should be mindful of selecting metrics for monitoring employees' use of an adopted ERP system, given that system use is compulsory in such a context. Additionally, more management attention should be directed toward encouraging employees' extended use of an ERP's installed functionalities and applications of the system in a variety of work tasks. For example, ERP-related interventions, such as software and work process training, often stabilize at a point of being "just enough" for employees to perform their assigned work tasks and activities [79], which are not designed to encourage further exploration of ERP functionality. For best results, managers should also devise interventions that are capable of elevating employees' satisfaction because user satisfaction not only contributes to individual employees' benefits from using the ERP system but is also the key to successful IS use in the long run [19,20].

Second, the ServQ of the IS staff is vital to ensuring the success of an adopted ERP system because it directly affects employees' overall satisfaction and may exert an indirect effect by amplifying the positive influences of IQ and SQ on extended use. This phenomenon suggests that managers need to closely monitor the ServQ of internal IS staff not only during delivery of ERP-related services but also in their regular service encounters with end-users. To help employees' exploitation of the ERP's functionality, we recommend that managers continuously develop the IS staff's expertise in ERP applications so they can provide updated technical support and on-site education that end-users need for use extension. Our findings also highlight the need to direct managerial efforts in developing an interpersonally oriented IS service team that can provide pleasant service experiences to end-users.

6.3. Limitations

Our findings should be considered in light of a few limitations. First, our sample includes 151 respondents, of which 81 percent

are staff and only 19 percent are managers. This distribution is because, in our data collection period, managers were more reluctant to join the study. However, mangers and staff may have different considerations on the weights of each quality factor because managers and staff use different functions of ERP systems (transaction vs. decision making), with a different use frequency (daily vs. monthly, etc.). Future studies may consider investigating whether differences exist between managers and non-managers to provide a more comprehensive evaluation. Second, this study assesses an overall evaluation of the IS staff's services rather than their services focused on the ERP system. We call for future research to explore whether the IS staff's system-focused vs. organization-wide services would produce different results in terms of the direct effects and moderation effects on employees' use of a mandated system, such as ERP. Third, our study focuses only on the manufacturing industry, and different results may emerge when investigating other industries. For example, whether the role of ServQ may be strengthened in the service industry is unclear. Future studies could collect data from additional industries to understand the relative impact of the quality factors. Fourth, we assess extended use and frequency of use to indicate the system use of an adopted ERP system, which may be insufficient to capture all the essential elements of system use in the context. A promising avenue for future research is to follow the two-stage approach proposed by Burton-Jones and Straub [41,42] to develop a measure based on a precise definition and conceptualization of system use in the specific context.

In conclusion, the current study contributes to the ERP literature because it focuses on the post-implementation phase, whereas previous studies have devoted most of their attention to the implementation stage. Understanding ERP post-implementation success is crucial because ERPs are widely adopted and because most firms have gone beyond the go-live stage. Thus, firms should shift their focus from implementation difficulties and challenges to post-implementation successes to receive the desired outcomes from their huge investments. The findings also extend the ERP literature by viewing the success of a mandated system from the users' perspective because users' exploitative and explorative use of the ERP system is the basis that leads to the success of the ERP system at the organizational level. Finally, our scrutiny of the interaction effects of ServQ with IQ and SQ advance a new research direction for improving the D&M model. While firms typically rely on the vendor for implementation, in-house IS staff becomes essential to the end-users whenever there is an error to be corrected, optimization to be met, and upgrades or training to be provided [11]. We hope that this study encourages more research attention that explores the contextualization of system use and the relationships between ServQ and other quality dimensions of an IS.

Appendix A. A comparison of our study and previous studies on ERP post-implementation success

	Article	Theory	Sample/methodology	Main results (ERP post-implementation performance)
	Firm level			
1	Gattiker and Goodhue, *MIS Quarterly*, 2005	Organizational Information Processing theory	■ Survey of 111 manufacturing plants. ■ OLS regression.	ERP may deliver intangible benefits to firms: better information, more efficient internal business process, and better coordination between different units of the firm.
2	Banker et al., *MIS Quarterly*, 2006	Dynamic Capability theory	■ Survey data of 1077 U.S. manufacturing plants ■ WLS regression	Through the mediation effect of manufacturing capabilities, ERP systems have an impact on plant performance, including product quality, product time to market, and plant efficiency
3	Cotteleer and Bendoly, *MIS Quarterly*, 2006	Operations management and continuous improvement	■ Longitudinal order lead-time data from an ERP implemented firm ■ ANCOVA and GLS	Order fulfillment lead-time showed a significant improvement immediately after ERP system deployment.
4	Ranganathan and Brown, *Information Systems Research*, 2006	No specific theory is used	■ Event study approach. ■ Test whether abnormal stock market return exists in 116 ERP investment announcement	ERP projects with greater functional scope or greater physical scope result in higher shareholder returns. Negative returns are found for projects with lesser functional scope and lesser physical scope.
5	Karimi, Somers, and Bhattacherjee, *Journal of Management Information Systems*, 2007a,b	Innovation Diffusion theory and Resource-Based View	■ Survey data of 148 US manufacturing firms ■ PLS	The extent of ERP implementation influences business process outcomes, including process efficiency, effectiveness, and flexibility.
6	Aral, Brynjolfsson and Wu, *Proceedings of International Conference on Information Systems*, 2006	IT productivity	■ Analyzes financial performance data for 623 ERP adopters from 1998∼2005. OLS regression.	ERP adoption improves productivity, inventory turnover, and asset utilization but not ROA, ROE, and profit margin.
7	Chou and Chang, *Decision Support Systems*, 2008	Organizational information processing theory (OIPT)	■ Survey of 166 responses across 10 industries ■ PLS analysis	Both customization and organizational mechanisms affect intermediate benefits (including coordination improvement and task efficiency), which in turn influence overall benefits.
8	Galy and Sauceda, *Information & Management*, 2014	No specific theory is used	■ Econometric, multiple regression analysis.	Increased technological competence affects net sales; relationships with outside experts affect earnings; return-on-assets and return-on-investment, top management support affects net sales and net income; long-range planning negatively affects earnings; and the sharing of information between departments affects net income, return-on-assets and return-on-investments.
9	McGinnis and Huang, *Information & Management*, 2007	ERP continuous improvement phase model and knowledge spiral model	■ Project prep and early business blueprint (via Q and A database)	Incorporation of knowledge management into firms' ERP post-implementation improves success rates of ERP systems.

Appendix A (*Continued*)

	Article	Theory	Sample/methodology	Main results (ERP post-implementation performance)
	Individual level			
10	Sykes et al., *MIS Quarterly*, 2014	Social network theory	■ Survey of 87 employees of a large corporation ■ Hierarchical regression analysis.	This study investigates employees' ERP post-implementation job performance. Workflow advice and software advice are associated with employee job performance.
11	Morris and Venkatesh, *MIS Quarterly*, 2010	Job characteristics model	■ 2974 employees in a telecommunications firm. ■ Generalized estimating equations	ERP system implementation moderated the relationships between three job characteristics (skill variety, autonomy, and feedback) and job satisfaction.
12	Ke et al., *Journal of Management Information Systems*, 2012	Self-determination theory	■ 127 organizational users in China	Autonomous job design and socialization tactics could trigger ERP users' intrinsic motivation to explore ERP features.
13	Boudreau, *Proceedings of HICCS*, 2003	Grounded theory	■ Case study	Learning is a key factor influencing ERP users' "quality of use" (i.e., limited use and extended use).
	Individual and organizational level			
14	Sasidharan et al., *Information Systems Research*, 2012	Social network theory and Delone-McLean model	■ 207, 156, and 142 responses in three phases of a US university's ERP post-implementation project ■ Hierarchical linear modeling	■ Firm level: centralized structures inhibit ERP implementation success ■ Individual level: high in-degree and betweenness centrality reported high task impact and information quality.
15	Gable, Sedera, and Chan, *Journal of the Association for Information Systems*, 2008	Delone-McLean model	■ Content analysis: survey data gathered from 27 public-sector organizations that implemented ERP.	■ This study re-conceptualizes "information system success" as a formative, multidimensional index that includes four dimensions in two halves. Impact half: individual and organizational impact. Quality half: system quality and information quality
16	Sedera and Gable, *Proceedings of ICIS*, 2008		■ Confirmatory analysis: survey data of 153 responses in a large university that implemented ERP	■ Highlights the importance of measuring ERP success from a multiple-stakeholder perspective.
17	Sedera and Tan, *Proceedings of PACIS*, 2005		■ Content analysis: survey data from 310 responses	■ User Satisfaction is measured and tested with 16 instruments.
18	Tsai, Shaw, Fan, Liu, Lee and Chan, *Decision Support Systems*, 2011	Delone-McLean IS success model	■ 249 Taiwanese firms ■ Structural equation model	The results reveal causal relationships among system providers, implementation consultants, project management, and performance (system quality, information quality, system use, user satisfaction, individual and organizational Impacts).
	Performance at individual level			
19	This Study	Delone-McLean IS success model	■ 151 ERP users ■ PLS analysis	Service quality, in conjunction with system quality and information quality, significantly affects ERP post-implementation success in terms of extended use and satisfaction.

Note: This table includes ERP studies that have been published in major IS journals (MIS Quarterly, Information Systems Research, Journal of Management Information Systems, Journal of Association for Information Systems, Information and Management, Decision Support Systems) and main IS conferences (ICIS, HICCS, ECIS, AMCIS, PACIS), which are identified using keywords such as enterprise resources planning, ERP, enterprise systems, post-implementation, and system success.

Appendix B. Measurement items

B.1. **ERP quality:** *Concerning the ERP you are using, please indicate the degree to which you agree/disagree with the following statements.*

System quality

System-related

SQ1. The ERP is easy to use.
SQ2. The ERP is easy to learn.
SQ3. The ERP always processes data accurately.
SQ4. The ERP requires only a minimum number of fields and screens to achieve a task.

Task-related

SQ5. The ERP meets my requirements.
SQ6. The ERP includes necessary features and functions for my job.
SQ7. The ERP user interface can be easily adapted to my personal approach.
SQ8. All the data that I use within the ERP are fully integrated and consistent (Deleted due to low factor loading).
SQ9. The ERP can be easily modified or improved according to my needs.

Information quality
Context

IQ1. The ERP provides output that seems to be exactly what I need.
IQ2. Information needed from the ERP is always available.
IQ3. Information from the ERP is in a form that is readily usable.

Representation

IQ4. Information from the ERP is easy to understand (Deleted due to low factor loading).
IQ5. Information from the ERP appears readable, clear, and well formatted.
IQ6. Information from ERP is concise.

Service quality: Please indicate the degree to which you agree/disagree with the following statements regarding the service quality provided by your company's IS department in general.*Tangibility*

SRQ1. The IS department has up-to-date hardware and software.
SRQ2. The physical facilities in the IS department are visually appealing.
SRQ3. The staff in the IS department is well dressed and neat in appearance.
SRQ4. The appearance of the physical facilities of the IS department is in keeping with the type of services provided.

Reliability

SRQ5. When the IS department promises to do something by a certain time, it will do so.
SRQ6. When users have a problem, the IS department shows a sincere interest in solving it.
SRQ7. The IS department is dependable.
SRQ8. The IS department provides its services at the times it promises.
SRQ9. The IS department insists on error-free records.

Responsiveness

SRQ10. The IS department tells users exactly when services will be performed.
SRQ11. The staff in the IS department give prompt service to users.
SRQ12. The staff in the IS department is never too busy to respond to users' requests.

Assurance

SRQ13. The behavior of the staff in the MIS department instills confidence in users.
SRQ14. I feel safe in my transactions with the MIS department staff.
SRQ15. The staff in the MIS department is consistently courteous with users.
SRQ16. The staff in the MIS department has the knowledge to do its job well

Empathy

SRQ17. The IS department has operating hours that are convenient to all users.
SRQ18. The IS department give users personal attention.
SRQ19. The IS department has the users' best interests at heart.
SRQ20. The staff of the IS department understands the specific needs of users.

B.2. **Post-implementation success***: Concerning the ERP you are using, please indicate the degree to which you agree/disagree with the following statements*

User satisfaction

Sat1. I am satisfied with the system quality.
Sat2. I am satisfied with the information quality.
Sat3. I am satisfied with the service quality.
Sat4. I am satisfied with the overall ERP system.

Individual benefits

PER1. I have learned much through the presence of the ERP.
PER2. The ERP enhances my awareness and recall of job-related information.
PER3. The ERP enhances my effectiveness in the job.
PER4. The ERP increases my productivity.

Extended use

CIU1. I intend to continue using the ERP in my job.
CIU2. I intend to use more functions of the ERP.
CIU3. I intend to continue using the ERP for processing more tasks.
CIU4. I intend to suggest that my company should stop using the current ERP system (Reverse Coded).

Appendix C. Common method factor test

We followed Podsakoff et al. [59] and Liang et al. [74] and performed a *common method factor test*. Each construct was converted to a second-order construct, and each of its indicators was converted to a single indicator construct. To create the common method factor, we used indicators from all the constructs. Each single-indicator construct was modeled to be determined by (1) its second-order construct and (2) the method factor. The two squared path weights represented the variance explained by the substantive construct and common method. In Table A1, we found that, for each indicator, the variance explained by its substantive construct was much greater than that explained by the common method factor; thus, there is less concern for common method bias in this study.

Table A1
Common method factor test results.

Construct	Indicator	Substantive factor loading	$R1^2$	Method factor loading	$R2^2$
System related	1	0.915	0.837	−0.107	0.011
	2	0.894	0.799	−0.107	0.011
	3	0.823	0.677	0.241	0.058
	4	0.801	0.642	0.061	0.004
Task related	1	0.767	0.588	0.026	0.001
	2	0.760	0.578	0.017	0.000
	3	0.812	0.659	−0.118	0.014
	4	0.729	0.531	−0.060	0.004
Contextual	1	0.791	0.626	−0.007	0.000
	2	0.726	0.527	0.100	0.010
	3	0.867	0.752	−0.102	0.010
Representational	1	0.940	0.884	−0.055	0.003
	2	0.900	0.810	0.051	0.003
Tangibility	1	0.835	0.697	−0.021	0.000
	2	0.969	0.939	−0.101	0.010
	3	0.585	0.342	0.081	0.007
	4	0.587	0.345	0.087	0.008
Reliability	1	0.916	0.839	−0.019	0.000
	2	0.917	0.841	−0.027	0.001
	3	0.889	0.790	0.026	0.001
	4	0.869	0.755	0.004	0.000
	5	0.792	0.627	0.018	0.000
Responsiveness	1	0.888	0.789	0.009	0.000
	2	0.954	0.910	−0.054	0.003
	3	0.854	0.729	0.046	0.002
Assurance	1	0.845	0.714	0.117	0.014
	2	0.955	0.912	−0.017	0.000
	3	0.986	0.972	−0.126	0.016
	4	0.906	0.821	0.017	0.000
Empathy	1	0.925	0.856	−0.027	0.001
	2	0.903	0.815	−0.127	0.016
	3	0.810	0.656	0.085	0.007
	4	0.839	0.704	0.068	0.005
Extended use	1	0.640	0.410	0.051	0.003
	2	0.956	0.914	0.069	0.005
	3	0.915	0.837	0.192	0.037
	4	0.839	0.704	0.170	0.029
Satisfaction	1	0.952	0.906	0.091	0.008
	2	0.907	0.823	0.245	0.060
	3	0.565	0.319	0.235	0.055
	4	0.988	0.976	0.107	0.011
Individual benefits	1	0.773	0.598	0.015	0.000
	2	0.978	0.956	0.102	0.010
	3	0.920	0.846	0.036	0.001
	4	0.856	0.733	0.082	0.007
Average		0.850	0.733	0.030	0.009

Appendix D. Cross-factor loadings

	System-related	Task-related	Con_textual	Repre_sentation	Tangi_bility	Relia_bility	Respon_siveness	Assu_rance	Empathy	Satis_faction	Individual benefits	Extended use
SQ1	**0.79**	0.44	0.35	0.37	0.41	0.21	0.19	0.18	0.20	0.44	0.40	0.32
SQ2	**0.72**	0.33	0.25	0.37	0.39	0.26	0.25	0.26	0.25	0.42	0.31	0.24
SQ3	**0.66**	0.49	0.47	0.46	0.20	0.18	0.17	0.16	0.20	0.39	0.41	0.40
SQ4	**0.82**	0.52	0.37	0.47	0.40	0.27	0.26	0.33	0.32	0.51	0.41	0.32
SQ5	0.55	**0.80**	0.55	0.40	0.31	0.10	0.07	0.19	0.16	0.49	0.54	0.44
SQ6	0.43	**0.80**	0.52	0.34	0.29	0.20	0.18	0.28	0.30	0.51	0.51	0.42
SQ7	0.42	**0.80**	0.33	0.26	0.26	0.08	0.05	0.16	0.19	0.40	0.38	0.32
SQ9	0.37	**0.69**	0.34	0.28	0.18	0.17	0.13	0.21	0.17	0.34	0.29	0.36
IQ1	0.39	0.52	**0.81**	0.41	0.26	0.18	0.18	0.23	0.24	0.44	0.54	0.48
IQ2	0.34	0.46	**0.81**	0.40	0.26	0.35	0.28	0.31	0.33	0.54	0.55	0.46
IQ3	0.42	0.42	**0.78**	0.55	0.33	0.20	0.18	0.15	0.19	0.45	0.43	0.42
IQ5	0.48	0.33	0.49	**0.91**	0.29	0.06	0.13	0.12	0.13	0.33	0.32	0.26
IQ6	0.53	0.44	0.53	**0.92**	0.28	0.13	0.19	0.17	0.16	0.47	0.43	0.39
SRQ1	0.42	0.31	0.26	0.25	**0.75**	0.44	0.37	0.40	0.37	0.48	0.17	0.17
SRQ2	0.47	0.33	0.30	0.34	**0.85**	0.42	0.39	0.33	0.35	0.46	0.23	0.19
SRQ3	0.25	0.09	0.16	0.12	**0.64**	0.47	0.44	0.40	0.46	0.36	0.15	0.17
SRQ4	0.26	0.35	0.35	0.23	**0.76**	0.31	0.30	0.34	0.31	0.38	0.34	0.29
SRQ5	0.26	0.12	0.27	0.09	0.50	**0.90**	0.76	0.72	0.76	0.50	0.20	0.25
SRQ6	0.23	0.16	0.21	0.08	0.47	**0.88**	0.74	0.75	0.77	0.51	0.19	0.20
SRQ7	0.29	0.19	0.23	0.08	0.53	**0.90**	0.76	0.77	0.72	0.48	0.23	0.24
SRQ8	0.25	0.17	0.31	0.12	0.50	**0.86**	0.75	0.69	0.75	0.47	0.18	0.22
SRQ9	0.31	0.12	0.29	0.11	0.40	**0.84**	0.65	0.60	0.67	0.42	0.27	0.33
SRQ10	0.25	0.11	0.25	0.18	0.41	0.72	**0.89**	0.71	0.71	0.43	0.20	0.17
SRQ11	0.24	0.14	0.20	0.09	0.42	0.70	**0.91**	0.72	0.74	0.43	0.15	0.14
SRQ12	0.29	0.14	0.26	0.20	0.52	0.70	**0.89**	0.72	0.72	0.44	0.18	0.20
SRQ13	0.32	0.27	0.30	0.11	0.47	0.22	0.78	**0.94**	0.74	0.53	0.36	0.38
SRQ14	0.32	0.27	0.24	0.11	0.45	0.73	0.74	**0.94**	0.77	0.51	0.32	0.31
SRQ15	0.22	0.14	0.20	0.19	0.41	0.69	0.72	**0.88**	0.73	0.43	0.24	0.23
SRQ16	0.29	0.32	0.30	0.17	0.47	0.71	0.70	**0.92**	0.74	0.52	0.33	0.37
SRQ17	0.26	0.23	0.24	0.13	0.42	0.70	0.75	0.73	**0.88**	0.54	0.26	0.20
SRQ18	0.23	0.25	0.25	0.09	0.46	0.73	0.69	0.74	**0.88**	0.49	0.24	0.23
SRQ19	0.34	0.26	0.33	0.20	0.47	0.73	0.67	0.69	**0.90**	0.58	0.33	0.31
SRQ20	0.34	0.22	0.30	0.15	0.44	0.71	0.76	0.77	**0.91**	0.52	0.29	0.31
SAT1	0.55	0.58	0.51	0.39	0.45	0.34	0.28	0.34	0.38	**0.88**	0.53	0.48
SAT2	0.43	0.50	0.58	0.47	0.32	0.26	0.24	0.26	0.35	**0.87**	0.49	0.45
SAT3	0.43	0.30	0.41	0.29	0.53	0.58	0.58	0.55	0.57	**0.69**	0.35	0.34
SAT4	0.46	0.52	0.50	0.39	0.42	0.35	0.32	0.37	0.44	**0.90**	0.50	0.52
IND1	0.30	0.40	0.45	0.21	0.25	0.21	0.12	0.20	0.23	0.41	**0.77**	0.50
IND2	0.44	0.48	0.48	0.37	0.22	0.13	0.12	0.19	0.19	0.44	**0.91**	0.52
IND3	0.47	0.46	0.48	0.38	0.26	0.17	0.17	0.26	0.20	0.47	**0.89**	0.51
IND4	0.52	0.55	0.59	0.43	0.28	0.22	0.19	0.33	0.30	0.52	**0.91**	0.59
EXT1	0.41	0.52	0.54	0.40	0.32	0.26	0.26	0.36	0.32	0.53	0.61	**0.85**
EXT2	0.27	0.32	0.34	0.21	0.20	0.14	0.07	0.16	0.12	0.33	0.38	**0.78**
EXT3	0.26	0.22	0.31	0.13	0.08	0.20	0.06	0.23	0.17	0.25	0.44	**0.76**
EXT4	0.17	0.25	0.32	0.16	0.06	0.21	0.10	0.24	0.19	0.27	0.29	**0.70**

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Pei-Fang Hsu is an associate professor in the Institute of Service Science, College of Technology Management, National Tsing Hua University, Taiwan. She received her Ph.D. in Information Systems from the Paul Merage School of Business at University of California, Irvine. Her research focuses on adoption and value of enterprise systems, IT service quality measurement, IT's impact on service innovation, and multinational corporations. She has published her research works in Decision Sciences, Decision Support Systems, International Journal of Information Management, International Journal of Electronic Commerce, Electronic Commerce Research and Applications etc.

HsiuJu Rebecca Yen is a professor and the director in the Institute of Service Science at National Tsing Hua University, Taiwan. She received a M.S. and Ph.D. in Psychology from Rutgers, the State University of New Jersey. Her current research interests include services marketing and management, consumer behavior, and service innovation. She has published in Research Policy, Journal of the Academy of Marketing Science, Decision Support Systems, Information & Management, International Journal of Electronic Commerce, Marketing Letters, IEEE Transactions on Engineering Management, International Journal of Service Industry Management, Journal of Services Marketing, the Service Industries Journal, International Journal of Production Economics, Journal of Experimental Social Psychology, Journal of Applied Social Psychology, and other venues.

Jung-Ching Chung received her MBA degree at college of technology management, National Tsing Hua University, Taiwan, and currently works at UPS Supply Chain Solutions.