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Organizational impact of system quality, information quality, and service quality

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ABSTRACT

Increased organizational dependence on information systems drives management attention towards improving information systems' quality. A recent survey shows that "Improve IT quality" is one of the top concerns facing IT executives. As IT quality is a multidimensional measure, it is important to determine what aspects of IT quality are critical to organizations to help Chief Information Officers (CIOs) to devise effective IT quality improvement strategies. In this research, we model the relationship between information systems' (IS) quality and organizational impact. We hypothesize greater organizational impact in situations in which system quality, information quality and service quality are high. We also hypothesize a positive relationship between system quality and information quality. We test our hypotheses using survey data. Our structural equation model exhibits a good fit with the observed data. Our results show that IS service quality is the most influential variable in this model (followed by information quality and system quality), thus highlighting the importance of IS service quality for organizational performance. This paper contributes theoretically to IS success models through the system quality-to-information quality and IS quality-to-organizational impact links. Implications of our results for practice and research are discussed.

1. Introduction

Quality in an organization is defined by Reeves and Bednar (1994) in terms of quality as excellence, quality as value, quality as conformity to specifications, and quality as meeting customer expectations. Information systems (IS) quality can be understood using Reeves and Bednar's framework of quality (Swanson, 1997). Excellence in IS quality involves using state-of-the-art technology, following industry "best practice" software standards, and delivering "error-free" performance. The value of IS can be realized by improving profit margins for the firm, providing easy-to-use and useful applications, and designing easily maintainable software. IS quality as conformance denotes designing systems that conform to the end users' information requirements and adhere to industry standards. Meeting customer expectations of IS quality is accomplished by offering appealing, user-friendly interfaces, entertaining user requests for changes, and satisfying the stakeholders of the IS.

The above quality definitions broadly characterize IS quality measures, system quality, information quality, and service quality. For example, system quality represents the quality of information processing itself, which is characterized by employment of state-of-the-art technology, a system offering key functions and features (denoted as IS excellence), and software that is user friendly, easy to learn, and easily maintainable (denoted as IS value). Information quality, a concept that is related to the quality of information system outputs, can be described in terms of outputs that are useful for business users,

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relevant for decision making, and easy-to-understand (representing IS quality as value) as well as outputs that meet users' information specifications (representing IS quality as conformance to specification). Service quality is defined as the level of service delivered by IS service providers to business users (as compared to their expectations) in terms of reliability, responsiveness, assurance, and empathy. These concepts of IS service quality are reflected through IS meeting user expectations (by satisfying IS users by providing services to users at the time promised, building confidence in IS users, and being courteous to users when dealing with service requests) and demonstrating IS excellence (by having highly knowledgeable IS experts and by ensuring "error-free" performance).

Total Quality Management (TQM) influences organizational performance as quality of products and services has been found to be the most important factor determining businesses' long-term success (Anderson and Zeithaml, 1984). TQM is also applied to IS quality management because of its emphasis on the organizational and socio-behavioral aspects of quality improvement. Process improvement, a technically oriented TQM technique in the IS context, has not been integrated with other TQM concepts such as providing customer focus (Ravichandran and Rai, 2000). TQM techniques have been selectively applied in the past to software quality assurance research (Rai et al., 1998), system design and construction accuracy, and the system development process (Diaz and Sligo, 1997). Nevertheless, application of IS quality management techniques such as the Capability Maturity Model (CMM) has resulted in improved system development productivity (Diaz and Sligo, 1997). Organizations can achieve improvements in system quality, development cost, and project schedule with IS quality management practices. Some of these practices include institutionalization of quality management practices, senior management leadership, and establishment of performance standards for system development activities (Ravichandran and Rai, 2000). However, an integrated approach in the application of TQM techniques in the IS context is lacking; in particular, there has been less emphasis on the application of quality management techniques for improvement of information quality and service quality. In spite of their importance, IS quality issues have not been given adequate emphasis by IS researchers (Nelson et al., 2005).

Ackoff (1967) alludes to five misconceptions underlying the design of information systems and states: "The most important informational deficiency the managers suffer from is abundance of irrelevant information". Information quality problems, such as incorrect information due to program or data errors and irrelevant information due to changed user requirements, exist even today (Strong et al., 1997). Though 50 years of software development has come and gone, software quality today is no better than it was decades ago (Whittaker and Voas, 2006; Parnas, 2003), and software is typically plagued with problems such as hard-to-use user interfaces and fragmented software modules that are difficult to integrate. IS managers, in the interest of producing software quickly, tend to ignore quality improvement methods (Slaughter et al., 1998). In a 2007 survey of CIOs conducted by the Society for Information Management (SIM), "Improve IT quality" emerged as one of the top five concerns facing IT executives (Luftman and Kempaiah, 2008).

By properly leveraging IT, organizations can achieve internal operational efficiencies by managing internal resources more efficiently and effectively and attain strategic advantages by improving customer service. Thus, IT quality is highly important to organizations to derive value in terms of benefits such as improved decision making, providing possible future business avenues, identifying profitable projects and providing accurate and timely information. Increased dependence of organizations on information systems and the organizational losses associated with poor information quality drive management attention toward IS quality improvement (Ravichandran and Rai, 2000).

Because of the critical role of IS quality in the success of business and information system function, IS quality occupies a very prominent place in IS success models. DeLone and McLean (1992) have identified IS success as a multifaceted construct consisting of quality measures (system and information quality), attitudinal outcomes (use and satisfaction), and performance-related outcomes (individual and organizational impacts). DeLone and McLean (1992, p. 88) call for further development and validation of their model: "... much work is still needed, particularly in assessing the impact of information systems on organizational performance." There has been little research on quality measures of IS success models, as Nelson et al. (2005) note: "Although the satisfaction and usage constructs have been well studied in the information systems literature, there has been only limited attention to information and system quality over the past decade" (p. 199). After a review of research on IS success models, Petter et al. (2008) reiterate DeLone and McLean's (1992) previous concern: "... there is insufficient empirical evidence to evaluate most of the relationships at the organizational level" (p. 258).

As noted above, CIOs are highly concerned about IT quality because of inadequate efforts to improve IT quality in organizations. Further, in spite of the vast literature on "IS success models", there has been little or no empirical evidence relating the IS quality variables directly to organizational impact. Thus, we examine the following research questions:

(i) What are the individual and combined influences of system quality, information quality, and service quality on organizational impact?
(ii) What is the effect of system quality on information quality?

This study makes several contributions. First, our research provides a comprehensive examination of the three information system quality attributes of system quality, information quality, and service quality. We describe their individual and combined influences on organizational impact. Our results show that service quality has the greatest impact of all three quality constructs, thus highlighting its importance to both internal efficiency and strategic benefits. By understanding the relative importances of these IS quality attributes, IS managers can allocate resources accordingly and thus plan for an effective IS quality management program. Our research results provide evidence for additional links in IS success models that are not

explicitly incorporated in the DeLone and McLean (2003) IS success models. Thus, our research results regarding direct links between the constructs of IS quality and organizational impact provide good justification for considering the inclusion of these additional links in IS success models after further research and validation.

Second, our research examines the linkage between system quality and information quality, which, to our knowledge, has not been previously explored. Our results provide evidence for the indirect effect of system quality (through information quality) on organizational impact. Our results point to the relevance of the system quality – information quality association for IS success model research.

Third, our results are validated within a non-US context (Hong Kong); most previous studies were based on US companies. Mahmood and Mann (2000) suggest, "... it is important that researchers add an international dimension to the matter of IT investment-performance relationship, extending beyond the United States to encompass the experience of organizations in other developed countries" (p. 5). We use a comprehensive instrument for measuring the organizational impact construct that considers both the internal efficiency variables and strategic variables, which were lacking in most previous IS success model studies. Our study, in part, also serves as a validation of the IT impact instrument of Mahmood and Soon as a dependent variable in the context of the IS success model. Our contribution meets the call of Petter et al. (2008) for comprehensive measurement instruments: "... researchers ... (should) apply rigorous success measurement methods to create comprehensive, replicable, and informative measures of IS success" (p. 258).

The paper is organized as follows. Section 2 provides theoretical background on the subject. Section 3 describes the construct development for systems quality, information quality, service quality, and organizational impact. After this theoretical and construct development, Section 4 contains the research model and research hypotheses that explain the relationships among our constructs. Section 5 describes the research methodology and includes construct measurement, data collection, and hypothesis testing. Section 6 contains a discussion of our results, and Section 7 includes conclusions, implications, limitations, and areas for future research.

2. Theoretical background

The theoretical background is organized into three sections. The first section describes IS success models. The second section deals with empirical studies related to IS success models. The third section summarizes previous research results and describes the present research.

2.1. IS success models

Information systems quality is an important measure of IS success. A stream of research has been conducted to identify IS success measures. DeLone and McLean (D&M) introduced a comprehensive taxonomy to organize this diverse research. Based on a review of 180 empirical studies, they developed a model of "temporal and causal" interdependencies between six categories of IS success (DeLone and McLean, 1992). Seddon (1997) presented and justified a re-specified and extended version of the D&M model of IS success by splitting the D&M model into two variance submodels (of use and success) and eliminating the process model interpretation. Although the model has been tested only partially, it has provided a solid theoretical framework toward consolidating previous research on IS success.

Pitt et al. (1995) argued that existing IS success measures seemed strongly product focused and that the IS department was not just a provider of products but also of services. With an increasing percentage of IS budgets being devoted to IS services, more emphasis is being given to the service dimension of IS (Kettinger and Lee, 1997; Pitt et al., 1995; Watson et al., 1998). The SERVQUAL instrument has been validated and used in the IS context (Pitt et al., 1995; Watson et al., 1998). Though there has been criticism (Van Dyke et al., 1997) regarding the use of a gap measure for service quality or preference for a direct measure with SERVPERF (Cronin and Taylor, 1994), the relevance of SERVQUAL attributes to the measurement of IS success appears to have been generally accepted (Kettinger and Lee, 1997). Parasuraman et al. (1994) proposed and tested the SERVQUAL + instrument, which has 21 items, in three alternative formats. Kettinger and Lee (2005) validated this instrument with direct measures for applicability in the IS context. Pitt et al. (1995) developed an augmented IS success model incorporating service quality as an additional element in the D&M model (1992). An "updated" IS success model was proposed in 2003 by DeLone and McLean, which includes IS service quality. As IT impacts not only immediate users, but also work groups, organizations, industries, consumers, and society, DeLone and McLean (2003) replaced the individual impact and organizational impact constructs of their original IS success model with "net benefits" constructs in their "updated" model; the authors argue that their revised IS success model can be applied at multiple levels of analysis depending on the task at hand.

2.2. Empirical studies related to IS success models

Most empirical studies related to IS success models have dealt with individual impact rather than organizational impact. Petter et al. (2008) analyzed the relationships between the six constructs of the D&M model (2003) by reviewing 180 articles related to IS success published in the period of 1992–2007. At the individual level of analysis, the authors found some support for several of the 15 pairwise associations. At the organizational level, however, only 3 of the 15 associations found some

support (i.e., system quality → net benefits, system quality → use, and use → net benefits). Of these, only one relationship relevant to this research has some empirical support – i.e., the association between system quality and organizational benefits was positive. Another meta-analysis was performed by Sabherwal et al. (2006), whose research was based on 121 previous studies published in the period of 1980–2004. They determine the relationship between IS success variables (user satisfaction, system use, perceived usefulness, and system quality), user-related constructs, and context-based constructs. The authors found support for the associations between system quality and use, user satisfaction, and net benefits; furthermore, they found support for the associations of use → net benefits and net benefits → use. The net benefits analyzed by the authors are at the individual level.

Some of the recent studies that have validated IS success models are as follows. Rai et al. (2002) validated the two models of IS success, DeLone and McLean (1992) and Seddon (1997), with student users of an integrated student information system. The study used five variables (system quality, information quality, perceived usefulness, user satisfaction, and IS use) to test the models at the individual level. The study found that both IS success models exhibited a reasonable fit to the data. Iivari (2005) tested the D&M model (1992) using a mandatory system with employees of a municipal corporation as subjects. They used individual impacts and found significant results for most paths of the success model. Wu and Wang (2006) tested the D&M model (2003) without service quality and found good support for knowledge management system success.

Bradley et al. (2006) studied the impact of plan quality on organizational impact through the intermediary variables of system quality and information quality. They concluded that variations in IS success are explained by variations in plan quality and corporate culture exhibited by the firm. The relationship between system quality and organizational impact was significant for entrepreneurial firms in a limited way but not significant for formal firms. Yet another recent study (Prybutok et al., 2008) analyzed the relationship between leadership, IT quality, and net benefits in an e-government environment through a field survey of a municipal city government. They showed support for the relationship between overall IT quality and overall net benefits in this setting. The net benefits construct used by the authors is not solely an organizational impact instrument as it has three questions relating to individual satisfaction, individual performance, and organizational performance. As the IT quality measure they used is a combination of the three quality aspects, the respective impacts of system quality, information quality, and service quality on the dependent variable are not known. Furthermore, the studied e-government was applied in a municipal city government context, which is a special case of a nonprofit public organization. The organizational impacts of interest would be different for this type of organization compared to typical business organizations. Thus, their study results may not be generalizable to industrial organizations.

2.3. The present study

In summary, most previous empirical studies related to IS success models have dealt with individual benefits rather than organizational benefits (Petter et al., 2008; Sabherwal et al., 2006). There have been no comprehensive studies examining the interrelationships among system quality, information quality and service quality and their combined direct effect on organizational impact. The measures of organizational benefits used in previous studies mostly emphasized only profitability or cost-related measures (Petter et al., 2008), which comprise only a partial measure of IT impacts on organizations. Some of the previous research took place in the context of special organizations, such as e-government or entrepreneurial organizations, thus making those results not applicable to formal business organizations.

We extend the previous research, which is mostly based on individual impact, to organizational impact. The present research aims to determine the respective and combined effects of IS system quality, information quality, and service quality on organizational impact. In doing so, drawing from prior research, we develop and use a comprehensive instrument to measure organizational impact that includes both internally and externally focused organizational variables related to internal efficiency, customers, suppliers, and products/services. We also derive and use comprehensive instruments to determine IS system quality, information quality, and service quality. In addition, we analyze the mediating role of information quality in impacting organizational variables, which has not been studied in previous "IS success" studies. Our model has four constructs, with system quality and service quality as independent variables, information quality as both an independent and a dependent variable, and organizational impact as a dependent variable. We test our model using data collected from various organizations in Hong Kong. We run our model using structural equation modeling and present the results pertaining to the effects of IS quality on organizational impact.

While we base our research on D&M IS success models because of their prominence in providing intermediate IS effects on IS success, we do not include the intermediate variables IS use and IS user satisfaction in our model for the following reasons. While IS use and IS satisfaction were well researched in the past, the value of these variables in IS success models has been questioned (Seddon, 1997; Bradley et al., 2006; Rai et al., 2002; Gable et al., 2003). Seddon (1997) points out the difficulties with the D&M success model with reference to the meaning of the use construct. He identified three possible meanings for IS use: use as a proxy for benefits from use; use as a behavior representing "future use"; and use as an event in a process leading to net benefits. He further mentioned that the last two meanings of IS use have no place in IS success models as they do not denote success. Only the first meaning (i.e., use as a proxy for benefits) represents an IS success measure. While IS use serves as a proxy for benefits in voluntary systems (Seddon, 1997), IS use provides for little variability in mandatory systems and hence can be eliminated (Sedera and Gable, 2004; Petter et al., 2008). In summary, IS use does not play a role in IS success measures because it is not the use of IS itself that is important; rather, it is the impact of that use on orga-

nizations that is important and represents a success measure (Bradley et al., 2006). As our study focuses on organization-level analysis, we use organizational impact as an IS success measure to represent benefits from IS use.

IS user satisfaction had been a widely used single measure of IS success in the past (DeLone and McLean, 1992). Several researchers (for example, Bailey and Pearson, 1983; Doll et al,, 1994) have developed instruments to measure user satisfaction. However, many of the items in the satisfaction instruments readily map to items measuring system quality and information quality (Gable et al., 2003). For example, Doll and Torkzadeh developed a 12-item instrument to measure end user computer satisfaction (EUCS), which consists of the items content, accuracy, format, timeliness, and ease of use. Rai et al. (2002) state that user satisfaction can be measured indirectly through information quality, system quality, and other variables. In a study relating IT investments and organizational performance, Teo and Wong (1998) concluded that satisfaction is not a distinct dimension. In a study of the enterprise systems success model, Sedera and Gable (2004) observed that satisfaction items loaded with system quality in the factor analysis. As user satisfaction items are thus already included in information quality or system quality, we chose not to include satisfaction in our model.

3. Construct development

Features of IS quality have been grouped by previous researchers into metrics such as system quality, software quality, data quality, information quality, and service quality. Of these, system quality and software quality are closely related as both relate to the technical aspects of a software system. Information quality, which is dependent on data quality, deals with the information content and presentation format provided to the stakeholders of a firm. We describe below the development of constructs we use in this research for organizational impact, system quality, information quality, and service quality.

3.1. Organizational impact

Organizational impact represents the firm-level benefits received by an organization because of IS applications. The organizational impact of IT is realized through business performance (e.g., Brynjolfsson and Hitt, 1996; Kohli and Devaraj, 2003; Kearns and Lederer, 2004; Osei-Bryson and Ko, 2004; Rai et al., 2006), which leads to business value (e.g., Barua et al., 1995; Mukhopadhyay et al., 1995; Tallon et al., 2000; Lee, 2001; Melville et al., 2004). Organizational impact has been measured as competitive advantage and strategic value (Mahmood and Soon, 1991; Sethi and King, 1994), market value, organizational efficiency and effectiveness, and capacity utilization (Barua et al., 1995). IT resources create economic value by increasing operational efficiencies and creating competitive advantage (Melville et al., 2004; Rai et al., 2006).

Several authors have developed constructs to measure IT impacts on organizations. Mahmood and Soon (1991) studied IT impacts on organizational strategic variables at two levels: the organization and its parent industry. At the organizational level, IT impacts organizations by affecting competitive forces (Porter, 1985). IT impacts the industry in which the firm competes by changing its markets, products and services or the economics of production (Mahmood and Soon, 1991). The validated instrument for organizational impact included six variables at the organizational level (inter- and intra-organizational efficiencies, buyers and consumers, competitive rivalry, suppliers, and search and switching costs) and four variables at the industry level (markets, products or services, economics of production, and pricing). The comprehensive instrument developed by Mahmood and Soon (1991) was tested by Sethi and Carraher (1993).

Sethi and King (1994) developed the instrument named CAPITA (Competitive Advantage Provided by an Information Technology Application) for IT impact based on the extent to which an IT application provides competitive advantage to the organization. Based on Bakos and Treacy's (1986) categorization of IT impacts on an organization, Sethi and King defined CAPITA at the level of competitive strategy. Based on the Porter model of competitive advantage, the authors developed an instrument that includes five variables: efficiency (ability to produce products at a lower price), functionality (ability to provide differentiation and customer service to customers), threat (impact on bargaining power of customers and suppliers, which are affected by switching and searching costs), preemptiveness (first mover effects and barriers to competitors), and synergy (integration with business goals and strategy). Based on the above studies and using a process-oriented model, Tallon et al. (2000) developed an instrument for organizational impact in terms of business value of IT on various business activities within the value chain. The six dimensions used by these authors are process planning and support, supplier relations, production and operations, product and service enhancement, sales and marketing support, and customer relations. The above dimensions were intended to span all value chain activities on the premise that IT impacts both primary and secondary activities of a value chain.

Sedera and Gable (2004) proposed and validated an eight-item scale instrument for organizational impact in the context of enterprise systems success that included items such as cost reduction, productivity improvements, increased capacity, and business process change. Bradley et al. (2006) categorized IT impact into three levels: strategic impact emphasizes organizational goals, strategies, policies, and objectives; tactical level impact focuses on resource allocation and performance monitoring; operational impact deals with resource use and labor productivity. A recent study by Rai et al. (2006) analyzed the impact of IT-enabled supply chain integration on organizational performance. The authors used three constructs for IT impact: operational excellence, customer relationship, and revenue growth. These measures are aimed at assessing the competitive advantage of a firm compared to its competitors in the industry.

As seen from the above studies, organizational impacts at the firm level can be broadly classified into two categories: organizational impacts internal to the organization and organizational impacts external to the organization. We note that

a similar classification was adopted by Ravichandran and Lertwongsatien (2005), who used two categories of organizational performance: operating performance and market-based performance. There are five indicators that compose the construct of organizational impact, two of which are related to internal impacts (product cost control and internal organizational efficiency) and three to external impacts (supplier switch/search costs, product/service enhancements, and market information support). Product cost control is concerned with reduction of costs of new product designs, existing product re-designs, and product marketing. Internal organizational efficiency is related to efficiency considerations of the decision making process, internal communication/co-ordination, strategic planning, and profit margin. Supplier switch/search costs reflect the ease with which alternate supply sources and alternate products/services can be found and the cost effectiveness of the suppliers handling the firm's business. Product/service enhancement was defined in terms of the extent to which IS improves the quality and availability of products/services to customers. Market information support was defined as the information provided to the firm with respect to customer needs, market trends, and new markets.

Having decided on the five indicator variables for our organizational impact construct as above, we now derive the items suitable for these indicators. We used mostly Mahmood and Soon's (M&S) instrument as a source of items for our organizational impact construct. This instrument is by far the most comprehensive instrument for organizational impact as it consists of 10 constructs and 49 measurable items. Though the development of the M&S instrument is influenced by strategic thinking, its constructs are related to both internal and external organizational impact. The M&S instrument compares well with recent instruments used for organizational impact (Bradley et al., 2006). In addition to strategic impacts, the M&S instrument covers operational impact (through internal organizational efficiency) and tactical impact (through products and services). The M&S instrument has been used by other researchers for organizational impact measurement items (for example, Tallon and Kraemer, 2007). However, the M&S instrument is very long, with 49 items. We needed a shorter and more parsimonious instrument for organizational impact as otherwise the number of items in our survey would be too large because of the additional constructs for system quality, information quality, and service quality needed for our research. We arrived at a shorter 23-item instrument for organizational impact construct by including only those items that are relevant to each indicator.

We derived items for the above five indicators of our organizational impact construct mostly based on M&S by adapting selected items for the constructs and by rewording for clarity and to suit the indicator variables. We selected only the items that are relevant based on the descriptions of our five indicators and ignored the rest of the items. For the product cost control indicator, we kept three items from the economics of production construct of M&S that are related to costs (e.g., minimizing the cost of designing new products or the cost of adding features to existing products); we did not keep other items from economics of production as they were not related to costs and fewer other studies have used such items as part of costs (e.g., achieving economies of scale in software/hardware usage, improving utilization of machinery, and improving level of production were not included as they were not directly related to the indicator product cost control). We also added to this construct another item, "minimize/control marketing costs", taken from the market construct of M&S because of its relevance to overall product costs. For internal organizational efficiency, we adapted the items from the same construct of M&S with slight modifications for better clarity. The five items for the supplier switch/search cost construct were drawn from the suppliers construct of M&S; we dropped three items from the M&S suppliers construct on the grounds of redundancy (e.g., firm gaining leverage over suppliers, enhance firms' "make versus buy" decision). For the product/service enhancement construct, we adopted items from the products and services construct of M&S with slight rewordings. The three items for the market information support construct were obtained using the items related to customer information and needs from the market construct of M&S; the other items are not included as they are not directly related to market information support or because of their infrequent use in prior research (e.g., reinforce customer loyalty; improve competitive efficiency of the firm). Through the above process, we arrived at a 23-item, five-dimensional instrument for organizational impact (Appendix B.1).

Our construct for organizational impact and its five indicators are comparable to the constructs used by other researchers. The product cost control dimension in our research is similar to the efficiency dimension in CAPITA (Sethi and King, 1994), the production and operations variable in IT business value (Tallon et al., 2000), and the cost reduction item of organizational impact (Sedera and Gable, 2004). The internal organizational efficiency dimension in our research has similarities with several other instruments (efficiency dimension in Sethi and King, 1994; operations excellence construct in Rai et al., 2006; impact of operational and tactical IS use constructs in Bradley et al., 2006; supplier relations variable in Tallon et al., 2000). The items of the supplier switch/search costs construct were used in the threat dimension of CAPITA (Sethi and King, 1994) and the supplier relations variable in IT business value (Tallon et al., 2000). Product/service enhancement items are described in the functionality construct of CAPITA (Sethi and King, 1994), the product and service enhancement variable in IT business value (Tallon et al., 2000), and the impact of operational IS use in IT business value (Bradley et al., 2006). The market information support construct used in our research is also similar to the construct of sales and marketing support used in IT business value by Tallon et al. (2000).

3.2. System quality

System quality represents the quality of the information system processing itself, which includes software and data components, and it is a measure of the extent to which the system is technically sound. Seddon (1997) notes that "system quality is concerned with whether there are bugs in the system, the consistency of user interface, ease of use, quality of documentation, and sometimes, quality and maintainability of program code" (p. 246). System quality is measured by attributes such

as ease of use, functionality, reliability, data quality, flexibility, and integration (DeLone and McLean, 2003). A comprehensive instrument for system quality was developed and validated by Sedera and Gable (2004), which resulted in nine attributes – ease of use, ease of learning, user requirements, system features, system accuracy, flexibility, sophistication, integration, integration, and customization.

Drawing from previous research, we group the attributes for system quality into two broad categories – system features from the system designer perspective (called system flexibility) and system features from the end user perspective (called system sophistication). The system flexibility dimension reflects the fact that the system is designed with useful/required features (and without unnecessary features) and the fact that software modifications can be performed by the system designer with ease (Wang and Strong, 1996). The system sophistication dimension denotes a user-friendly system (Miller and Doyle, 1987) that is easy-to-use, well documented, has a quick turnaround time (Bailey and Pearson, 1983), and uses modern technology enabling user-friendliness of systems. The items used in this research are similar to those used by Nelson et al. (2005). The scale items for System Flexibility and System Sophistication are listed in Appendix B.2.

3.3. Information quality

Information quality refers to the quality of outputs the information system produces (DeLone and McLean, 1992), which can be in the form of reports or online screens. Huh et al. (1990) define four dimensions of information quality: accuracy, completeness, consistency, and currency. Accuracy is agreement with an attribute about a real world entity, a value stored in another database, or the result of an arithmetic computation. Completeness is to be defined with respect to some specific application, and it refers to whether all of the data relevant to that application are present. While consistency refers to an absence of conflict between two datasets, currency refers to up-to-date information. Researchers have used a variety of attributes for information quality. Nelson et al. (2005) have used the constructs of accuracy, completeness, currency, and format for information quality; the additional construct used by these authors – format – is related to the presentation layout of information outputs.

We arrived at the dimensions for information quality based on the following. The well-accepted end user computing satisfaction (EUCS) instrument (Doll et al., 1994) has five constructs comprising information quality: content, accuracy, format, ease of use, and timeliness. In our research, ease of use and timeliness are included in system quality because they are influenced by the hardware/software system itself. We include information accuracy item in our 'content' construct because it is closely related to information content. Thus, we arrive at two broad categories for information quality: information content and information format. Information content measures the relevance of the information presented to the user in the report/inquiry screens and the accuracy and completeness of the information. Information format measures the style of presentation of information and whether information is provided in an easy-to-understand format. The scale items used for information content and information format are listed in Appendix B.3.

Our constructs are comparable to those used by previous researchers. All five items used by DeLone and McLean (2003) to measure information quality (accuracy, timeliness, completeness, relevance, and consistency) are included in our content dimension, except that timeliness is considered in our system quality construct as response time. Our dimensions are comparable to those used by Rai et al. (2002) (i.e., content, accuracy, and format) as we included accuracy as part of the content dimension. All of the items of the information quality measure used in this research are also present in some form in the data quality instrument developed by Wang and Strong (1996). Our dimensions are also comparable to the six-item instrument developed and validated by Sedera and Gable (2004) for information quality as five of the six items are included as part of our dimensions.

3.4. Service quality

The construct *service quality* has been defined as the degree of discrepancy between customers' normative expectations for service and their perceptions of service performance. The seminal work on service quality is that of Parasuraman et al. (1988), which culminated in the development of the SERVQUAL instrument. Cronin and Taylor (1994) presented the SERVPERF instrument, which measures only customer perception of quality, as a sufficient measure of value. In our study, we elicit these "experienced" levels of various service attributes (i.e., perceptions of quality).

In the present study, the service quality construct was measured by four indicators: reliability, responsiveness, assurance, and empathy. Scale items were adopted from Pitt et al. We used four constructs for service quality as opposed to the five constructs used by Pitt et al. – we dropped the 'tangibles' construct. The rationale for this approach is that the measure for the 'tangible' dimension had low reliability in the study of Pitt et al. (1995), and our choice is consistent with the choices of previous researchers (Kettinger and Lee, 1997; Carr, 2002) who excluded tangibles dimension in IS-adapted service quality measurement. The reliability construct measures the extent to which the IS department strives to improve the information services provided to users. Responsiveness includes items that measure the extent to which the IS staff are willing to help users and provide prompt service. Assurance is the ability of the IS staff to build users' confidence. While the original construct for assurance has five items, we merged two of the items into one based on pre-testing of the instrument, resulting in four items for this construct. The empathy construct measures the personal attention and caring provided by the IS staff. The original construct for empathy has five items, but we used four items because of a possible duplication in meaning between two of the items. The scale items for the four indicator variables of service quality are provided in Appendix B.4.

4. Research hypotheses

Based on the theoretical discussion and the constructs derived in the previous section, hypotheses were drawn from the model in Fig. 1 and tested. System quality, information quality and service quality are determinants of organizational impact. System quality will also have an indirect effect on organizational impact through information quality.

4.1. System quality

A well-designed, developed, and implemented system is a necessary prerequisite to deriving organizational benefits. The benefits that could be derived include cost reduction, increased revenues, and improved process efficiency (Bakos, 1987). Conversely, a system that is not well designed and constructed will likely run into occasional system crashes, which will be detrimental to business operations and result in increased product cost to the firm. Furthermore, a system that is easily maintainable has a longer life, resulting in spreading of the software costs over a longer period, which in turn results in lower costs to the firm (Swanson, 1997). The system quality in the case of data warehousing has been shown to be positively associated with perceived net benefits in terms of individual productivity and ease of decision making (Wixom and Watson, 2001), thus resulting in increased internal organizational efficiency. Bradley et al. (2006) have shown that system quality is positively associated with organizational impact at the operational level within entrepreneurial firms. The above arguments lead to the hypothesis that systems with high flexibility characterized by high maintainability and many useful system features have high organizational impacts in terms of product cost control (through reduced product cost) and internal organizational efficiency (through improved decision making).

To create business value for a firm through its information systems, the system should ensure efficient delivery of IS through system attributes such as availability of documentation and ease of use (Salmela, 1997). A system that is well documented will carry lower software maintenance costs for the firm. Software must be of high quality to achieve a competitive advantage for the firm (Slaughter et al., 1998). A system with high sophistication (i.e., one that uses modern technology and provides user-friendly interfaces) will lead to high organizational impact in terms of supplier switch/search costs because suppliers are comfortable using easy-to-use systems. This system would be cost effective for the suppliers handling the firm's orders due to the firm's user-friendly and well-integrated systems and the fast response times. Furthermore, a system with high sophistication (due to high integration of functions possible with Enterprise Resource Planning (ERP) and Supply Chain Management (SCM) applications) will result in increased profitability (Hendricks et al., 2007) and increased internal co-ordination among the functional areas, thus leading to increased internal organizational efficiency. Thus, we posit:

H1a: System quality is positively associated with organizational impact.

In general, software quality may be used to mean system quality. Overall, lower software quality results in high costs due to software's not serving its intended purpose, not being designed as specified, being prone to errors, having few security provisions, and not being robust (Torn, 1990). Thus, low-quality software results in low information quality (with respect to the information content dimension) because of irrelevant and inaccurate/incomplete information. Furthermore, a system that is flexible can be modified easily and quickly, thus meeting changed user information needs quickly and efficiently, which leads to relevant and up-to-date information outputs to users, implying high information quality. The above

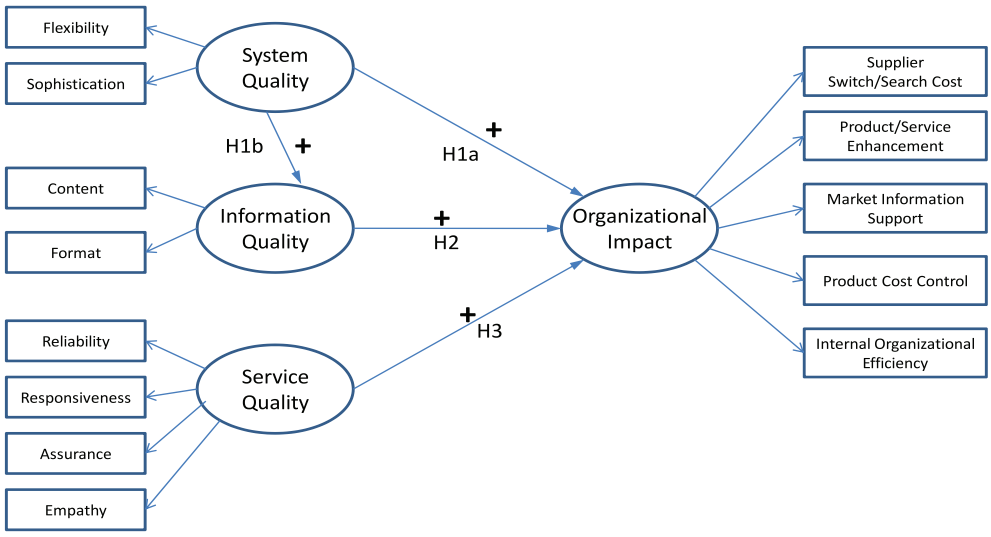

Fig. 1. Research model.

arguments support the premise that high flexibility of system quality (i.e., maintainability, useful features of system) leads to high information content (i.e., useful and relevant information).

A system that utilizes user-friendly and modern technologies (such as GUI – graphical user interfaces) can present information to users in an easy-to-understand format, enabling them to use information systems effectively. A well-integrated system provides complete and accurate information so that its information outputs will be useful for users' daily jobs and relevant for decision making purposes. The above arguments imply that high system sophistication (i.e., modern technology, user-friendly, well integrated) leads to high information format (i.e., easy-to-understand and consistent outputs) and high information content (i.e., complete, accurate, relevant to decision making). Thus, we posit:

H1b: System quality is positively associated with information quality.

4.2. Information quality

Information systems processing is similar to production processing in manufacturing organizations. If the product (information) is not delivered on time (timeliness) and the product (information) does not conform to the needs (relevance) of customers (users), then the customers (users) will be dissatisfied and the firm will lose business (Clikeman, 1999). Information provided by an IS that does not conform to its users' needs is subject to heavy maintenance costs and disruption of operations in the organization, resulting in high costs to the organization (Swanson, 1997). When better operational information is available, organizations benefit in terms of reducing labor costs, reducing waste, better utilizing machinery, and lowering inventory costs (Banker et al., 1990). Thus, high information content (i.e., accurate, complete, and relevant information) leads to better product cost control and increased organizational efficiency (i.e., increased profit margin, increased decision making efficiency).

Data quality is at the heart of information quality in that poor data quality results in poor information quality. Poor data quality, and hence poor information quality, has adverse effects on organizations at operational, tactical, and strategic levels (Redman, 1998). At the operational level, customers will be dissatisfied and employees will lack job satisfaction because of inaccurate or incomplete information. At the tactical level, the quality of decision making will be adversely affected by irrelevant information. Selection and execution of a sound business strategy will become difficult because of inaccurate or delayed information. On the other hand, high information quality in terms of information content (i.e., accuracy, completeness, relevance to decision making) can lead to high organizational impact in terms of market information support (i.e., anticipating customer needs) and internal organizational efficiency (i.e., high-quality decision making). Thus, we posit:

H2: Information quality is positively associated with organizational impact.

4.3. Service quality

IS departments act as service units for various users in the organization, and organizational success depends on how well the IS services are delivered. The primary use of SERVQUAL, as modified for IS service quality, has typically been related to the delivery of information services by IS departments (Pitt et al., 1995; Kettinger and Lee, 2005). IS services delivered on time and with error-free performance by the IS unit (i.e., reliability of IS service quality) will result in timely and efficient decision making, which in turn leads to better internal organizational efficiency.

By having knowledgeable IS specialists who maintain good communication through courteous interactions with business units (assurance), have users' best interests at heart and are able to understand users' needs better (empathy), IS services will become better aligned with organizational goals, resulting in improved quality of decision making and improved profitability (internal organizational efficiency), better anticipation of customer demands and more accurate sales forecasting (market information support). Furthermore, prompt provision of services to end users by the IT unit (responsiveness) will enable rapid responses to new business opportunities (through market information support).

The impact of IS service quality can be understood from the impact of a firm's service quality on the firm performance. Delivering quality service is a prerequisite for business success that leads to customer loyalty, higher profitability, lower cost (Grant, 1989), higher revenues (Reicheld and Sasser, 1990), increased customer satisfaction, long-term economic returns for the firm (Anderson et al., 1994) and increased repurchase intensions (Soteriou and Chase, 2000). In the IS context, there are two types of users to whom IS services are delivered: internal users and external users such as customers and suppliers. IS specialists, by providing prompt and reliable services to users and by understanding users' specific needs, can better anticipate and serve customer needs through appropriate product/service enhancements. IS specialists, by insisting on error-free records and providing dependable services (reliability), will ensure the continuity of successful business operations and profitability (internal organizational efficiency). In the past, business disruptions due to inefficient IS operations have been reported by several sectors, such as the brokerage, credit card, and ATM sectors (Ravichandran and Lertwongsatien, 2005). Thus, IS service quality is positively related to market information support, product/service enhancement, and internal organizational efficiency.

According to the resource-based view (RBV), IT-related resources (for example, human IT) serve as potential sources of competitive advantage (Bharadwaj, 2000). Human IT resources include technical IT skills and managerial IT skills. According to RBV, IT specialists with these skills will be able to integrate IT and business processes more effectively, develop reliable

and cost-effective applications, communicate well with business users, anticipate future business needs, and innovate with new product features. Furthermore, managerial IT skills help IT specialists to coordinate better with business units, resulting in successful systems. Accordingly, if a firm employs IT experts with IT/business skills and managerial IT skills, who are courteous with users and develop better relations with them (assurance) and who are skillful in understanding users' specific needs (empathy), innovation can take place by adding new features to existing products or designing new products (product/service enhancement) at low cost (product cost control) and/or by anticipating better customer needs (market information support). Thus, we posit:

H3: Service quality is positively associated with organizational impact.

5. Research method

Seddon (1997) defines an "information system" implicitly in the IS success model as "... either some aspect of an application of information technology (IT), one individual application, a group of applications (including those of an entire organization) ... (p. 246)". Pitt et al. (1995) indicate that the unit of analysis for service quality can be either an information system or an IS department. Following the above definitions, we consider the unit of analysis to be "one or more information systems" engaged by a user.

The research method that follows describes construct measurement for the IS quality constructs and organizational impact as well as the data collection procedure for empirical testing. Partial least squares-based structural equation modeling was applied to validate the instruments based on confirmatory factor analysis and for hypothesis testing using path coefficients.

5.1. Construct measurement

The constructs used in this study are system quality, information quality, service quality and organizational impact. For each construct, we identified the underlying domains of that construct and used items from previous research to represent each domain. Then we tested the constructs for their psychometric properties. Scale items are presented in Appendices B.1–B.4.

We used perceptual measures rather than objective measures for organizational performance because it is difficult to isolate the organizational performance effects due to IS quality as changes in profits and market share can result from factors other than IS quality. Not all the items of organizational performance are quantifiable (for example, product/service enhancement and market information support). Venkatraman and Ramanujam (1987) found strong correlations between perceptual measures of business performance and objective measures. Likewise, Tallon et al. (2000) argued that executives' perceptual measure is a good substitute for objective data. Furthermore, researchers have employed users' perceptions about the organizational impact of IS in prior studies.

Recently, some concerns have been raised regarding the usage of perceptual measures for both independent and dependent variables as it may create a common method variance (CMV) phenomenon (Sharma et al., 2009; Straub and Burton-Jones, 2007). The rationale is that when the data on independent variables (IVs) and dependent variables (DVs) are self-reported by the same respondent, spurious correlations could result because of the common method used to collect the data, which cannot necessarily be attributed to the underlying phenomenon being tested. However, others have argued against the above stated premise as follows. When researchers choose different methods for measuring IVs and DVs, the results could understate the relationship between the variables because of the compounding of the different problems associated with different methods, thus understating the underlying true effects (cf. Straub and Burton-Jones, 2007). Furthermore, CMV is more significant in abstract compared to concrete measurement scales because of the greater subjectivity involved in responding to abstract items (for example, in the case of attitudes). As IS research often deals with specific and concrete items that are IT-related (as compared to psychology, sociology, or education), IS research is less susceptible to CMV (Malhotra et al., 2006). Accordingly, in this research, as we measure items that are less ambiguous (for example, well-integrated systems, easy-to-understand information formats, responsiveness items of service quality, or inter-organizational efficiency items), there is less risk of CMV.

The organizational impact construct is measured by five indicators, as described in the previous sections: supplier switch/search costs (five items), products/service enhancement (three items), market information support (three items), product cost control (four items), and internal organizational efficiency (eight items). As each indicator has multiple questionnaire items, the average of the items is taken as the measure of that indicator variable. System quality is measured by two indicators, flexibility and sophistication, with three and six items, respectively. Information quality is measured with indicator variables of content (five items) and format (three items). Service quality has four indicator variables: reliability with five items, responsiveness with four items, assurance with three items, and empathy with four items. Like the organizational impact construct, the indicators for IS quality constructs are computed through averages of the questionnaire items relevant to those indicators.

5.2. Sample and data collection

Empirical data for instrument validation and hypothesis testing were collected through a field survey of firms in Hong Kong. A mail questionnaire was used as the primary means of data collection. The questionnaire was pre-tested with several experienced managers to increase the face validity of the research instrument. These managers had knowledge of both busi-

ness and information technology and similar backgrounds to the actual respondents. Respondents were asked to examine the wording of each scale item for clarity and meaning and to suggest areas of improvement. The overall consensus of the respondent panel with respect to both the constructs and items suggested that the measurement scales had adequate face validity. The revised questionnaire was given to an IT researcher for feedback and comments. The final questionnaire was mailed to 800 randomly selected accounting managers from the Hong Kong Society of Accountants membership list (the society had over 20,000 members, all holding CPAs – Certified Public Accountant certificates) and accompanied by an informational letter stating the purpose of the research and ensuring confidentiality. They were chosen because we needed the target respondents to possess both IT knowledge and overall business knowledge relevant to their companies. Because they regularly use accounting information systems, they are familiar with information system quality issues and business performance. Functional managers may not be a good choice because they are familiar with their own function only and are generally unaware of IT or IS features.

In addition to background information, the questionnaire included items that asked respondents about their perceptions of business impact, system quality, information quality, and service quality. Regarding organizational impact, the respondents were to give on a 7-point scale (1 = strongly disagree, 7 = strongly agree) their perceptions regarding a statement such as, "IS helps us to anticipate better customer needs". Regarding IS quality items, respondents were required to answer on a 7-point scale (1 = strongly disagree, 7 = strongly agree) regarding their overall perception of the information systems they use. For example, "our information system outputs (including on-screen and printed outputs) have good appearance and format."

Respondents were asked to return the questionnaire either by mail or by fax. A reminder was sent to non-respondents two weeks after the initial mailing. Approximately 30 surveys were not usable because either the questionnaires were returned through the mail as undeliverable or the completed and returned questionnaires were incomplete. The mailing resulted in a total response of 90 usable questionnaires, representing approximately a 12% response rate. The companies' characteristics are shown in Table 1.

The distribution of business types in our sample included 8% in properties, 10% in services, 24% in the financial services sector (finance, banking, insurance) and 22% in the trading sector (wholesale, retailing, trading). Our sample company characteristics are comparable to the industry statistics obtained from the Hong Kong Government (http://www.info.gov.hk and other sites): services: 10%, trading: 28%, financial: 13%. The median number of employees in the sample companies is 170. The median number of IT staff in a company is 6. We also obtained information on the computer literacy level (high/medium/low) of the general staff in the company. The majority of the respondents rated their staff's computer literacy level as "medium", which accounted for 68% of the total sample. The remaining 21% and 11% rated their staff's computer literacy as "high" and "low", respectively. Typically, general staff possess average to above average computer skill levels.

Table 1
Characteristics of sample data.

Business type	Frequency	Percentage
(a) Frequency distribution of business types		
Properties	7	7.8
Finance, banking, insurance	22	24.4
Manufacturing	13	14.4
Hotels and catering	1	1.1
Telecommunication	10	11.1
Transportation	3	3.3
Utility	1	1.1
Service	9	10.0
Wholesale, retailing, trading	20	22.2
Others	4	4.4
(b) Frequency distribution of company size (number of employees)		
Number of employees		
<50	24	26.7
50–99	10	11.1
100–499	21	23.3
500–999	10	11.1
1000–4999	19	21.1
5000–9999	2	2.3
>10,000	4	4.4
Mean = 1309		
(c) Frequency distribution of IS department size (number of staff)		
Number of IS staff		
<9	49	54.4
10–19	13	14.5
20–49	9	10.0
50–99	10	11.1
100–499	5	5.6
500–1500	4	4.4
Mean = 69		

5.3. Instrument validation

The psychometric properties of the constructs were tested using confirmatory factor analysis (CFA) using SmartPLS 2.0 M3 (Ringle et al., 2005). SmartPLS is similar to PLS-Graph and is a component-based path modeling program based on partial least squares (PLS). We chose PLS path modeling because PLS makes fewer demands on the underlying data distribution and sample size compared to covariance-based structural equation modeling (Kuechler et al., 2009). Because of these advantages, PLS path modeling is being widely used to analyze survey data (Verhagen and Dolen, 2009; Kuechler et al., 2009; Gefen and Straub, 2005).

We applied PLS modeling to validate the constructs of system quality, information quality, service quality, and organizational impact and to test the hypotheses. Straub et al. (2004) specify that reliability and construct validity are mandatory validities for instrument measurement. While reliability is an issue of measurement within a construct, construct validity has to do with measurement between constructs. Convergent validity and discriminant validity are components of construct validity (Straub et al., 2004). Thus, we examined reliability, convergent validity, and discriminant validity for the four constructs as follows.

Reliability is used to evaluate the internal consistency of a construct. CFA analysis of PLS provides the values for Cronbach's alpha and composite reliability for each construct. As can be seen from Table 2, most of these values exceed the minimum cutoff (the cutoffs for Cronbach's alpha and for composite reliability in CFA are both 0.70 (Straub et al., 2004)). Thus, the four scales demonstrate adequate reliability.

Convergent validity can be examined through CFA within PLS modeling. The three criteria recommended by Fornell and Larcker (1981) for establishing convergent validity are: (1) all indicator factor loadings should be significant and exceed 0.707 so that over one half of the variance is captured by the latent construct (Gefen and Straub, 2005; Straub et al., 2004); (2) construct reliabilities should exceed 0.70; and (3) average variance extracted (AVE) by each construct should exceed 0.50. As shown in Table 2, factor loadings for all 13 items (belonging to four latent constructs) in the CFA model were significant at $p = 0.001$, and all items had factor loadings greater than 0.707; only one item had a loading of 0.67, which was also deemed acceptable as it is well above 0.60 (Bradley et al., 2006; Hair et al., 1998). Composite reliability of all four constructs exceeded 0.70 (the minimum reliability was 0.85). Furthermore, all AVEs exceeded 0.50 (the minimum AVE was 0.61). Thus, convergent validity was established.

For testing the discriminant validity of hypothesized scales, Gefen and Straub (2005) recommend two criteria: (1) the square root of AVE for a construct should be larger than their corresponding inter-construct correlation coefficients (alternatively, each AVE should exceed the corresponding squared inter-correlations); and (2) the within-construct item loadings should exceed the inter-construct cross loadings by at least 0.10. From the inter-factor correlations in Table 3, we can see that the AVEs range from 0.61 to 0.89, and each AVE is much larger than the corresponding squared inter-construct correlations. From Appendix A, it can be seen that each within-construct loading exceeds the cross loadings by at least 0.10 (for example, the flexibility → system quality loading (0.80) exceeds the cross loadings, which range from 0.31 to 0.49). Thus, the result provides evidence that all of the constructs used in the study are distinct.

5.4. Hypothesis testing

Having established the reliability, convergent validity, and discriminant validity of the constructs, the next step is to test the structural model for the hypothesized paths. Using a bootstrap sampling method, 500 samples were generated to esti-

Table 2
Measurement of constructs and indicators (with reliabilities).

Latent construct	Indicators	Number of items	Factor loadings (*t*-values)	Cronbach's alpha	Composite reliability
System quality	Flexibility	3	0.80 (16.6)	0.67	0.85
	Sophistication	6	0.92 (51.0)		
Information quality	Content	5	0.94 (54.7)	0.88	0.94
	Format	3	0.95 (83.6)		
Service quality	Reliability	5	0.90 (50.5)	0.83	0.95
	Responsiveness	4	0.90 (29.0)		
	Assurance	3	0.92 (61.1)		
	Empathy	4	0.92 (48.7)		
Organizational impact	Supplier switch/search costs	5	0.79 (15.5)	0.84	0.88
	Products/service enhancements	3	0.67 (6.6)		
	Market information support	3	0.78 (9.3)		
	Product cost control	4	0.82 (15.5)		
	Internal organizational efficiency	8	0.82 (14.2)		
Criteria			Loading > 0.707 $t > 1.96$	>0.70	>0.70

Table 3
Discriminant validity: AVEs versus squared correlations.

	System quality	Information quality	Service quality	Organizational impact
System quality	0.75			
Information quality	0.47	0.89		
Service quality	0.47	0.50	0.83	
Organizational impact	0.17	0.24	0.25	0.61

mate path coefficients using PLS. Fig. 2 shows path coefficients for each hypothesized path and the corresponding *t*-values that denote significance of the coefficients (*t*-values >1.96 represent significance level $p < 0.05$) along with R^2 values for the dependent variables of information quality and organizational impact. As can be seen from Fig. 2, all hypothesized paths are significant, except the direct path from system quality to organizational impact ($\beta = 0.70$ for the path system quality → information quality, $\beta = 0.01$ for system quality → organizational impact, $\beta = 0.27$ for information quality → organizational impact, and $\beta = 0.30$ for the path service quality → organizational impact). However, there is an indirect effect of system quality (through information quality) on organizational impact. Overall, our hypothesized research model was supported. The total effects on organizational impact are 0.30 for service quality, 0.27 for information quality, and 0.20 for system quality (considering both direct and indirect effects). Furthermore, a total of 29% of the variance of organizational impact is explained by system quality, information quality, and service quality together; in addition, 49% of the variance of information quality is explained by system quality.

6. Discussion

In this research, we posit that there are linkages between system quality, information quality, service quality and organizational impact based on the premise that variance in organizational impacts can be addressed through variance in IS quality. We also posit that information quality is the key mediator between system quality and organizational impact. The hypothesized model is then empirically validated using data collected from a field survey of firms located in Hong Kong. Our study has two key contributions for IS research. First, it provides a link between system quality, information quality, and service quality and organizational impact using comprehensive instruments. In particular, it contributes to IS success research by pointing out the salience and relevance of IS service quality as a contributor to organizational impact; since there were few studies since service quality was added in the modified D&M model of 2003. Second, it contributes to the IS success model by presenting information quality as a key mediating construct between system quality and organizational impact and, in doing so, describes the process by which system quality impacts firm performance, which has been lacking in IS success-based research.

The central research question for this study was whether system quality, information quality and service quality impact organizational performance measures. Overall, our findings show significant direct or indirect organizational impacts of system quality, information quality, and service quality. System quality does not have a significant direct association with organizational impact; hence, hypothesis H1a is not supported. Possible reasons for this lack of support are as follows. System quality is a measure of the extent to which the system is technically sound, error-free, easy to learn, user friendly, well documented, flexible, etc. These features of an information system are only remotely related to organizational impact. Another

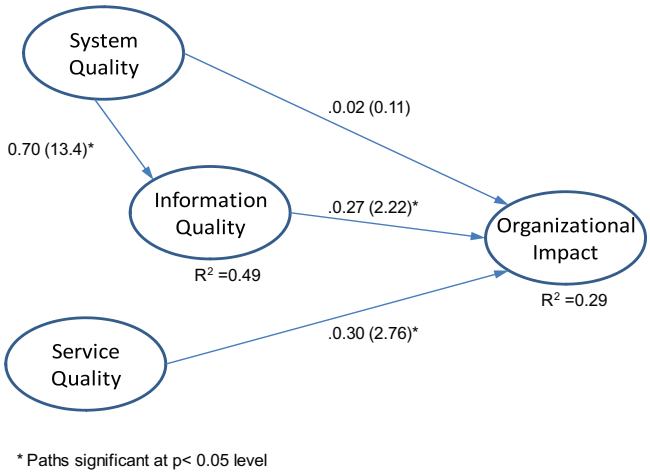

Fig. 2. Structural PLS model.

reason for the insignificant association is the mediator variable of information quality. Because of the mediation by information quality of the relationship between system quality and organizational impact, the direct association between system quality and organizational impact may have become insignificant. Thus, system quality influenced organizational impact indirectly through information quality rather than directly.

Our results show that a positive significant relationship exists between system quality and information quality. Thus, H1b is supported. A poor system (software or hardware) will most likely result in poor information output. Use of modern technology, formal development methods, and appropriate system features for users will facilitate improving information quality. Improvements in system quality can help provide easy-to-understand information outputs and timely reports, and changed information needs can be quickly met. A poor software system will place the firm at a competitive disadvantage because of its inability to provide quality information, specifically in terms of content and format.

System quality, while not associated with business impact directly, is positively related to business impact indirectly through information quality. In the past, system quality and information quality have been considered as independent determinants of other success variables. The linkage between system quality and information quality established in this research provides a justification for modifying the existing IS success models. This linkage could impact the path coefficients of various relationships in IS success models.

A significant positive relationship exists between information quality and organizational impact, thus supporting hypothesis H2. Information outputs can help the firm to identify alternate supply resources and to locate substitute products/services. With the advent of electronic commerce, information outputs can be produced with listings of suppliers that are more economical and advantageous to the firm, which results in favorable supplier searching/switching costs and, consequently, an increased competitive advantage to the firm. Furthermore, with the increased popularity of inter-organizational information systems, quality information can help to verify the status of a firm's order by directly accessing the supplier database, which will reduce the order lead times, resulting in reduced inventory costs for the firm. For the firm to achieve these benefits, the system should adhere to industry standards for ensuring common platform or Electronic Data Interchange (EDI) between the firm and its suppliers/customers (Swanson, 1997).

Our results show that the IS service quality significantly and positively influences organizational impact, thus strongly supporting hypothesis H3. The service quality dimensions (reliability, responsiveness, assurance, empathy) relate to the ability to provide prompt and high-quality services to users. We found that the better the services that are provided by the IS department (for example, by fulfilling their promises promptly, providing dependable services, and ensuring that users have error-free records), the more productive users will be, which can lead to better organizational performance.

Comparing effect sizes and variance explained (R^2 values), we found that system quality explained 49% of the variance in information quality ($\beta = 0.70$). System quality, service quality and information quality together explained 29% of the variance in organizational impact. Of these, service quality had the maximum impact ($\beta = 0.30$), followed by information quality and system quality. While information quality had a direct effect of 0.27, system quality had a total effect of 0.20 (consisting of a direct effect of size 0.02 and an indirect effect through information quality of 0.18), suggesting that organizational impact is most strongly determined by service quality, followed by information quality and system quality. A possible explanation is as follows. Because of the prominence of end user computing, users may need to design their own report formats and content to obtain the information they need. For the users to complete these functions, they need technical support/help-desk support and training to help them. These functionalities are achieved through better-quality service provided by IS department staff.

While previous studies of IS success models do not provide adequate support in an organizational context, our study is of value as it provides empirical evidence for the association between IS quality variables and organizational impact. Some reasons for the lack of support in previous research are as follows. First, most research related to IS success in the past had an individual rather than an organizational focus. Most previous research employed user satisfaction as a measure of overall IS success, so previous analyses focused on issues related to user satisfaction, such as individuals' IS usage and the individual benefits derived from IS. Furthermore, the TAM (Technology Acceptance Model) was the most dominant model in the last two decades: a search on ABI/INFORM using the keywords "Technology Acceptance Model" or "TAM" in abstracts returned 2302 articles. As the basic constructs of TAM (ease of use, usefulness, and use) are individual-oriented, strong emphasis was placed on individual benefits in IS success studies. Thus, few studies analyzed IS success at the organizational level. Second, even those few organizational-level studies used incomplete instruments for organizational benefits. Some studies measured organizational benefits using one or two items (organizational efficiency, time/effort for decision making, or productivity/competitiveness individually). Thus, the instruments for organizational benefits used in previous research were not standardized. As different studies employed different measurement instruments for organizational-level benefits, the results regarding the relationships between IS success variables and organizational benefits were mixed and hard to interpret. Third, the measurement instruments used for IS quality measures in some previous studies used only single-item measures, thus resulting in insignificant relationships. Fourth, using respondents such as operational level users who are unable to answer questions relating to organizational impact and IS quality variables is another reason for the lack of significant results that link IS quality and organizational impact (Petter et al., 2008).

In contrast to previous research on IS success models, we used a multifaceted instrument for organizational impact (23-items) that included organizational operational efficiency issues, product development cost considerations, market-oriented demand considerations, product/service enhancement-related topics, and supplier effectiveness considerations. Thus, our measurement instrument for organizational impact is more comprehensive than those used in most previous studies as it

includes constructs both internal and external to the organization. We also used more comprehensive instruments for system quality (nine items), information quality (eight items), and service quality (16 items) compared to previous studies. The use of a comprehensive instrument for organizational impact and IS quality variables and the use of high-level executives, who can answer questions relating IS quality and organizational impact, as respondents in our study permitted us to observe significant relationships between IS quality and organizational impact in our study.

The results of our research have consequences for IS success models. Our significant direct associations between IS quality constructs and organizational impact (i.e., information quality → organizational impact, service quality → organizational impact, and system quality → information quality) were not explicitly incorporated in the DeLone and McLean IS success models (1992, 2003). The fact that a high proportion of the variance in organizational impact is explained by service quality and information quality may provide good justification to consider direct paths from information quality and service quality to the organizational impact construct and from system quality-to-information quality in IS success models. Our results also confirm the previous research results regarding constructs in IS success models. In an effort to determine the distinct constructs for the IS success models for enterprise systems, Sedera and Gable (2004) performed an empirical study using exploratory factor analysis and confirmatory factor analysis. They determined that the enterprise success model has only four important and distinct dimensions: individual impact, organizational impact, system quality, and information quality. The other dimensions of the success model were not selected. However, the authors did not include service quality in their study. Our research findings confirm Sedera and Gable's finding that IS quality constructs are significant components of IS success. Thus, we conclude that the associations among system quality, information quality, and service quality and organizational impact as determined in this research may have the potential, after further research, to revise IS success models.

6.1. Comparison with previous studies

Overall, our results are comparable to those of Prybutok et al. (2008), who show that the IT quality, which includes system quality, information quality, and service quality, positively impacts net benefits in an e-government context. However, these two studies are not exactly comparable. The net benefits measure used by Prybutok et al. has three question items that test user satisfaction, individual performance and organizational performance; thus, it is difficult to isolate the extent to which organizational performance is associated with IT quality because the authors used IT quality at a gross level rather than separately estimating the effects of system quality, information quality, and service quality on organizational performance. Our results are only in partial agreement with those of Bradley et al. (2006) as they show that system quality has a significant relationship with operational impact and information quality has no significant relationship with operational impact across both types of firms (formal and entrepreneurial). Contrary to that, in our study, system quality did not have a significant direct effect on organizational impact, though there is an indirect effect through information quality. Furthermore, the R^2 values for the dependent variables (impact) in Bradley et al.'s study are comparable to the values obtained in our study (0.06–0.26 in Bradley et al. versus 0.29 in our study). However, the instruments used in our study and those used by Bradley et al. are not the same. Our results are also in agreement with the results of Thong et al. (1996) in that vendor support significantly influences organizational impact in small businesses. The instrument used for vendor support consists of a subset of the questions from the SERVQUAL instrument used in this research, and the instruments used for organizational impact in our study and in Thong et al.'s study are not comparable.

There have been other studies in which organizational performance has been shown to be influenced by factors related to a resource-based view. The resource-based view (Barney, 1991) posits that firms gain a competitive advantage based on resources that are specific, valuable, rare, imperfectly imitable, and not substitutable by other resources; in fact, firms attain a competitive advantage by assembling these resources into capabilities. In the IT context, Bharadwaj (2000) showed that IT infrastructures enable firms develop key applications rapidly, share information across products and services and implement transaction processing and inter-organizational systems. Human IT resources (technical skills, managerial skills and specific relationships between the IS department and user departments) are associated with operational efficiency and competitive advantage (Mata et al., 1995). Ravichandran and Lertwongsatien (2005) established that organizational performance depends on the extent to which IT is used to support a firm's core competencies, which in turn depends on IS capabilities, which in turn depend on the nature of IS resources. Other studies highlight the association between IT capabilities (such as IT infrastructure, IT business experience, and relationship infrastructure) and firm performance (Santhanam and Hartono, 2003; Bhatt and Grover, 2005).

The IT quality variables discussed in this research and the IT resources and capabilities based on a resource-based view are related because of their positive influences on organizational impact; the IT resources will lead to better IT quality parameters. IT resources that are valuable and inimitable can be rent yielding. For example, creating a sophisticated IT infrastructure combining hardware and software assets can be inimitable as such an infrastructure requires innovatively combining the technological components to suit corporate needs. Such an inimitable IT resource will yield better competitive advantage and corporate performance. An IT infrastructure including modern technology, well-integrated and flexible IT architecture, and GUI-oriented software is required for high system quality. Human IT resources in the form of both technical and managerial skills are necessary to provide better service quality and information quality. IT capability in operational competence will result in better service quality in terms of reliability and assurance. Thus, IT resources (both infrastructural and human) and IT capabilities help to achieve better system quality, information quality, and service quality, which in turn

lead to organizational impact. As argued above, IS quality variables can be improved through better IS resources and capabilities in terms of IT infrastructures, human IT resources, and the IT-user relationship infrastructure.

7. Conclusion

Increased organizational dependence on information systems and losses resulting from poor IT quality drive management attention toward IT quality improvement. A 2007 survey of CIOs indicated that "Improve IT quality" is one of the top concerns facing IT executives. As IT quality is a multidimensional measure, it is important to determine which aspects of IT quality are critical to organizations to help CIOs to device effective IS quality improvement strategies with which scarce resources can be allocated more effectively. Our research explores the linkage between IS quality (system quality, information quality, service quality) and organizational impact. Our results indicate that, overall, IS quality dimensions have a significant positive influence on organizational impact either directly or indirectly.

7.1. Implications for practice

It is expected that the results of this study can be used by managers to structure their IS strategies to best benefit their businesses. First, any actions taken to enhance IS service quality can subsequently improve organizational performance. Alternatively, given limited resources, higher priority should be given to IS service quality, information quality, and system quality enhancements (in that order). More emphasis should be placed by CIOs on training the IS staff to develop better attitudes toward service orientation. Both IS managers and general managers should be made aware of the importance of IS quality. IS quality is important for the long-term health of both the IS department and the organization as a whole. Short-sighted and quick solutions will give rise to more expensive fixes in the future, which will result in high costs for the organization. Furthermore, service quality enforcement in the organization should not be considered a one-time job (Watson et al., 1998). There should be a mechanism for continuous service quality improvement and a corresponding commitment to IS quality by the organization.

Second, high information quality is associated with high organizational impact. Information quality can be improved in several ways: for example, by aligning IT strategy with business strategy, using data mining techniques to improve business intelligence, and using data warehousing techniques to aid business decision making. By linking IT strategy with business strategy, information outputs can be designed to provide information that enhances organizational effectiveness. Similarly, data warehousing and data mining techniques provide relevant information (implicit and explicit) to decision makers, which will improve decision making.

Third, information quality plays a mediating role in the relationship between system quality and organizational impact. Thus, IS managers should improve system quality to improve information quality. In doing so, IS managers should emphasize up-to-date hardware and software, graphical user interfaces, and well-designed and well-documented systems. If system quality is poor, it is unlikely that information quality can be improved dramatically. For instance, concise and easy-to-understand outputs are unlikely without modern information technology features, such as graphical user interfaces and online processing capabilities.

Fourth, programs for improving software quality should be established. Such investments have reduced direct software costs, resulting in return on investment (ROI) of up to 10–1 (McConnel, 2002). For example, Motorola saved $611 K on a process improvement program costing $90 K, and Raytheon saved $4.48 million with a $580 K investment (Diaz and Sligo, 1997). Different methods of improving software quality exist (Boegh et al., 1999): Process improvement methodologies, such as CMM, ISO9001, and SPICE; product quality methodologies such as ISO 9126 and Euromethod; and metrics methodologies such as the Goal-Question-Metric paradigm.

Fifth, IT service management programs should be undertaken by organizations because IS service quality is the most important variable affecting business performance. Following IT service management standards such as ITIL (Information Technology Infrastructure Library) will lead to improvement in IS service quality and lower the costs of providing and managing IS services (Johnson et al., 2007). Developed in the 1980s by the British Government's Central Computer and Telecommunications Agency, ITIL is the most popular process framework for managing IT services. ITIL is a set of best practices for aligning IT management with business needs. The most important components of ITIL are service delivery, application management, service support, and IT infrastructure management (Braun and Winter, 2007). Several businesses have benefited from adopting IT service management (ISTM) protocols. For example, the IT providers at Caterpillar reduced response time to resolve Web incidents after the firm implemented ITIL procedures. Proctor & Gamble saved $125 million by implementing ITIL-based service management processes (Galup et al., 2009). ISTM is an emerging discipline that is aimed at optimizing IT services by aligning IT with business objectives. Current initiatives based on the ITIL framework include IBM's Process Reference Model for IT, HP's ITSM reference model, and Microsoft's Operating Framework (Galup et al., 2009). In brief, organizations are encouraged to implement ISTM procedures so that service quality can be improved and business benefits can be increased.

Sixth, IS managers should improve IS capabilities (IT infrastructure, human IT resources, and the IS unit's relationships with business units) so that system quality, information quality, and service quality can be improved. As per the

resource-based view, increasing IS capabilities in the core IS functional areas (such as planning, system development, IS support, and IS operations) and developing IS applications to enhance core competencies of the business will help to improve IS quality and organizational performance (Ravichandran and Lertwongsatien, 2005). IS managers should aim at developing valuable, rare, inimitable, and non-substitutable IS capabilities to increase competitive advantage to the firm. Such IS capabilities in system development will be unique to the organization and integrate well with organizational processes, resulting in increased information quality. The unique IS capabilities in terms of custom-made and mature IT support services will be tailored to the skill level of end users and will meet the specific needs of each business unit, thereby increasing the service quality. System quality may be improved through better IS capabilities, such as an integrated IT infrastructure tailored to serve the specific needs of the users or administrative routines to manage hardware and software (Bharadwaj, 2000). Such measures will reduce disruptions to business operations, thereby increasing business benefits.

7.2. Limitations and future research

Though our research validates the model in a non-US environment, namely Hong Kong, there is a need for cross-cultural work in the field because of the importance of IS quality. The results reported may have been biased by perceptions of quality practices and organizational performance reporting practices from respondents in this country. On the other hand, this study can be used as a benchmark for studying the impacts of system quality, information quality, and service quality on organizational impact in other Asian countries. Though our sample seems relatively small, it meets the minimum sample size requirement necessary for the statistical analyses.

One of the issues with which readers might be concerned is how the results of this research would have changed if functional managers or IT managers instead of accounting managers were used as respondents. If IT managers were the respondents, they would very likely rate system quality, information quality, and service quality highly because IT quality is a reflection of the performance of the IT department. Furthermore, IT managers might not be able to assess organizational impacts very accurately because they are not part of an end user group. These biases could potentially distort the results. Functional business managers (for example, production managers) could more accurately assess the items of the internal organizational efficiency construct of organizational impact. While production managers might experience and be able to report the benefits of IS more accurately, they might not be in a position to accurately reflect on system quality and information quality because of their relatively minimal contact with the IT department. Nevertheless, future research could compare other types of respondents to the results of this research.

The present research can be extended by employing different respondents to answer questions relating IS quality measures and organizational impact measures. By doing so, one could reduce the CMV bias, if any, thus resulting in a more accurate estimation of the effects of the IVs on the DVs. Sharma et al. (2009) specify that CMV is smallest when a perceptually anchored method is used for collecting data on IVs (as used in this study) and a system-captured data collection method is used for DVs (for example, data obtained from historical records and other objective resources, such as those captured by a computer system). While the above method uses multiple sources for data collection, several methods exist to estimate and control the effect of CMV in mono-method measurements, such as Harman's single-factor test or the marker variable technique. The CMV-adjusted correlations can then be used to test the viability of the research model. Testing of the model using the above methods is left for future research. Accordingly, the present research can be extended by incorporating one or more of the above techniques to alleviate the effect of CMV.

One of the limitations of our research is the choice not to use control variables, such as industry type, organization size or management support, that could potentially influence the dependent variables. We did not include these additional control variables in the model because of our relatively small sample size. However, the correlations were computed outside of the model between organization size and industry type and each of the five indicators of organizational impact; none of these correlation coefficients were significant, implying a possible lack of influence of the selected control variables on organizational impact.

This paper provides a starting point for a new direction for research on an enduring topic. IS quality is an ongoing process in industry. It is therefore especially appropriate to examine the relationship between IS quality and organizational impact over time. The present study only examined one point in time. Perhaps the effects of IS quality on performance do not show up until a period of time has elapsed. Naturally, a more extensive longitudinal study may uncover other important findings with regard to the effects of IS quality on corporate performance. Second, the research may be repeated for different IS contexts, such as web-based information systems or outsourcing. Such contexts may provide additional perspectives on the topic. Third, the link between system quality and information quality should be incorporated into the IS success models. Future research may be conducted to re-validate IS success models by including the system quality information quality linkage. Fourth, we explored only one link (system quality-to-information quality) of all of the possible associations among system quality, information quality, and service quality. The present research can be extended to explore other links: for example, service quality affects information quality because empathy can lead to better information content.

Appendix A

A.1. Factor and cross loadings

	System quality	Information quality	Service quality	Organizational impact
Flexibility	**0.80**	0.43	0.49	0.31
Sophistication	**0.92**	0.72	0.68	0.38
Content	0.62	**0.94**	0.69	0.43
Format	0.68	**0.95**	0.66	0.49
Reliability	0.65	0.65	**0.90**	0.52
Responsiveness	0.63	0.63	**0.90**	0.37
Assurance	0.57	0.60	**0.92**	0.43
Empathy	0.66	0.70	**0.92**	0.46
Supplier switch/search costs	0.32	0.47	0.45	**0.79**
Products/service enhancements	0.18	0.21	0.16	**0.67**
Market information support	0.19	0.28	0.27	**0.78**
Product cost control	0.33	0.38	0.37	**0.82**
Internal organizational efficiency	0.44	0.44	0.51	**0.82**

Note: The loadings of the indicator variables on the corresponding factor are shown in bold.

Appendix B

B.1. Indicators and items for organizational performance

Indicator/item description	References
Supplier switch/search cost (five items)	Mahmood and Soon (1991)
IS helps us to identify alternative supply sources	Sethi and King (1994)
Locate substitute products/services	Tallon et al. (2000)
Ensure cost effectiveness of your supplier in handling your orders	
Ensure cost effectiveness of your supplier in replenishing your inventory	
Minimize uncertainty in ordering lead time	
Products/service enhancement (three items)	Mahmood and Soon (1991)
IS helps us to make the products/services information available to customers	Sethi and King (1994)
Maintain high products/services innovation	Tallon et al. (2000)
Add value to existing products/services	Bradley et al. (2006)
Market information support (three items)	Mahmood and Soon (1991)
IS helps us to enhance sales forecast accuracy	Tallon et al. (2000)
Anticipate better customer needs	
Identify groups of customers whose needs are not being met	
Product cost control (four items)	Mahmood and Soon (1991)
IS helps us to minimize the cost of designing new products/services	Sethi and King (1994)
Minimize the cost in adding features to existing products/services	Tallon et al. (2000)
Minimize the cost of tailoring products/services to market segments	Sedera and Gable (2004)
Minimize/control marketing costs	
Internal organizational efficiency (eight items)	Mahmood and Soon (1991)
IS helps us to ensure high efficiency in decision making process and high quality of final decision	Sethi and King (1994)
Ensure high efficiency in internal meetings and discussions	Bradley et al. (2006)

Appendix B (*continued*)

Indicator/item description	References
Ensure good co-ordination among organization's functional areas	Rai et al. (2006)
Provide good evaluation on annual budget	
Provide good evaluation on capital (fixed asset and investment) budget	
Maximize the company's profit margin	
Maximize the company's market share	
Maximize company's strategic planning efficiency	

B.2. Indicators and items for system quality

Indicator/item description	References
System flexibility (three items)	
Our information systems are easy to learn	Miller and Doyle (1987) and Sedera and Gable (2004)
Equipped only with useful features and functions	DeLone and McLean (2003) and Sedera and Gable (2004)
Flexible to make changes easily	Wang and Strong (1996) and Nelson et al. (2005)
System sophistication (six items)	
Our information systems are applied modern technology	
Well integrated	Bailey and Pearson (1983) and Nelson et al. (2005)
User-friendly	Miller and Doyle (1987)
Good documentation	Salmela (1997)
Short response time for on-line enquiry	Bailey and Pearson (1983)
Short time lag between data input and output for batch processing	Bailey and Pearson (1983)

B.3. Indicators and items for information quality

Indicator/item description	References
Information content (five items)	
Our information outputs (including on-screen and printed outputs) are accurate	Doll et al. (1994)
Complete	Nelson et al. (2005) and Huh et al. (1990)
Concise	Kahn et al. (2002)
Useful in our daily jobs	Kahn et al. (2002)
Relevant for decision making	Doll et al. (1994)
Information format (three items)	
Good appearance and format	Nelson et al. (2005) and Wang and Strong (1996)
Comparable to other outputs (consistency)	Huh et al. (1990)
Easily to understand	Wang and Strong (1996)

B.4. Indicators and items for service quality

Indicator	References
Reliability (five items)	Parasuraman et al. (1988)
When IS promises to do something by a certain time, it does so	Kettinger and Lee (1997)
When users have a problem, IS shows a sincere interest in solving it	Pitt et al. (1995)
IS services are dependable	Carr (2002)
IS provides its services at the time it promises to do so	
IS insists on error-free records	

(*continued on next page*)

Appendix B (*continued*)

Indicator	References
Responsiveness (four items)	Kettinger and Lee (1997)
IS tells users exactly when services will be performed	Pitt et al. (1995)
IS employees give prompt service to users	Carr (2002)
IS employees are always willing to help users	
IS employees are never too busy to respond to users' requests	
Assurance (three items)	Kettinger and Lee (1997)
Users will feel safe in their transactions with IS's employees	Pitt et al. (1995)
IS employees are consistently courteous with users	Carr (2002)
IS employees have the knowledge to do their job well	
Empathy (four items)	Kettinger and Lee (1997)
IS gives users individual attention	Pitt et al. (1995)
IS has operating hours convenient to all its users	Carr (2002)
IS has the users' best interests at heart	
Employees of IS understand the specific needs of its users	

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