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EIS Information:
Use and Quality Determinants

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ABSTRACT

This article reports on the findings of research investigating the influence of information quality on EIS information use, as well as the possible impact of ease of use, user involvement, IS maturity, and system sophistication on EIS information quality. To test the research hypotheses, data was collected from 216 UK-based executives. A structural equation modeling (SEM) technique for data analysis and model measurement was applied. Information quality was found to influence EIS information use. Also, ease of use, user involvement, the IS integration dimension of IS maturity, and EIS sophistication were found to influence executives perception of information quality. Further findings, limitations, implications for researchers, and practitioners are discussed.

Keywords: ease of use; EIS; EIS sophistication; information quality; information use; IS maturity; UK; user involvement

INTRODUCTION

Information use is important for organizational learning and competitive advantages, and an understanding of the factors that affect such usage is critical (Low & Mohr, 2001). Managers receive information in various forms (e.g., printed, graphics, verbal, visual, etc.) and from different internal and external sources (e.g., memos and letters, scheduled and unscheduled meetings, telephone, office visits, computer reports, periodicals, conventions, social/civic activities, etc.). Earlier research findings indicated that executives relied more heavily on informal sources of information, compared to formal sources. Of the written media, memos and non-computer reports were considered more valuable than computer reports (McLeod, Jones, & Poitevent, 1984; Jones & McLeod, 1986). However, later research findings show an improvement in managers' ranking of computer-based information sources, compared to non-computer-based sources, and more emphasis on external sources, compared to internal resources (e.g., Benard & Satir, 1993; Lan & Scott, 1996).

Executive information systems (EISs) are systems that provide executives with information that is relevant to their work (Walstrom & Wilson, 1997, p. 77). EISs are assumed to provide improvements in the quantity and quality of information made available to executives. This includes providing more timely, concise, relevant, and accessible information. However, since an EIS is one of many information sources available to managers to support their work activities, the extent to which managers use this source is expected to vary. Among other factors, EIS use may be influenced by its users' perception of information quality (Seddon & Kiew, 1994; Leidner, 1996). In earlier investigations, EIS information quality was ranked as the most important characteristic of an executive information system (Bergeron, Raymond, & Lagorge, 1991), and the frequency of EIS use was best explained by the quality of information (Leidner, 1996).

Understanding the factors that possibly influence EIS information quality is crucial to EIS development and organizational information management. However, most of the prior EIS research focused on the reasons and methods of EIS development and implementation (e.g., Rockart & Delong, 1988; Watson, Rainer, & Houdeshel, 1997; Bergeron et al., 1991; Rainer & Watson, 1995; Watson & Carte, 2000; Poor & Wagner, 2001). In addition, much of the limited prior research on EIS use focused on the mode, benefits, and impact of use on decision making (e.g., Elam & Leidner, 1995; Nord & Nord, 1995; Frolick, Parzinger, Rainer, & Ramarapu, 1997). In addition, the literature on information quality is generally prescriptive, and empirical evidence that links information quality to EIS information use is rather limited.

Little is known about the factors that influence systems-related perceptions (Agarwal, Prasad, & Zanino, 1996; Igbaria, Guimaraes, & Davis, 1995; Venkatesh & Davis, 1994), including the perception of EIS information quality. This study investigates the relationship of EIS information use to EIS information quality and the possible impact of ease of use, user involvement, information systems (IS) maturity, and system sophistication on EIS information quality using UK-based data.

The article is organized accordingly. The first section presents the study background, followed by the research model and hypotheses, data analysis and results, discussion, research limitations, and the article ends with conclusions.

BACKGROUND

Failure stories of EIS in organizations have been documented in the literature (e.g., Glover, Watson, & Rainer, 1992; Rainer & Watson, 1995; Young & Watson, 1995; Nandhakumar & Jones, 1997; Liang & Miranda, 2001). Such failures can be linked to organizational, management, social, cultural, behavioral, psychological, and technological factors (McBride, 1997; Nandhakumar & Jones, 1997; Poon & Wagner, 2001). Executives are often disappointed by the quality of information received from EIS and get frustrated when trying to operate them (Pervan & Phua, 1997).

Information quality is believed to be one of the most important characteristics that determine the degree to which information is used (O'Reilly, 1982). The rather limited previous empirical research on information quality and information systems effectiveness suggests a positive relationship between perceived information quality and information use. In particular, information quality was found to be central to EIS success (e.g., Bergeron, Raymond,

Rivard, & Gara, 1995; Leidner, 1996; Koh & Watson, 1998; Rainer & Watson, 1995; Rockart & Delong, 1988). Also, managers were found to likely trust information of high quality and, hence, are more likely to rely on such information in making decisions or evaluating performance (Low & Mohr, 2001).

Quality is viewed as the fitness for use or the extent to which a product/service successfully serves the purposes of its consumers (Juran, Gryna, & Bingham, 1974). Information quality refers to the extent to which the available information meets the information requirements of its users (Seddon & Kiew, 1994). Kahn, Strong, and Wang (2002) draw distinctions between the quality dimensions of information as a product and information as a service. Information product quality includes dimensions such as the tangible measures of accuracy, completeness, and freedom from errors. Service quality, on the other hand, includes dimensions related to the service delivery process as well as the intangible measures of ease of manipulation, security, and added value of the information to consumers. Although the conventional view of information quality is product oriented, both product and service quality are important aspects of information quality (Pitt, Watson, & Kavan, 1995; Wang & Strong, 1996).

The information quality literature suggests the existence of a number of views on what constitutes the dimensions (attributes) of information quality. Raghunathan (1999), for instance, used accuracy as a measure of information quality. Clikeman (1999) identified information quality to include the dimensions of relevance, reliability, timeliness, and cost. From a consumer's perspective, a framework was developed to capture the underlying information quality in four groups (Strong, Lee, & Wang, 1997; Wang & Strong, 1996; Huang, Lee, & Wang, 1999): (1) intrinsic (e.g., accuracy, reliability, believability); (2) contextual (e.g., relevancy, completeness, timeliness); (3) representational (e.g., conciseness, consistency, interpretability); and (4) accessibility (e.g., access, security). Also, Cambridge Research Group (1997) developed an instrument to assess information quality across 17 dimensions, hence providing a benchmark of the information quality status of an organization.

Nevertheless, the growing body of knowledge on information quality is mostly prescriptive. It focuses primarily on information quality definitions, dimensions and attributes, and quality measurement and improvement approaches (e.g., Ballou & Pazer, 1985, 1995; Firth & Wang, 1996; Huang et al., 1999; Madnick & Wang, 1992; Orr, 1998; Redman, 1992; Strong et al., 1997; Wang & Strong, 1996; Yang, Strong, Kahn, & Wang, 2002). Yet, empirical evidence that links information quality to systems use is somewhat limited.

On the other hand, information systems effectiveness research models and frameworks — for example, Ives, Hamilton, and Davis, 1980; Fuerst and Cheney, 1982; Raymond 1990; the Technology Acceptance Model (TAM) (Davis, 1989; Davis, Bagozzi, & Warshaw, 1989); Diffusion of Innovations (e.g., Rogers, 1995); the Theory of Planned Behavior (TPB) (e.g., Taylor & Todd, 1995a); Social Cognitive Theory (SCT) (e.g., Compeau, Higgins, & Huff, 1999) — and past relevant research produced useful insights to individuals' behavioral reactions to information systems and the factors that may influence such reactions. However, despite a substantial body of empirical evidence linking user perceptions to use, little is known about the factors that influence

systems-related perceptions (Agarwal et al., 1996; Igbaria et al., 1995; Venkatesh & Davis, 1994), including perceptions of information quality.

There are only a few empirical studies (e.g., Bergeron et al., 1995; Rainer & Watson, 1995; Young & Watson, 1995; Kim, 1996; Leidner, 1996; Bajwa, Rai, & Brennan, 1998; Koh & Watson, 1998; El-Kordy, 2000) that investigated EIS effectiveness and its determinants. Although recognized as a major determinant of EIS success, information quality received little attention as a construct in the past empirical research on information systems effectiveness. Specifically, information quality was often treated as a component of a general measure of user satisfaction in past empirical research. As a result, empirically driven evidence on the possible influence of information quality on EIS information use and the factors that may influence users' perceptions of EIS information quality should be of interest to both IS researchers and practitioners.

Although the literature on information systems effectiveness suggests a number of technical, managerial, and organizational factors that are believed to influence perceived information quality, only ease of use (e.g., Davis et al., 1989; Straub, Limayem, & Karahanna-Evaristo, 1995; Igbaria, Zinatelli, Cragg, & Cavaye Angele, 1997), user involvement (e.g., Barki & Hartwick, 1989; Watson et al., 1997; Khalil & El-Kordy, 1997; Srivihok, 1999), IS maturity (e.g., Cheney & Dickson, 1982; King & Sabherwal, 1992; Millet & Mawhinney, 1992; Igbaria et al., 1997), and EIS sophistication (e.g., Davis et al., 1989; Rainer & Watson, 1995; Bergeron et al., 1995) are investigated in this study. The selection of these research variables was guided by: (1) the findings of the prior research that investigated their influence on information systems use and user satisfaction (e.g., Seddon & Kiew, 1994; Kraemer, Danziger, Dunkle, & King, 1993; Khalil & El-Kordy, 1999; Leidner, 1996), and (2) the restricted research resources that were available to the researchers.

RESEARCH MODEL AND HYPOTHESES

The proposed research model (Figure 1) suggests that the use of EIS information is a function of EIS perceived information quality. The review of the literature reveals that user satisfaction with information systems was studied from three perspectives: attitudes toward the information system, information quality, and effectiveness (Kim, 1989). One of those dimensions, information quality, was found to be an important factor for EIS success (Bergeron et al., 1995; Leidner, 1996; Koh & Watson, 1998; Rainer & Watson, 1995; Rockart & Delong, 1988). Consequently, information quality was included in the proposed model as a direct determinant of EIS information use.

Figure 1 depicts ease of use, user involvement, IS maturity, and EIS sophistication as possible determinants of EIS information quality. The information of an EIS that is perceived to be easier to use and less complex has a higher chance to be perceived positively by its users. User participation in EIS development efforts is expected to enhance his or her perceived information quality through the intervention of a needs-based psychological component (i.e., user involvement) (McKeen, Guimaraes, & Wetherbe, 1994; Rainer & Watson, 1995). Also, a more mature IS function should be in a better position to plan, design, implement, and operate effective EIS, and consequently, users are ex-

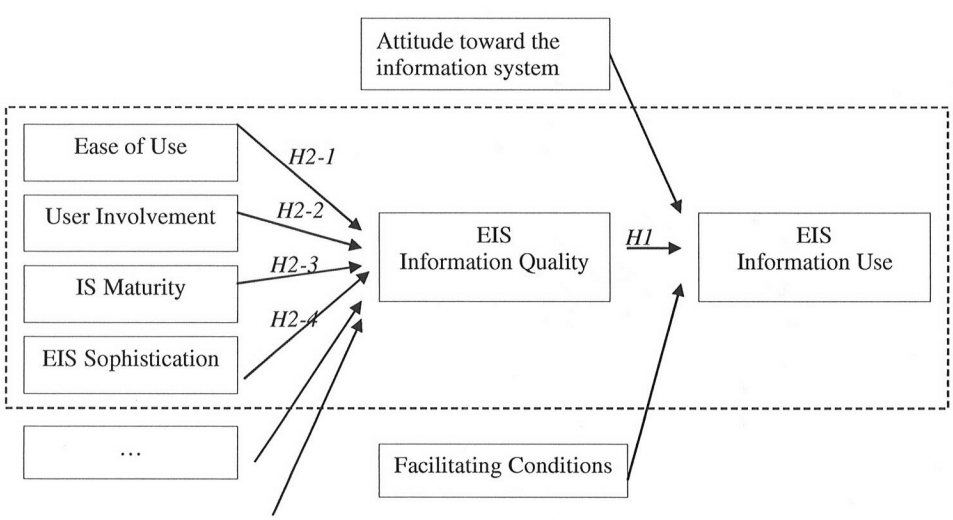
pected to have more positive beliefs about their information quality. In addition, system sophistication — the availability of EIS functions (e.g., status access, exception reporting, drill down, etc.) is expected to positively influence the perceived information quality of the systems. These expectations are put together in proposed hypotheses.

EIS Information Use and Information Quality

Perceived information quality is defined as the extent to which users believe that the information systems available to them meet their information requirements in terms of timeliness, accuracy, format, and relevance of the information generated by the system (Seddon & Kiew, 1994; Leidner, 1996). The direct link between different facets of user satisfaction and usage is supported by a large body of empirical research (e.g., Baroudi, Olson, & Ives, 1986; Ein-Dor & Segev, 1986; El-Kordy, 1994; Lucas, 1975, 1978; Robey, 1979; Raymond, 1985; O'Reilly, 1982; Torkzadeh & Dwyer, 1994). However, few studies examined the link between information quality and computer-based information use. Such a link is especially important in the context of EIS, which is mainly designed to provide managers with the timely, precise, and relevant information they need.

A number of investigations focused on information quality as a determinant of EIS use. Bergeron et al. (1995) defined effect towards EIS in terms of satisfaction with the EIS information quality, accessibility, and services provided by the EIS staff. Their study found that effect of EIS has a positive influence on its use. This finding is consistent with the finding of a prior study that information quality is the most important characteristic of an EIS (Bergeron et al., 1991). Also, Leidner (1996) found that frequency of EIS use was best explained by the quality of the

Figure 1. The research model



EIS information. Kraemer et al. (1993) reported that information quality has a significant positive influence on perceived usefulness of computer-based information.

The inclusion of perceived information quality as a direct determinant of information use is based on Delone and Mclean's (1989) and Seddon's (1997) models of IS success, which propose information quality is a direct antecedent of systems use. Also, the Technology Acceptance Model (TAM — Davis et al., 1989) and Theory of Reasoned Action (TRA — Fishbein, 1980) imply that beliefs about the system's quality is expected to influence its use. Accordingly, the following hypothesis is proposed:

H1. EIS perceived information quality positively influences EIS information use.

Determinants of Perceived Information Quality

Ease of Use

Perceived ease of use is defined as the degree to which a person believes that using a certain system is effort free (Davis, 1989, p. 320). A significant amount of research investigated the influence of perceived ease of use on actual use or the intention to use (e.g., Davis et al., 1989; Davis, 1989; Straub et al., 1995; Compeau & Higgins, 1995; Adams, Nelson, & Todd, 1992; Sjazna, 1996; Igbaria et al., 1997; Gefen & Straub, 1997) with mixed results. Perceived ease of use was also found to explain a considerable variance in perceived usefulness (Mathieson, 1991; Sjazna, 1996; Adams et al., 1992; Igbaria et al., 1997).

However, little attention was given to the influence of ease of use on perceived information quality in the past empirical research. For example, Doll and Torkzadeh (1988) reported significant relationships between ease of use and information quality dimensions, namely, content, timeliness, and accuracy. Also Srinivansan (1985) reported a positive relationship between system quality in terms of perceived reliability and information quality. Thus, one can argue that a system that is perceived as "easy to use" has a better chance to be perceived as providing high-quality information. Therefore, the expected relationship of perceived ease of use to perceived information quality will be tested using the following hypothesis:

H2-1. EIS ease of use positively influences EIS information quality.

User Involvement

Following Barki and Hartwick (1989), involvement is defined as the degree to which the user believes that the system possesses two characteristics: relevance and importance. In contrast with participation, involvement refers to a psychological state of the individual rather than a set of activities during systems development. Kappelman and McLean (1991) suggested involvement to mediate the influence of user participation on systems success. In the context of EIS, user participation is reported to increase the chances of user acceptance and successful implementation because it helps tailor the system to meet users' perceptions (Franz & Robey, 1986; Watson et al., 1997).

A study on 52 EIS users found that participation in EIS development is positively related to EIS information quality (Srivihok, 1999). Barki and Hartwick (1994) reported a positive influence of involvement on user attitudes. No prior studies, however, have directly tested the influ-

ence of user involvement on perceived information quality. Higher levels of user involvement are likely to lead to better perceptions of information quality; similarly, a system that is seen to be unimportant and irrelevant to the person stands little chance of being perceived as high-quality output. This expectation will be tested via the following hypothesis.

H2-2. User involvement positively influences EIS information quality.

IS Maturity

IS maturity is defined as the overall status of the IS function within the organization (King & Sabherwal, 1992). The level of IS maturity reflects the progress of the information systems function in the organization from the era of data processing to the strategic IS era (Wastell & Sewards, 1995). Raymond (1990) reported a positive relation between the organization's managerial and technical sophistication in implementing, operating its information systems, and systems usage and satisfaction. Results from a survey of senior IT managers found that managerial IT knowledge is a dominant factor in explaining the extent of IT use (Boynton, Zmud, & Jacobs, 1994). Selim (1997) found IS maturity to be the main determinant of user satisfaction with information systems. IS maturity was also found to correlate with the success of strategic IS applications (King & Sabherwal, 1992).

Millet and Mawhinney (1992) argue that if the MIS structure is not well developed, management should consider postponing the investment in EIS until the MIS can adequately support such a system. This implies that the chances of EIS application to succeed are expected to increase with the maturation of the overall organizational IS function. Prior studies (Igbaria et al., 1997; Taylor & Todd, 1995a, 1995b) recommended that future studies should clarify the relationship between systems success/failure and the development stage of IS in the organization. Thus, the researchers believe that the possible influence of IS maturity on EIS information quality warrants investigation, particularly when past investigations are lacking. As the IS function matures, the organization's managerial and technical sophistication in planning, implementing, operating, and using its information systems improves. Subsequently, experienced IS staff are expected to build and manage better quality systems, especially strategic systems such as EIS. Therefore, IS maturity is expected to have a positive impact on the perceived quality of EIS. Such an expectation is formulated in the following hypothesis:

H2-3. IS maturity positively influences EIS information quality.

EIS Sophistication

The availability of EIS capabilities/functions was found to positively influence EIS use (Rainer & Watson, 1995; Bergeron et al., 1995; Raymond, 1985). It can be argued, as the managerial activities and roles vary, it is expected that an EIS that addresses a greater number of the executive problems (through the availability of more functions) will be perceived as of higher quality output, compared to the output of a less sophisticated system. Based on the Triandis (1980) model of behavior and attitude and TAM (Davis et al., 1989), EIS sophistication is expected to directly influence perceived information quality as well as EIS-based information use. The possible

influence of system sophistication on information quality is formulated in the following hypothesis:

H2-4. EIS sophistication positively influences information quality.

METHODOLOGY

Sample

The unit of analysis in this investigation is the executive (respondent) who uses an EIS in an organization. A cross-section mail survey was used to collect data in order to test the research hypotheses. The study population consisted of potential users who had EIS available to them in support of their work. The lack of information on the EIS user population precluded random selection and made the use of a purposive sampling design acceptable. Judgment was used to select units (respondents) that are representative or typical of the target population (Singleton, Straits, & Straits, 1993). Customer lists of major EIS vendors are considered one of the most direct sources of information regarding EIS users (Elam & Leidner, 1995).

Data was collected from UK-based EIS users working in organizations that were included in the customer list of a major EIS vendor. Nine hundred sixty surveys were sent out to all managers on the vendor's customer list. The authors and the EIS vendor made the necessary arrangements to conduct the survey while maintaining the confidentiality of the data and the anonymity of the respondents. Out of the 960 distributed surveys, only 216 completed (usable) surveys (22.5% response rate) were returned after an initial mailing, reminder letters, and a second mailing.

An analysis of the questionnaires received at different points of the data collection might be used to estimate the nonresponse bias (Babbie, 1990, p. 180). Analysis of variance was used to compare the mean value of five demographic characteristics between the first 35 respondents from the first mailing and the last 35 respondents from the second mailing. The results (Table 1) indicate that there are no statistically significant differences between the respondents from the first wave and those from the second. This test suggests that respondents to the survey are representative of the population and that their responses could be aggregated across the two response waves.

The respondents represented a broad cross-section of different industries and different sized firms (Table 2). The sample consisted of 13.9% one managerial level below the CEO, 47.7% two levels below the CEO, 13.4% three levels below the CEO, and 22.8% four levels or more below the CEO. They also came from different functional areas, with 53.7% of the respondents coming from finance and accounting. Managers from IT/IS functional area constituted 19% of the respondents, 15.3% reported from general management positions, 10.2% from marketing, sales, and advertising, and only 1.4% reported from production.

Variables Definitions and Measures

The scales used to measure the constructs included in the research model are presented in Table 3 and are discussed subsequently.

EIS Information Use

This study measures EIS information use (Info-use) by asking the respondents to determine the extent of their dependence on EIS-based information compared to

Table 1. Response bias analysis demographic data

Industry Sector	Frequency	%	Number of employee	Frequency	%
Finance/Banking/ Insurance	44	20.4	≤ 500	21	9.7
Pharmaceuticals, Chemicals	22	10.2	501-1000	19	8.8
Health Service	21	9.7	1001-5000	91	42.1
Retail, Trade	35	16.2	5001-10000	31	14.4
Government	4	1.9	10001-25000	23	10.6
Public Utilities	9	4.2	More than 25000	19	8.8
Manufacturing, Engineering	48	22.2	Missing	12	5.6
Publishing, Media, Information	5	2.3	Total	216	100
Airline, Transportation, leisure	8	3.7			
Logistics, Distribution	15	6.9			
Others	5	2.3			
Total	216	100			

Table 2. Sample characteristics

Sample Characteristics	Mean (first 35 /first mail)	Mean (last 35 /second mail)	ANOVA	
			F	P
Age of respondents	41.4000	39.0588	1.484	0.227
Years of education	15.9143	16.3793	0.035	0.853
Managerial experience (years)	11.5429	9.9714	0.326	0.570
Company size (no. of employees)	9362.5806	6206.0938	1.586	0.213
Number of EIS functions	4.7143	4.8286	1.332	0.252

other information sources (El-Kordy, 1994). The respondents were asked to report on the percentage of their information needs satisfied through four sources: personal contacts, paper-based sources, direct use of EIS, and EIS output provided by others. The extent of EIS information use is the sum of the percentages of the information needs satisfied through the direct and the indirect use of EIS.

Information Quality

This study measured perceived information quality (IQ) using a subset of the end-user computing satisfaction (EUCS) instrument developed and tested by Doll and Torkzadeh (1988). The end-user computing satisfaction instrument consists of five sub-scales: content, accuracy, format, ease of use, and timeliness. A confirmatory factor analysis of the instrument revealed that it can be used as a standardized measure of user satisfaction with a specific application, and that researchers can use these sub-scales with confidence as they have adequate validity and reliability (Doll, Xia, & Torkzadeh, 1994). The researchers followed the recommendations of Seddon and Kiew (1994) to eliminate the perceived ease-of-use-related items from the instrument in order to measure only satisfaction with information quality. Respondents were asked to answer nine questions concerning the information quality of their EIS on a five-point scale ranging from hardly ever, 25% of the time, 50% of the time, 75% of the time, to always.

Ease of Use

Perceived ease of use (PEOU) is defined as the degree to which a person believes that using a certain system is effort free (Davis, 1989). The study used the perceived ease of use instrument developed

and tested by Davis (1989) and verified by other researchers (e.g., Adams et al., 1992; Chin & Todd, 1995). Respondents were asked to indicate on a five-point scale their agreement or disagreement with four statements pertinent to EIS perceived ease of use.

User Involvement

User involvemet (INV) is defined as the degree to which the user believes that the system possesses two characteristics: relevance and importance (Barki & Hartwick, 1989). This construct is measured using the instrument developed and tested by Barki and Hartwick (1994). The respondent is asked to describe the importance and relevance of EIS to his/her job on a seven-point scale using six pairs of adjectives.

IS Maturity

IS organizational maturity (MAT) refers to the overall status of the IS function within the organization. Prior studies used various criteria to measure information systems maturity. This study measures IS maturity using the nine-item instrument developed by King and Sabherwal (1992). This measure was based on previous scales of organizational maturity (Benbasat, Dexter, & Mantha, 1980) and was able to display high levels of reliability and validity. Respondents were asked to describe nine aspects of the overall information systems environment of their organization on a six-point scale ranging from no extent to a very great extent.

EIS Sophistication

In accordance with Bergeron et al. (1995), this study measured EIS sophistication by ascertaining the presence of various technical features associated with EIS applications. The study adapted this measure by asking the respondent to choose the EIS capabilities available in their EIS out of a list of eight capabilities. Those were standard reporting, exception reporting, ad-hoc/unscheduled query, drill down capability, simple analyses (e.g., spreadsheets), what-if-analyses/modeling, external databases, and soft data (e.g., news and forecasts).

ANALYSIS AND RESULTS

Descriptive Statistics

Table 4 describes the managers' use of various information sources available to them. The results show that EIS is used to satisfy only 44% of the executives' information needs: 29% through direct use and 15% through indirect use. The results also show that executives in the sample still satisfy 56% of their information needs through other conventional information sources such as paper-based sources (29%) and personal contacts (25%).

These results are consistent with previous research on managers' use of computer-based information. Many executives today still depend on paper summaries or information provided by administrative staff, while those who use personal computers often receive data heavily manipulated by others in the organization (Bartholomew, 1997). The dependence on personal contacts may be explained by the nature of this source as a rich communication channel able to convey both hard and soft information (Watson et al., 1997).

The means and standard deviations for the constructs are reported in Table 5. EIS information quality is calculated as the

Table 3. Constructs measures

Information quality (IQ):
IQ1. Do you think the output is presented in a useful format?
IQ2. Is the information clear?
IQ3. Is the information accurate?
IQ4. Does EIS provide the critical information you need?
IQ5. Does EIS provide sufficient information?
IQ6. Does EIS provide up-to-date information?
IQ7. Do you get the information you need in time?
IQ8. Does EIS provide reports that are about exactly what you want?
IQ9. Does the system provide the precise information you need?
Ease of Use (EOU):
EOU1. I find EIS easy to interact with
EOU2. I find it easy to get EIS to do what I want it to do
EOU3. My use of EIS requires a lot of mental effort
EOU4. I find it is easy to become skilful at using EIS
User involvement (INV):
INV1. Important/unimportant
INV2. Essential/nonessential
INV3. Trivial/fundamental
INV4. Of no concern to me/of concern to me
INV5. Relevant to me/irrelevant to me
INV6. Matters to me/doesn't matter to me
IS maturity (MAT):
MAT1. Extent to which IS staff are informed about business plans and operations
MAT2. Extent to which top management is informed about information technology
MAT3. Extent to which information technology impacts the organization's performance
MAT4. Extent to which IS supports many functions in the organization
MAT5. Extent to which information technology is available throughout the organization's premises
MAT6. Extent to which IS performance is evaluated in terms of contribution to the organization's overall objectives rather than cost savings
MAT7. Extent to which IS planning is formalised
MAT8. Extent to which IS planning takes the business plans into consideration
MAT9. Extent to which top management is involved in IS planning
EIS Sophistication (SOFIS):
Number of functions available in your EIS.
EIS Information Use (INFOUSE):
The percentage of information needs satisfied via the use of EIS (directly and through others)

The research instrument was pilot tested on 22 respondents, who were participants in the executive MBA evening program at City University Business School. Most of the students were full-time executives and part-time students. The participants were considered representative of the real-world managers. Using the feedback from the pilot test, a number of the questions were reworded for clarity, and the final questionnaire was shortened.

average score (3.57) of nine quality attributes on a five-point scale. This result indicates that, on average, EIS are perceived to provide a satisfactory level of information quality. The relatively low standard deviation (0.71) is an indicator of a relatively low dispersion of the responses around their mean. In addition, the means of the individual items (dimensions) of information quality reveal that the executives' satisfaction with the accuracy, clearness, and timeliness dimensions of EIS information was higher than their satisfaction with the precision, relevancy, and format dimensions. Although this result reflects a higher-than-average perception of EIS informa-

Table 4. Levels of use of EIS information and other information sources

Information sources available to the EIS user	Mean	Std. Deviation	Minimum	Maximum
EIS information use (direct)	29.08%	0.2283	0%	100%
EIS information use (indirect)	15.15%	0.1653	0%	80%
Paper-based sources	29.97%	0.1888	0%	85%
Personal contacts	25.27%	0.1906	0%	90%

tion quality, more efforts are needed to improve EIS information quality and meet executives' information needs.

Also, the results in Table 5 show that EIS is perceived to be moderately easy to use (mean = 3.66 on a five-point scale). This result is consistent with the finding of an earlier study of UK organizations (Fitzgerald & Murphy, 1994), indicating a moderate level of ease of use. However, this finding somewhat differs from the high level of ease of use (mean = 4.5 on a five-point scale) reported by the Finnish and English EIS users in Partanen and Savolainen (1995).

User involvement was calculated as the average score of the respondents' evaluation of the importance and relevance of EIS to their job using six adjectives on a seven-point scale. The mean of user involvement score is 5.79 (on a seven-point scale), which indicates that users perceived EIS as being highly relevant and important to their job. The standard deviation of 1.02 reflects a relatively low dispersion of the values around their mean.

IS maturity is the average score of nine items corresponding to different aspects of the IS function on a six-point scale, ranging from no extent to a very great extent. The total maturity score has a mean of 3.38 and a standard deviation of 0.57, which reflects a moderate overall IS maturity status. The questionnaire items related to the extent of information technology (IT) penetration in the various functions in the organization received higher ratings than the items related to IT management and systems evaluation based on their impact on the organizational goals. Although this finding reflects only a relatively moderate level of IS maturity, it is higher than the generally low IS maturity level in the small to medium-sized UK manufacturing organizations reported in Wastell and Sewards' (1995) study.

As to EIS sophistication, the results in Table 6 show that, on average, EIS provide from four to five capabilities to their users (mean = 4.56). Table 6 displays the distribution of the EIS capabilities in the sample. More than 99% of the executives had access to ad-hoc query capabilities, and more than 82% had access to simple information analyses (i.e., spreadsheets) capabilities. However, only 19% of the execu-

Table 5. Descriptive statistics

Construct	Mean	S.D.
1- EIS information use (INFOUSE)	0.4423	0.2599
2- Information quality (IQ)	3.5653	0.7078
3-Easy of use (EOUA)	3.6551	0.7019
4- User involvement (INV)	5.7901	1.0211
IS maturity (MAT)	3.3762	0.5734
5- EIS sophistication (SOFIS)	4.5324	1.5578

Table 6. Frequency of reported availability of EIS functions

EIS Functions	Frequency (N=216)	Valid Percent
Standard Reporting	214	99.1%
Ad-hoc / Unscheduled Query	165	76.4%
External Databases	54	25.0%
Simple Analyses/ Spreadsheets	178	82.4%
Exception Reporting	116	53.7%
Drill-down Capability	150	69.4%
What-if Analyses / Modelling	60	27.8%
Soft data e.g. news, forecasts	41	19.0%

tives reported to have access to soft data (i.e., news, forecasts), and only 27% were found to have access to what-if analysis and modeling capabilities. Such findings echo the results of an earlier similar survey in the UK (Perera, 1995).

Hypotheses and Model Testing

The exogenous variables in this study include ease of use, user involvement, IS maturity, and EIS sophistication. The two endogenous variables are information quality and information use. A structural equations modeling (SEM) technique was applied to test the research model, which incorporates linkages between all exogenous variables in order to detect any partial or full mediation by information quality (e.g., Kowtha & Choon, 2001). The AMOS 3.61 package was used since it has the ability to test relationships between constructs with multiple indicators. It provides maximum likelihood estimates of paths, assessment of measurement model, and modification indices that can help in model identification.

The Measurement Model

To assess the measurement model, Table 7 illustrates the standardized loading of the indicators on their corresponding constructs, their critical ratios (the parameter estimate divided by its standard error), the coefficient of determination as an indicator of composite reliability, and the variance extracted estimate.

From Table 7, the standardized factor loadings, which are indicators of the degree of association between a scale item and a construct, are highly significant (with critical ratio ranging from 6.41 to 17.42), where critical values greater than 0.2 indicate loading significance at $p < 0.05$. With the exception of IS maturity, all items loaded clearly on their corresponding constructs, demonstrating both convergent and discriminate validity.

The results of the analysis suggest that the IS maturity construct includes two dimensions. The first dimension is *IS Integration* (MAT1, MAT2, MAT6, MAT7, MAT8, and MAT9), which reflects the extent of IS alignment and integration with the organization. The second dimension is *IT Penetration* (MAT3, MAT4, and MAT5), which reflects the extent of IT dissemination within the organization. A comparison between the means of the two dimensions of IS maturity shows a significantly higher IT penetration mean (4.02) than the IS integration mean of 3.07 ($p < 0.001$). This result suggests that the technological focus of the IS functions in the surveyed companies is stronger than their

Table 7. Standardized loadings, critical ratio composite reliability, and variance extracted

Constructs	Scale Items	Standardized loading	Critical Ratio	Composite reliability	Variance extracted
IS Maturity:					
IS Integration	MAT1	0.59*			
	MAT2	0.56	6.48		
	MAT6	0.58	6.62		
	MAT7	0.68	7.39	0.80	0.42
	MAT8	0.77	7.96		
	MAT9	0.68	7.41		
IT Penetration	MAT3	0.65	6.41		
	MAT4	0.78	6.53	0.71	0.45
	MAT5	0.58*			
Ease of Use	EOU1	0.81*			
	EOU2	0.77	11.95		
	EOU3	0.82	12.67	0.87	0.63
	EOU4	0.78	12.07		
Involvement	INV1	0.82*			
	INV2	0.84	15.1		
	INV3	0.87	15.85		
	INV4	0.90	16.86	0.95	0.77
	INV5	0.91	17.05		
	INV6	0.92	17.42		
Information Quality	IQ1	0.69*			
	IQ2	0.65	8.91		
	IQ3	0.56	7.76		
	IQ4	0.80	10.84		
	IQ5	0.76	10.29	0.91	0.53
	IQ6	0.65	8.97		
	IQ7	0.72	9.78		
	IQ8	0.83	11.20		
	IQ9	0.85	11.50		

** Indicates parameters fixed at 1.0 in the original solution, thus no critical ration is provided*

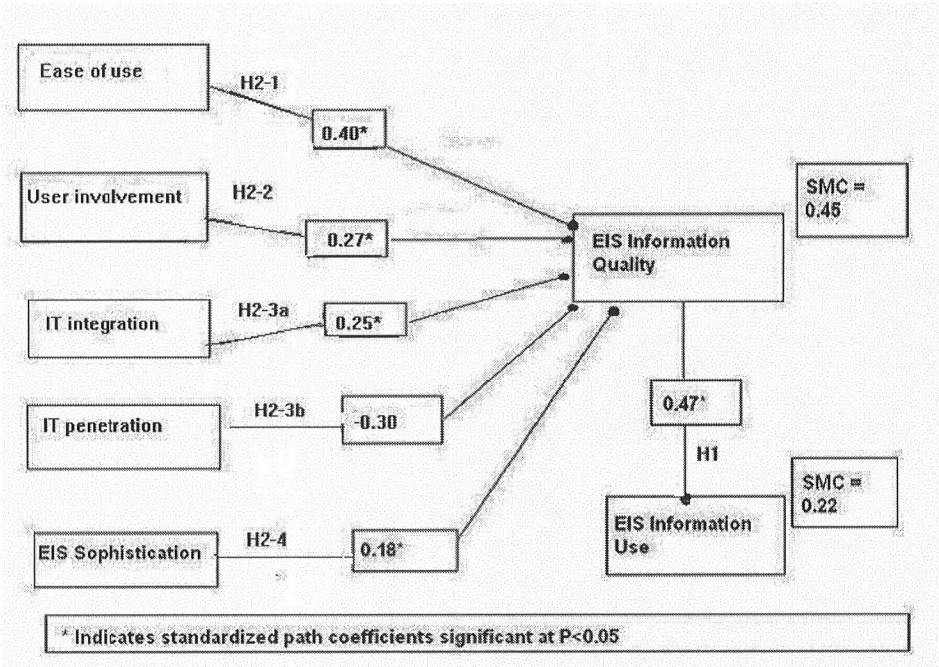
business alignment and integration focus. The two dimensions of IS maturity (IS integration and IT penetration) are included in the structural equation modeling analysis.

Regarding reliability, composite reliabilities are similar to Cronbach's alphas internal reliability estimates (Nunnally, 1978). The composite reliabilities in Table 7 range from 0.71 to 0.91, and a composite reliability of 0.70 or greater is considered acceptable for research (Fornell & Larcker, 1981). In addition, the variance extracted estimates, which describe the variation explained by the indicators relative to measurement error, range from 0.77 to 0.42. These estimates exceed the cutoff value of 0.50 (Hair, Anderson, Tatham, & Black, 1998), except for the two IS maturity dimensions (IS integration and IT penetration). While the results indicate adequate composite reliabilities for all variables, the variance extracted estimates adequately justify using all constructs with the exception of IS maturity (IS integration and IT penetration). Therefore, IS maturity-related results should be interpreted with caution.

The Structural Model

Path coefficients analysis was used to test the research hypotheses. Figure 2 shows the standardized path coefficients, which allow the comparison between variables measured differently. The signifi-

Figure 2. The revised model and path coefficients



cance of a path coefficient is given by its critical ratio (CR), where a CR greater than 2 means that the coefficient is significant at $p < 0.05$. Figure 2 also shows the squared multiple correlation (SMC) values, which represent the total variance explained in the endogenous variables by their respective determinants.

The path coefficient for the effect of information quality on information use is 0.47 ($p < 0.001$) and CR = 6.56. This result indicates a positive influence of perceived EIS information quality on EIS-based information use. However, information quality explains only 22% of the variance in information use. As for information quality, the results show that ease of use is the strongest determinant of information quality, with a path coefficient of 0.40 ($p > 0.001$) and CR = 5.55. The path coefficient of 0.27 from involvement to information quality ($p < 0.001$) and CR = 4.13 comes next.

Also, only one dimension of IS maturity has illustrated a significant positive impact on information quality. IS integration with the organization was found to influence perceived information quality (path coefficient = 0.25, CR = 2.9, $P<0.01$). This result suggests that the integration and the alignment of the IS function within the organization may be more influential on the perceived information quality of EIS than the mere IT penetration of the organization is. Finally, EIS sophistication shows a positive significant impact on perceived EIS information quality (path coefficient = 0.18, CR = 3.0, $P<0.01$).

Table 8. The results of path analysis

Hypothesis	Path		Standardized Path coefficient	Critical Ratio (CR)[1]	Variance Explained SMC
	From	To			
H1	Information Quality	Information use	0.47	6.56	0.22
H2-1	Ease of use	Information Quality	0.40	5.55	
H2-2	User Involvement	Information Quality	0.27	4.13	
H2-3a	IS Integration	Information Quality	0.25	2.93	0.45
H2-3b	IT Penetration	Information Quality	-0.03	-0.35	
H2-4	EIS Sophistication	Information Quality	0.18	3.00	

[1] *CR > 2 indicates path coefficients significant at p<0.05*

Table 8 summarizes the results of path analysis. With the exception of *H2-3b*, the test results support the acceptance of all hypotheses.

The Fit of the Structural Model

To test the goodness of fit of the structural model, several indices were computed and are summarized in Table 9. A statistically significant Chi-square (Chi-square = 756, df = 391; $p < 0.001$) was found, which suggests that the hypothesized model is sufficiently close to the observed data. However, the Chi-square statistic is marginally useful when used alone, due to its sensitivity to sample size and departure from multivariate normality. Alternatively, the ratio of the Chi-square to the degrees of freedom CMIN/DF (e.g., Sharma, 1996) was used. CMIN/DF was found to be approximately 1.9 (below the thresholds of 2-5), which suggests an acceptable model fit.

Furthermore, although both values are lower than desired, the goodness of fit index (GFI = 0.80) and the adjusted goodness of fit index (AGFI = 0.77) indicate a reasonable model fit. The root mean square error of approximation (RMSEA = 0.07) is at an acceptable level. Finally, the comparative fit index (CFI = 0.90), which is identical to McDonald and March's relative noncentrality index (RNI), and the Tucker-Lewis coefficient (TLI = 0.89), also known as Bentler-Bonett non-normed fit index (NNFI) (Arbuckle, 1997), suggests a good model fit. Overall, the indices in Table 9 indicate that the hypothesized model exhibits a satisfactory fit with the observed data.

DISCUSSION

The research model of this study was designed to investigate the possible impact of user involvement, ease of use, IS maturity, and system sophistication on users' perception of information quality on one hand, and the possible impact of information quality on EIS information use on the other hand. With the exception of the relationship of the IT penetration dimension of IS maturity on EIS information quality, the data analyses support all the hypothesized relationships between the independent and dependent variables in the research model. EIS information quality was found to positively influence EIS information use; and EIS information quality, in turn, was found

Table 9. The fit indices for the tested research model

Fit Indices	Guidelines	Model Testing Results
Chi-square significance	P < 0.05	P < 0.001
Chi-square/Degrees of Freedom (CMIN/DF)	< 2 – 5	1.9
Goodness of Fit (GFI)	> 0.90	0.80
Adjusted Goodness of Fit (AGFI)	> 0.80	0.77
Root mean square error of approximation (RMSEA)	< 0.1	0.07
Comparative Fit Index (CFI/RNI)	> 0.90	0.90
Tucker-Lewis coefficient (TLI/NNFI)	> 0.90	0.89

to be positively influenced by ease of use, user involvement, the IS integration dimension of IS maturity, and EIS sophistication.

The finding of a positive impact of EIS information quality on information usage is consistent with the findings of a number of past similar studies. For instance, Bergeron et al. (1995) found the satisfaction with information content to have a positive influence on the frequency of use and on the level of EIS internalization in the user's work. Also, Leidner (1996) reported EIS information quality to be the main determinant of frequent use of EIS. The positive impact of information quality on EIS usage was expected, since the quality of EIS information output was reported to be a key to EIS information use (Rainer & Watson, 1995). Furthermore, information quality was found to be the most important attribute of EIS from the top managers' point of view (Bergeron et al., 1991).

When information is perceived as relevant to their needs, and reliable in terms of accuracy and content, managers are more likely to use it (Low & Mohr, 2001). However, EISs were found to satisfy only 44% of the executives' information needs, of which only 29% are satisfied through direct use of EIS. Improvement in EIS information quality is likely to increase the proportion of information needs that can be satisfied via direct use of an EIS. Additionally, the analysis of the data on EIS information quality suggests that the executives were satisfied with EIS information accuracy, clearness, and timeliness, but less satisfied with its relevancy, precision, and format. Therefore, managers and EIS developers need to cooperate effectively in order to improve the overall quality of EIS information, consequently, enhancing its use.

Ease of use was found to be the strongest determinant of EIS information quality, followed by user involvement, IS maturity, and system sophistication. The finding of a strong, positive impact of ease of use on EIS information quality is logical and lends further support to the literature suggesting accessibility as an important information quality attribute (Strong et al., 1997; Wang & Strong, 1996; Huang et al., 1999). It is also consistent with those of the prior studies that investigated accessibility and information use (O'Reilly, 1982), and ease of use and perceived usefulness (Mathieson, 1991; Sjazna, 1996; Adams et al., 1992; Igbaria et al., 1997). Inaccessible EIS information has no value to users, and its quality will be negatively perceived.

Consequently, in order to boost users' positive beliefs in EIS information quality, an EIS must be easy to interact with, flexible, and easy to learn. Continuous user training and orientation programs, along with investments in flexible and easy-to-learn EISs, should improve information quality, and consequently, their use.

The positive impact of user involvement on EIS information quality comes in accordance with our expectation. Effective managers' participation in EIS planning and implementation is expected to develop positive beliefs concerning the relevancy and importance of the systems (Barki & Hartwick (1989) to their decision-making and activities. In this context, the findings of this study is consistent with those of Srivihok (1999), where a positive correlation was detected between participation in EIS development and EIS information quality. This particular finding implies that user participation results in an accurate assessment of the users' information needs, avoids the development of unnecessary features, and therefore creates a higher user perception of the system's information quality. Therefore, top management should consider providing an environment that is conducive to users' participation and involvement in EIS planning and implementation.

The factor analysis yielded two dimensions of the IS maturity construct: IS integration and IT penetration. IS integration was found to influence information quality. This finding emphasizes the importance of the organizational context in which EISs are introduced on the information quality of such applications. The insignificant influence of IT penetration on information quality implies that higher levels of IT dispersion in the organization may not be conducive to providing higher quality information output. When properly aligned and managed in an organization, the IS function should be capable of planning, designing, and implementing EIS applications that are likely to be perceived to offer useful and quality information to their users.

The impact of IS maturity on EIS information quality was not previously investigated. Research on information systems has treated satisfaction with information quality as an important component of user satisfaction with information systems. Likewise, the finding of a positive impact of the IS integration dimension of IS maturity on EIS information quality seems to be consistent with the findings of those studies that investigated the relationship of IS maturity to user satisfaction (e.g., Cheney & Dickson, 1982; Mahmood & Becker, 1985; Raymond, 1990). However, the IS maturity-related findings of this study should be cautiously interpreted since the results of the measurement model analysis (Table 7) suggest that the measurement of the IS maturity construct may be problematic.

Higher levels of EIS sophistication were found to contribute to stronger positive beliefs concerning information quality. Standard reporting, simple analysis, ad hoc queries, drill-down analyses, and exception reporting are the most common EIS capabilities reported by managers. The data also suggests that access to external and soft information data is still a scarce occurrence in the UK-based EIS applications. In other words, UK-based EIS applications provide internal reporting and control capabilities rather than environmental scanning capabilities. This finding lends support to Perera's (1995) findings in an earlier UK-based EIS study.

The limited access to external and soft information seems prevalent in the surveyed UK-based EIS applications. Such applications are likely used to support the internal reporting and control managerial

functions, rather than to support the more important planning and environmental scanning functions of executives. Designers and implementers of EIS applications need to ensure the availability of the reportedly lacking soft data and modeling capabilities to managers. However, EIS designers and implementers should also be aware of the possible negative impact of adding or enhancing the technical capabilities of the systems (i.e., provision of drill down) on ease of use as a strong determinant of perceived information quality.

RESEARCH LIMITATIONS

The implications from this study should be considered in light of its main limitations. First, information quality was investigated in this study as a strong determinant of EIS information use and, consequently, EIS effectiveness. The implicit assumption here is that using more information is associated with improved decisions. Such an assumption, however, is strongly supported by past research demonstrating positive effects of information use on improved organizational outcomes (e.g., Low & Mohr, 2001).

Second, the key informant methodology was used to collect the research data and to measure the research variables. Although this method is the most frequently used technique in IS research, it raises concerns about the respondent's ability to accurately answer questions (Low & Mohr, 2001). To address such a measurement limitation, future information systems effectiveness research could add to our understanding of the factors that affect managers' use of EIS information by relying on qualitative research or experimental methods in order to complement the results reported in this investigation.

Third, the variance extracted estimates for the two IS maturity dimensions—IS integration and IT penetration—are 0.42 and 0.45, respectively. These two estimates—the variation explained by the indicators relative to measurement error—are below the recommended cutoff value of 0.50 (Hair et al., 1998), which justifies using the construct-related data in the analysis. Therefore, our IS maturity-related results should be interpreted with caution. Future research may verify this measurement problem of IS maturity before searching for an alternative measure to operationalize the construct.

Finally, the objective of this study was to investigate the impact of information quality on EIS information. Therefore, the analysis focused on measuring only the direct path (influence) from EIS information quality to EIS information use, and no direct paths from the exogenous variables to EIS information use were measured. While the structural model exhibits a satisfactory fit with the observed data, only 22% of the variance in EIS information use is explained by EIS information quality. Having only information quality as a determinant of EIS information use weakens the explanatory power of our model. In an attempt to explain more variance in EIS information use, future research may be designed to measure the indirect as well as the direct paths from the exogenous variables of ease of use, user involvement, IS maturity, and EIS sophistication to EIS information use. Also, similar future research models may include other variables (e.g., perceived usefulness, facilitating conditions, user attitudes, user training) that are believed to affect EIS information use in order to explain more variance in both perceived information quality and EIS information use.

CONCLUSION

Faced with an abundance of data, executives are expected to assess EIS information quality in order to determine whether they should use them. This raises the question of what can be done to improve information quality. The results of this investigation concerning EIS information quality influence on information use by UK managers, and EIS information quality determinants (ease of use, user involvement, IS maturity, and system sophistication) contribute to IS literature on information systems success. The findings of this investigation suggest that information quality is an important determinant of information use, which ultimately leads to effective managerial decisions and improved organizational performance. EIS information quality, in turn, can be enhanced by fully or partially manipulating factors such as ease of use, user involvement, IS maturity (integration), and EIS sophistication.

UK executives were found to satisfy 55% of their information needs from sources other than EIS (i.e., personal contacts, paper-based sources). This finding may be explained by the fact that managers' perception of EIS information quality was found to be just above average. As such, it is important to develop and implement EISs capable of providing managers with information that better suits their information needs. Improvement efforts may focus on the installation of flexible and easy-to-learn EISs, enhancement of EIS capabilities to include soft and external data analysis and modeling, provision of an environment that is conducive to users' involvement in EIS planning and implementation, and strong commitment to achieving IS alignment and integration with business strategies and plans.

Given the limitations of this investigation, future research may be designed in order to replicate and extend this investigation using other exogenous variables, different sampling frames, and other EIS and information systems applications in order to verify our findings and enhance their external capacity to be generalized. The development of future research models and the selection of new variables should be guided by the models and framework available in the literature on information systems effectiveness.

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