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# THE ICEBERG ON THE SEA: WHAT DO YOU SEE?

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## Abstract

*Although organizations began to adopt enterprise systems (ES) in the 1980s (Hayman, 2000), academic interests have just started. This literature review of ES articles appearing in academic information systems (IS) journals indicates that while previous ES studies have provided some interesting findings, only limited aspects of enterprise systems have been explored. We have essentially focused on the iceberg above the sea, ignoring what is going on under the water. This paper contributes to the ES research by identifying strengths and weaknesses of ES research to date, and suggesting future research opportunities.*

## Introduction

Enterprise systems are “commercial software packages that enable the integration of transaction-oriented data and business process throughout an organization” (Markus and Tanis, 2000, pg. 176). A type of enterprise systems is enterprise resource planning (ERP) systems. “Enterprise systems represent an important contemporary phenomena in the organizational use of information technology” (Markus and Tanis, 2000, pg. 204). Companies that have completed ES implementation have reduced their cycle time, obtained faster information transactions, improved financial management, enhanced employee knowledge and skills, and laid the groundwork for electronic commerce (Davenport, 2000b). The key reason behind these ES benefits lies in the nature of enterprise systems, which aim to achieve the seamless integration of all the information flowing through a company (Davenport, 1998). Enterprise systems “represent a nearly complete re-architecting of an organization's portfolio of transactions-processing applications systems to achieve the integration of business processes, systems, and information - along with corresponding changes in the supporting computing platform (hardware, software, databases, telecommunications)” (Markus and Tanis, 2000, pg. 175). This integration feature differentiates ES from other software packages.

Due to the uniqueness of the enterprise system, it poses challenges to managers who try to adopt and implement the system with the aim to realize its promised benefits (Davenport, 1998; Markus and Tanis, 2000). Despite numerous challenges faced by practitioners, academic researchers exhibited little interest in the enterprise system phenomena until Gable decried the paucity of research examining large packaged software in the current IS research in 1998. A number of studies on ES have been conducted since that time.

There have been three literature reviews conducted in ES area so far; one focused on critical factors (Nah, Lau and Kuang, 2001), one identified scholarly activities related ES study (Klaus, Roseman and Gable, 2000), and another one browsed through ES articles published in journals and IS conferences during 1997-2000 (Esteves and Pastor, 2001). This paper offers a summary review of the ES literature and analyzes the reviewed articles in terms of research design, time period, and Epistemology (Orlikowski and Baroudi, 1991). The gap revealed by this review helps provide directions and suggestions for future research.

## Literature Review and Evaluation of ES Studies

The search of ES literature includes (1) finding articles in Proquest by typing in keywords such as “enterprise resource planning systems”, “ERP”, and “packaged software” in Proquest, a comprehensive database comprised of journals and newspaper and (2) locating ES related articles in journals that are not included in Proquest. Articles were chosen that meet three principles: (1) published after 1998, (2) published in peer-reviewed IS journals, and (3) ES issues-related. The search resulted in forty-four

articles, which were grouped under the stage that they mainly studied along the ES selection and implementation process. The stages investigated by these forty-four articles are as follows: (1) selection or initiation (i.e., organizational scanning of packaged software solutions [Rogers and Shoemaker, 1971]), (2) implementation (i.e., organizational efforts in diffusing ES into users' community [Kwon and Zmud, 1987]), (3) usage, (4) outcomes (i.e., ES impacts on organizations' performance [Kwon and Zmud, 1987]).

### ***ES Selection***

ES selection takes place prior to implementation. It is the process whereby organizations search, assess, and choose a software package based on an analysis of organizational needs, readiness, and technology characteristics (Iacovou, Benbasat and Dexter, 1995). Three selection studies were identified. Everdingen, Hilegersberg, and Waarts (2000) conducted surveys in ten European countries (Norway, Finland, Sweden, Denmark, Netherlands, Great Britain, Belgium, France, Spain, Italy), and found that the most important criterion for selecting an ERP system is its "fit" with existing business procedures, followed by flexibility, cost and user-friendliness of the system. Companies in different countries also emphasized different criteria (e.g., user-friendliness was more focused by Italian and Swedish companies, while flexibility was more valued by Spanish companies).

Interestingly, Bernroider and Koch (2001) conducted a similar survey in Australia with special focus on midsize and large organizations. What they found is that flexibility and adaptability are more highly valued by smaller than by larger organizations. In addition, they discovered that a large percentage of organizations included departments that would be affected by the implementation to make selection decision. Methods used in the decision process were different between smaller and larger organizations, in that the former used more static investment methods, while the latter employed more dynamic methods. Butler (1999) argued that implementation risks can be mitigated during the ES adoption, and provided detailed advice on how to define system requirements, negotiate software license, evaluate software vendors, define training requirements, and identify software modifications.

Studies on ES selection tend to be descriptive, prescriptive, and largely atheoretical. Future research on ES selection might apply IT innovation adoption-related theories (e.g., Theory of Reasoned Action) to the ES context. Also, it would be interesting to compare the findings from ES adoption with the findings from other IT innovation adoption studies. While current studies focus mainly on purchase and selection processes, it would also be useful to conduct longitudinal studies to examine effects of latent factors on the implementation process.

### ***ES Implementation***

Since enterprise systems are "built to support generic business processes that may differ quite substantially from the way any particular organization does business" (Markus and Tanis, 2000, pg. 177), ES implementation always involves dramatic organizational change, and thus becomes a major topic studied by researchers.

Three studies identified critical factors in ES implementation. Holland and Light (1999) categorized ES implementation factors into strategic (i.e., factors that are very important to success or failure of an implementation) and tactical (i.e., factors that facilitate the implementation process). They proposed that legacy systems, ERP strategy, business vision, top management support, and project schedule and plans belong to strategic factors, whereas tactical factors include client consultation, personnel, business process configuration (BPC), software configuration, client acceptance, monitoring and feedback, communication, and troubleshooting. In addition, using eight case studies, Holland and Light explained how the interaction between strategic and tactical factors determines the outcome of ES implementation. Bingi, Sharma, and Godla (1999) listed ten critical implementation concerns (e.g., how to obtain top management commitment, how to cooperate with vendors, how to motivate employees, and how to work with consultants). Based on a review of previous ES papers regarding critical factors affecting ES implementation, Nah, Lau, and Kuang (2001) identified eleven most critical factors (e.g., ERP teamwork and composition, top management support, and business plan and vision). The obstacles to achieving implementation success included lack of metrics, ignorance of change resistance, and inadequate analysis of management reporting requirements.

*Change management* is another major theme of ES implementation studies. Since the ES implementation tends to invoke users resistance due to perceived risk and habit (Sheth, 1981), Aladwani (2001) presented a three-phased change management process including knowledge formulation, strategy implementation, and status evaluation. Under each stage, Aladwani provided detailed descriptions about emerging issues and advice on what management should do to deal with those issues. Dong (2001)

conceptualized top management influence on motivating users adoption of an ERP system. While the above two articles focused on dealing with user issues, Koch (2001) was interested in investigating the use of BPR in ERP implementation by analyzing two cases. He implied that the integration of BPR with ERP implementation tends to bring positive implementation outcomes and suggested that broad participation from various departments is essential.

Some other studies address the *negative* aspects of ERP implementation. Besson and Rowe (2001) noted the difficulty in achieving ERP benefits due to the changing perceptions of ERP designers (senior managers, IS internal specialists, IS and strategy consultants, and software vendors), and interactions between ERP designers and users. Hanseth, Ciborra, and Braa (2001) illustrated that ERP could become an obstacle rather than a facilitator for organizational goals despite organizations' efforts. Clemons and Simon (2001) noted that human resource management might not conform to vendor-defined coordination and control. Soh, Kien, and Tay-Yap (2000) identified three categories of misfits, including data misfits (i.e., incompatibility between organizational requirements and ERP package in terms of data format), functional misfits (i.e., incompatibility between organizational requirements and ERP package in terms of the processing procedures required), and output misfits (i.e., incompatibility between the organizational requirements and ERP package in terms of the presentation format and the information content of the output). Stijin and Wijnhoven (2000) proposed that disparities between memory elements embedded in an ES package (e.g., knowledge and information) and related memory elements in an organization (e.g., individual and culture) contribute to the underperformance of some organizations that have implemented enterprise systems. Scott and Vessey (2000) argued that organizations should think of using failure experience to develop experiences and ways to deal with future problems.

There are other notable studies that focus on a special issue involved during the ES implementation. For example, Markus, Tanis, and Fenema (2000) analyzed multi-site ERP implementation at four levels— business strategy, software configuration, technical platform, and management execution. They argued that a successful multi-site ERP implementation need to address the interactions and trade-offs among the four different levels. Based on their case study, Willcocks and Sykes (2000) pointed out a surprising finding— that the roles of CIO and IT functions are seriously ignored; in order to contribute to the complex projects like ERP implementation, IT functions must possess nine capabilities (e.g., IT leadership and business systems thinking). Huang and Palvia (2001) identified two broad categories of factors that may affect ERP implementation (national/environmental and organizational/internal), and analyzed ERP implementation issues in developed and developing countries.

The above description reveals two characteristics of current ES implementation studies. Again, most ES implementation studies are descriptive, with the aim of understanding issues and causes of problems occurring in the implementation process. Future studies should focus on seeking theoretical foundations so that current theories can be tested or expanded. Second, current ES implementation studies exclude the implementation stage from other stages associated with the innovation adoption process. This perspective is not systematic; the innovation process is organic, and activities in each stage affect activities at other stages (Markus and Tanis, 2000). Therefore, future studies should adopt longitudinal methodology so that the causes and consequences of problems occurring in the implementation process can be deeply understood.

### ***ES Usage***

Usage, a behavior that occurs after implementation, is the process through which the outcomes of a system are realized. Holland and Light (2001) studied organizational ES usage. They defined three implementation stages. At stage one, organizations manage legacy systems and start the ES project. At stage two, ES implementation is complete and organizations exploit the functionality of the ES. At stage three, organizations have normalized ES and begin to obtain benefits from the system. Holland et al. used five constructs to describe each implementation stage: (1) strategic use of IT, (2) organizational sophistication, (3) penetration of the ES, (4) vision, and (5) drivers and lessons. From the case data of twenty-four organizations in the United States and Europe, this study shows that organizations follow an S-shaped curve and that most organizations are at the second stage. However, it is not clear how various constructs are weighted for each stage, or what rationales are used for this weighting.

ES usage can be studied at the individual level, and at the organizational level. The extent to which an organization benefits from an ES implementation depends on how skillfully, consistently users use the system and how committed users are in using the system (Klein and Sorra, 1996). Accordingly, it is apparent that ES usage at the individual level determines the stage of the organizational implementation and the realization of IT benefits. It would be interesting to distinguish different usage levels and link them to the ES usage at the organizational level. A multilevel method could be used to investigate the relationship (Kozlowski and Klein, 2000).

## **ES Outcomes**

ES can affect organizations in many ways, positively or negatively. Studies on ES outcomes are focused on the ES impacts on organizations (e.g., profits). While Markus and Tanis (2000) argued that the outcomes of an ES implementation are unpredictable due to the fact that it is always possible that things could go wrong in each phase, and that problems may not be immediately detectable or correctable, a considerable number of studies address the positive outcomes that an ES implementation can bring to the organization. For example, Saxon (2000) listed a number of benefits from SAP including the transparent access to all nationwide inventory information, a tracking system for all firearm assigned to RCMP, and reduced duplication and delay. Hill (1999) exemplified how SAP streamlined and enabled data access at a European Brewery. Hamu (1998) elaborated four types of advantages (i.e., budgetary advantages, technical advantages, managerial advantages, and economic impact) that an ES brings to an organization. Rajagopal and Tyler (2000) illustrated that cross-functional integration is a key benefit.

However, despite all those benefits expected from an ES, Themistocleous, Irani, and O eefe (2001) discovered from their web-based survey that the return on investment from an ES is low. Furthermore, using Max analysis of the processes of accumulation and circulation of capital, Robinson and Wilson (2001) argued that while it could be partial solutions to the problems faced by organization, ERP can not completely solve the contradictions of capitalist production. They concluded with the statement, the limitations of ERP are shown to be inherent in the necessary operation of an economic system based on the dominance of capital and its reproduction (Robinson and Wilson, 2001, pg. 22).

What is the impact of an ES on organizations? To what extent does an ES reduces operation costs, streamline business processes, improves collaboration among departments, enhance customer relationships, raise morale, increase decision-making quality, and improve control? Although companies may differ in the outcomes they achieve due to various factors (e.g., industry, size, financial resources, user competency, and culture), the lack of a thorough understanding of the impact of an ES on organizations warrants further study.

## **Others**

The research reviewed above focuses on ES adoption process issues; there are other studies focusing on future trends of enterprise systems, especially integration of ERP systems with other systems. This issue becomes critical because the best of breed IT strategy (i.e., adopting modules from different ERP vendors to suit unique organizational needs) appeals to organizations special needs and because single vendor-based IT strategy is problematic because of limited flexibility and increased risks due to sole reliance on one vendor (Light, Holland and Wills, 2001). Software vendors are extending the object concept to software development, so that their packages can be integrated seamlessly with other vendors' package into a whole system, and suggested frameworks to establish integrated ES (Bhattacharjee and Ramesh, 2000; Fan, Stallaert and Whinston, 2000; Fayad, Hamu and Brugali, 2000; Mustafa and Mejabi, 1999; Scott and Vessey, 2000). Scheer and Habermann (2000) illustrated how to use modeling methods to analyze requirements and customize ERP.

Some researchers have predicted improvements in process management, increased decision and analytical focus, ES componentization (i.e., ES functionalities become more modular and flexible [Davenport, 2000a, pg. 174]), increased ASP for enterprise systems, and integrated supply chain management (Auditore, 2000; Davenport, 2000a; Markus, Petrie and Axline, 2000a). Bennett and Timbrell (2000) further listed the financial and technical reasons for adopting ASP (e.g., cost reduction, cost control, access to advanced technical resources, and improved core competencies), and regarded ASP as a viable choice for organizations.

While researchers have projected changes in enterprise system development, the implications of these trends to management are unclear. Davenport (2000a) implied potential change in the decision making process. Li (1999) indicated that CIOs needed to shift their attention to more business-oriented approach and find ways to build intelligent enterprises (pg. 34). McPherson (1998) suggested ways to plan document output strategy. The exact challenges faced by managers (e.g., CEOs and CIOs) to build such systems remain to be seen. Neither do we know about the process of system integration, problems that will arise from the integration process, or the impacts of the integration on the organizations.

In addition to the above research stream, there are studies identifying differences between package software and customized software (Sawyer, 2000), finding reasons for system migration (Kremers and Dissel, 2000), and using ES for educational purposes (Hawking, Ramp and Shackleton, 2001; Stewart and Roseman, 2001).

The previous ES studies have explored criteria being used by organizations during the ES selection, suggested ways to reduce risks associated with ES implementation, identified various critical issues during the ES implementation process, revealed the complexity of ES implementation by tapping the negative aspects of ES implementation, classified ES usage at the organizational level, showed the perplexing findings about ES impacts on organizations, and predicted future trends of ES development. Various theories and frameworks have been used to explore enterprise systems including (1) learning theory (Scott and Vessey, 2000), (2) Barlett and Goshal's typology of firm strategy (Clemons and Simon, 2001; Markus, et al., 2000), and (3) Klein and Sorra's innovation implementation model (Dong, 2001). Several theoretical models have been developed, including the ES maturity model (Holland and Light, 2001), systematic analysis method of memory mismatches (SAMMM) (Stijn and Wensley, 2001), critical success model for ES implementation (Holland and Light, 1999), multi-site implementation framework (Markus, et al., 2000), and top management influence on ES implementation (Dong, 2001). Among the various proposed models, only one has been tested (Holland and Light, 2001).

IT adoption and implementation is defined as the organizational efforts in choosing an IT innovation and diffusing it into a user community (Kwon and Zmud, 1987). This process is affected by internal factors such as (1) key players including management, users, and in-house IT specialists, (2) interactions among those players, (3) organizational characteristics (e.g., size, culture, resources, strategy, and IT infrastructure), (4) how the process is structured and organized, and external factors including vendors, industry, and external consultants. The complexity of IT adoption and implementation processes varies with the number of those factors, and potential interactions. The more complex an IT adoption and implementation process, the less predictable the impacts of the technology on an organization. Furthermore, although previous ES studies have provided useful understanding regarding various aspects of ES (e.g., adoption, implementation and its impacts on organizations), limited factors have been examined and tested. Most studies have focused on what happened within organizations, paying little attention to factors related to organizational characteristics and external environments. Although theories and findings from IT innovation adoption and implementation literature can be relevant to ES implementation (e.g., TRA, TAM, participation and involvement, and planned change theory), the high risk inherent in ES adoption and implementation, and scope of the changes that enterprise systems invoke within organizations, necessitate further study to examine factors under different categories.

In addition, the review classifies previous ES studies in terms of methodologies and time period. As indicated in Table 1, various methodologies have been used, including survey, case study, conceptual study, literature review, and prescriptive studies. Among fifteen survey and case studies, twelve are single-snapshot cross-sectional studies, two using process tracing technique (i.e., continuous data collection using a "single discrete event" [Orlikowski and Baroudi, 1991, pg. 4]), and one multiple-snapshot cross-sectional study. No longitudinal studies were found (Table 2). Undoubtedly, survey and case studies can provide useful findings regarding enterprise systems. However, multiple-snapshot cross-sectional and longitudinal studies can further deepen and enrich our understanding of the complexity of the ES adoption and implementation and impacts of ES on organizations. The apparent lack of longitudinal and multiple-snapshot cross-sectional studies inhibits our complete understanding of enterprise systems.

**Table 1. Articles Classified by Research Design**

Research Design	Frequency	Percent
Survey	6	13.64
Case Study	9	20.45
Conceptual study	12	27.27
Literature Review	3	6.82
Prescriptive studies	14	31.82
	44	100%

**Table 2. Survey and Case Studies Classified by Time Period of Study**

Time Period of Study	Frequency	Percent
Cross sectional: single snapshot	12	80
ongitudinal	0	0
Cross sectional: multiple-snapshots	1	6.7
Process Traces	2	13.3
	15	100%

A further analysis of those forty-four ES studies was conducted using the epistemology classification of Orlikowski and Baroudi (1991), who classified various research studies into positivist, interpretive, and critical. As shown in Table 3, most current ES studies are positivist and descriptive; there is only one interpretive study and one critical study so far. This further indicates that ES studies are at their preliminary stage, with the main focus simply on understanding the process from ES adoption to implementation.

**Table 3 Articles Classified by Epistemology**

Epistemology	Frequency	Percent
Positivist		
“descriptive”	35	79.55
theoretical grounded	7	15.91
Interpretive	1	2.27
Critical	1	2.27
	44	100%

## Conclusion

A literature review of ES articles published in peer-reviewed IS journals during the period 1998-2002 indicates that while previous ES studies have provided interesting findings, only limited aspects of enterprise systems have been explored, and our understanding of enterprise systems is still preliminary. Most studies are descriptive, single-shot and cross-sectional in design. Although salient factors have been identified, empirical testing has not been conducted. Despite the cross-relationship between enterprise system studies, IT innovation, and IT implementation, few studies have adopted existing theories and frameworks. What we have studied focuses primarily on the iceberg above the sea, ignoring what is going on under the water. By revealing the gaps in the ES literature, we hope future studies can provide academic researchers and practitioners with richer information regarding ES adoption, implementation, and impacts on organizations.

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