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BEYOND ERP SYSTEMS AS A HYPE Understanding ERP systems as Distinct Technological, Organizational and Cognitive Phenomena

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ABSTRACT

This conceptual paper addresses the question why research on ERP systems makes sense. Its purpose is to show that ERP systems are not simply hype or buzz. This paper adopts the view that ERP systems are technological, organizational, and cognitive in nature. Along those dimensions, ERP systems can be distinguished from other IS, while also identifying similarities. Future research may concern the proposed characteristics of those dimensions and may also relate to their interactions and interrelations. Questions for investigation are presented throughout the paper. Further research promises to extend academic understanding of ERP systems, as a specific domain of IS. As a result, business practice can be supported to actually realize benefits with their ERP systems.

Keywords: ERP systems, technology, knowledge, effectiveness, integration, complexity, standardization

INTRODUCTION

Some scholars classify Enterprise Resource Planning (ERP) systems in the category of "buzzwords", probably together with other contemporary IS terms as customer relationship management, data warehouses, and knowledge management systems (Swanson, 2000). Moreover, ERP vendors start selling extended-ERP solutions that might as well include all those IS. The academic concern for ERP systems, in teaching and research, is increasing. But caution is advised! "[…] Empirical researchers should not confuse the current buzz about information systems with the existing population of systems deserving of study. Perhaps much too frequently for their own good, empirical researchers seem to be attracted to the 'latest and the greatest' just like everyone else. They plunge in to make observations of scattered and ill-understood phenomena still under substantial development and change, coming too often to findings destined to evaporate in their relevance much too soon. They tend to ignore that which has become widespread, well established and even mundane, and therefore fail to make the more obvious observations and draw the needed longer-term, underlying lessons for us (Swanson, 2000, p. 925)."

Did we all plunge in the ERP hype or are ERP systems really worthwhile studying? Some publications illustrate a plunge, specifically when they indeed appear to forget the rigorous body of relevant scientific literature. Fortunately, other papers support the point that - like this paper purports to demonstrate - ERP research is valuable for science and practice. This paper proposes to describe ERP systems along three dimensions, namely technological, organizational, and cognitive. After a methodological note, they are discussed along these three dimensions. Throughout the paper, questions for further inquiry are presented. Based on the understanding of ERP systems as distinct three-dimensional phenomena, the conclusion is drawn why ERP research is appealing.

A METHODOLOGICAL NOTE

Information systems are generally characterized as being technological and organizational in nature. Many different information technologies are available to organizations. Self-evidently, when applied in organizations, a diversity of organizational aspects is important too, for instance regarding task-technology fit (Zigurs and Buckland, 1998) or organizational change in the context of IT (Robey and Boudreau, 1999). A third – less commonly recognized - dimension is the cognitive dimension. Obviously, cognitive elements such as knowledge and information, are also important in the context of IS. Structuration theory of IT (Orlikowski and Robey, 1991; DeSanctis and Poole, 1994) and organizational memory theory (Walsh and Ungson, 1991; Stein and Zwass, 1995) both explicitly address this dimension. Cognitive issues may relate for instance to organizational learning during IS development and implementation (Robey et al., 1995; Salaway, 1987; Stein and Vandenbosch, 1996).

In order to compare and distinguish ERP systems from other IS, such as workflow management systems and e-commerce systems, they are characterized along those three dimensions. Based on 20 descriptions of ERP systems (used references marked with *) complemented with other ERP and (IS) literature, several general IS characteristics have been identified for each dimension. For instance, ERP systems are believed to highly integrate organizational processes, which can be derived to the characteristic 'organizational integration'. Groupware may also score high on organizational integration, whereas an e-commerce system may score low. The technological dimension is discussed next.

ERP'S TECHNOLOGICAL DIMENSION

Five general IS characteristics may be distilled for the technological dimension and filled out for ERP, namely development, applied technologies, complexity, standardization, and integration.

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1. Development

ERP systems are commercial packages from third-party suppliers. Currently, key suppliers are SAP AG, Baan, J.D. Edwards, PeopleSoft and Oracle. ERP systems can be understood as semi-finished products with tables and parameters to be configured in-house (Shang and Seddon, 2000). The organization may customize the ERP software by means of add-ons or other enhancements (Markus and Tanis, 2000; Keller and Teufel, 1998). Yet unanswered questions are how to decide what aspects of the ERP package need to be enhanced (to better fit the organization's needs), how, and under which conditions?

2. Applied technologies

ERP systems consist of multiple technologies such as client-server systems and web-technology with specific features, such as being real-time, online, and interactive (Brown et al., 2000; Madani, 2000). The application of multiple technologies is assumed to lead to specific concerns regarding complexity, standardization and integration, characteristics discussed next.

3. Complexity

Because of their large scale and organization-wide scope, ERP systems are considered to be highly complex. One may distinguish component complexity, coordinative complexity, and dynamic complexity (Banker et al., 1998). "[…] Component complexity refers to the number of distinct information cues that must be processed in the performance of a task, while coordinative complexity describes the form, strength, and interdependencies of the relationships between the information cues. Dynamic complexity arises from changes in the relationships between information cues over time, particularly during task performance (Banker et al., 1998, p. 435)." In these terms, complexity of ERP has not been investigated yet, nor the potential effects. Hypothetically, high complexity may for instance negatively influence the implementation process.

4. Standardization

ERP systems are developed largely out-house, and considered to be prewritten and of a generalized nature. The level of standardization - striven for by means of reference business process models supplied by ERP vendors and consultants (Keller and Teufel, 1998; Scheer, 1998) - appears to be high. The reference business process models should make technological realization easier. However, suppliers have tended to develop non-open systems, while standardization across packages did not take place (Loos, 2000). That may decrease ERP's flexibility, obviously an important requirement. Further componentization and standardization of interfaces are two solutions currently adapted to enhance flexibility (Loos, 2000; Sprott, 2000).

5. Technological integration

One may distinguish different forms of technological integration, for instance relating to the hardware architecture, components, data, and other IT. With respect to all those forms, ERP systems are regarded highly integrated. Take for example the SAP Strategic Enterprise Management (Meier et al., 2000). For vertical integration of business news, data are obtained from Internet, processed applying text mining, coupled to internal data from the ERP system, and provided to the managers. Researchers can help to develop such technologically integrated solutions and investigate problems that may occur. How reliable are for instance the text mining procedures? Do they filter the data in such a way that the information needs are fulfilled?

Next, ERP's organizational dimension is discussed, including organizational integration.

ERP'S ORGANIZATIONAL DIMENSION

The following three IS characteristics are distinguished: functionality, effectiveness orientation, and organizational integration.

1. Functionality

The ERP system allegedly supports many business processes, varying from human resource management to logistics (Davenport, 1998). Some functions of SAP R/3 (Table 1) illustrate this. Originally, ERP systems concentrated on those internal organizational processes. Currently, ERP systems evolve into extended-ERP, incorporating inter-organizational processes as e-business, and supply chain management (Kumar and Van Hillegersberg, 2000). The mentioned description of ERP functionality may fail to catch the 'spirit' of ERP systems, and might as well be outdated next week. Perhaps one of the pitfalls of studying a buzzword phenomenon?

R/3 Financial	R/3 Human resources	R/3 Logistics
1. Financial Accounting	1 Personnel Management	1 Product Data management
2. Controlling	2 Organizational Management	2 Sales and distribution
3. Joint Venture Accounting	3 Personnel Administration	3 Production planning and control
4. Investment Management	4 Recruitment	4 Project system
5. Corporate Real Estate Management	5 Personnel Development	5 Materials management
6. Enterprise Controlling	6 Training and Event Management	6 Quality management
7. Treasury	7 Compensation Management	7 Plant maintenance
	8 Benefits Administration	8 Service management
	9 Personnel Cost Planning	
	10 Time Management	
	11 Payroll Accounting	
	12 Travel Management	

Table 1. Functionality of SAP R/3 (SAP, 2000)

1. Effectiveness orientation

It is proposed here to use the concept of 'effectiveness orientation' to capture what ERP systems are about. The 'effectiveness orientation' - based on the framework by Quinn and Rohrbaugh (1983)- comprises of two dimensions, namely focus (internal/ external) and structure (flexibility/ control). It is proposed to exclude the mentioned added functionality from the ERP system. Instead, ERP is understood here as concentrating on control of resources and activities ***within*** the organization. Registering, planning, tracking, standardizing, optimizing, and performance measurement are all control functions embedded in ERP systems. It is yet unclear to what extent ERP systems contribute to enhanced performance, and under which conditions. May for instance the control focus inhibit overall effectiveness improvement?

2. Organizational integration

Organizational integration may be defined as "[…] the action of forming an ensemble, a coherent whole, of the various administrative units that make up the enterprise, each of which assumes certain functions (Alsène, 1999, p.27)." The organization may be interpreted as a collection of parts or subsystems (Katz and Kahn, 1966; Senge, 1990). One of the issues relating to ERP integration, then, is the definition of an organization in terms of interrelated subsystems. It is the question which aspects of the organization are dependent in what way and to what extent. Highly related aspects may be tighter integrated, while low interdependence can lead to very loosely coupling (Weick, 1969). How can organizations integrate their ERP-related internal processes? Some

organizations choose not to implement full ERP functionality, but for instance only implement human resource management and financial accounting components. In fact, they are not realizing an enterprise-wide system, or the proposed enterprise-wide integration. What does this mean in terms of such organizations' realization of ERP benefits? Do other ERP problems originate here as well?

The third dimension, addressed next, is the cognitive dimension.

THE COGNITIVE DIMENSION OF ERP

Five cognitive IS characteristics are distinguished, namely information, skills, knowledge, and paradigms, and cognitive integration.

1. Information

"[…] Information is the flow of messages, while knowledge is created and organized by the very flow of information, anchored on the commitment and belief of its holder (Nonaka, 1994, p.15)." Information can be seen as messages that can become knowledge when its receivers can interpret these messages. Though data may be interpreted as being cognitive as well, it is proposed here to regard data as technological in nature, being the stored bits and bytes that may become information. ERP information focuses on the functional domains, such as logistics and finance (see table 1).

2. Paradigms

Paradigms refer to the organizational beliefs and the reigning values and norms about 'what is good and what is bad', what one should and should not do (Kuhn, 1970). A key premise is that ERP systems embody best practices in their reference models (Davenport, 1998; Kumar and Van Hillegersberg, 2000), which allegedly leads to improved effectiveness. Reference models are based on theoretical and practical best practice assumptions (beliefs) for a given process. But processes exist within a rich context, including products and services, customers, suppliers, and employees (Van Stijn and Wensley, 2001). In which context do reference models apply?

3. Knowledge

Knowledge, or interpretive schemes, can be described as "[…] a mental template that individuals impose on an information environment to give it form and meaning (Walsh, 1995, p. 281)." Knowledge helps human actors to give the world meaning (Orlikowski and Robey, 1991). Process knowledge, both company-specific and general, is embedded in the ERP system. Procedural knowledge, such as economic controlling, logistics and sales procedures are programmed into the ERP system (Koch, 2000).

4. Skills

Skills are comparable to tacit (Nonaka, 1994) or soft knowledge (Anand et al., 1998), capabilities 'how things are done'. Usually, those capabilities have a personal quality, deeply rooted in action, commitment, and involvement (Nonaka, 1994). Skills may be elicited for the ERP in the form of routines or decision models, or in the form of a skill database in the HRM component of the ERP system, linking employees and skills.

5. Cognitive integration

Cognitive integration means integration of the above characteristic 'contents' of the ERP system. Integration may provide the organization with a comprehensive holistic view of the business (Gable and Rosemann, 2000), but it may also pose difficulties. Though crucial when considering that organizational effectiveness will be "[…] a function of the degree to which decision-makers have knowledge about the nature of these interdependencies (Duncan and Weiss, 1979, p. 83)", it may be very difficult to understand the organization as a whole. It should be noted that although integration is important, it should not become a goal in itself.

DISCUSSION

Technological	Organizational	Cognitive
Development	Functionality	Information
Applied technologies	Effectiveness orientation	Paradigms
Complexity	Organizational integration	Knowledge
Standardization		Skills
Technological integration		Cognitive integration

Table 2. Summary of the proposed dimensions and characteristics.

The basic premise is that, like any IS, the purpose of ERP systems is to support the organizational processes in order to enhance effectiveness. Effectiveness is a complex and controversial organizational construct. One could say that effectiveness means that the organization functions in such a way that it has a relative sustained competitive advantage over its competitors (Hamel and Prahalad, 1994; Kettinger et al., 1994). Such effectiveness, or performance, is dependent on how the organizational processes function. The design of those processes may be dependent on what is introduced here as the effectiveness orientation. ERP systems focus on control and internal processes. The latter characterization of ERP appears to counter the current trend of extended functionality and may appear to be rather artificial in this respect. However, for research purposes, because it makes it possible to study ERP systems within its borders, as well as its relations and interactions beyond. Illustratively, one could study ERP in relation to manufacturing and project planning (see Table 1), or investigate the impact of e-business on ERP.

The discussed characteristics of ERP systems may be used as potential metrics for studies of ERP success, that is currently ranging from drastic failure to extreme success (Boudreau and Robey, 1999). Though potential ERP benefits have been identified (Shang and Seddon, 2000), research on evaluation is scarce (Rosemann and Wiese, 1999). To what extent are benefits actually realized? How do identified critical success factors (Holland et al., 1999), such as top management commitment, attribute to these results? Allegedly, the integration of internal processes and the use of best practices are important factors contributing to the ERP system's success. Are they? What if cognitive contents the third party developing the ERP system had in mind are different than the actual knowledge of the organization that is implementing or using the ERP system? Such conflicting cognition (or organizational memory mismatches), may disable the organization to realize ERP benefits (Van Stijn and Wijnhoven, 2000). What other influences does such conflicting knowledge have? And how can organizations (and researchers!) deal with the tacit nature of much of this contextual knowledge? Tacit knowledge is particularly difficult to formalize and communicate (Nonaka, 1994). What difficulties does that pose on diagnosis and coping?

Like integration, one may consider complexity and standardization cross-dimensional characteristics too. ERP business process models intend to standardize the various cognitive elements. Furthermore, the organization may adapt its organizational processes to standard business process models, thus leading to organi-

zational standardization. Organizational complexity with respect to an ERP system may be very high, since the system relates to many different organizational functions and processes. Complexity with respect to the cognitive elements may also be very high. For instance, in the context of experts systems, knowledge complexity has been defined as "[…] the degree of depth and specialization of the internalized knowledge of human experts, the scope of the decision-making process, and the level of expertise required, including discipline-based knowledge, that is incorporated into the expert system application (Meyer and Curley, 1991, p. 456)." High technological, organizational, and cognitive complexity may cause the adoption of ERP systems to be more difficult than of low complexity IS, potentially causing ERP implementations to take much more time (and money) (Bingi et al., 1998). High complexity may also be hypothesized to make it difficult to realize benefits, as opposed to benefiting from low complexity IS.

CONCLUSION

Did we all plunge in the ERP hype or are ERP systems really worthwhile studying? This paper aimed to demonstrate that ERP system research is meaningful. The paper described ERP systems along the technological, organizational, and cognitive dimension, and proposed several general characteristics for each. Understanding them as three dimensional phenomena makes it clear that ERP systems exhibit a combination of specific characteristics that makes them distinct from other information systems that share some - but by no means all - of those characteristics. ERP is a distinct IS domain. A myriad of potential research questions have been posed and, clearly, many more issues may be identified. Considering that the proposed characteristics may be used as potential metrics for studies of ERP success, it is my contention that organizations may profit from future ERP research that aims to enhance our understanding of how to realize benefits with ERP systems. As long as we do not forget the rich body of IS and other scientific knowledge, and engage in high quality research, it's a challenge to conduct ERP research.

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