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The Relationship between Organizational Structure and Enterprise Resource Planning Systems: A Structural Contingency Theory Approach

Neil Morton
Florida Atlantic University

Qing Hu
Florida Atlantic University

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Neil A. Morton
Florida Atlantic University
nmorton2@fau.edu

Qing Hu
Florida Atlantic University
qhu@fau.edu

ABSTRACT

Despite its tremendous popularity and potential, the field of ERP implementation is littered with spectacular failures. We argue that the integrated nature of ERP systems, which generally requires an organization to adopt standardized business processes reflected in the design of the software, is not suitable for all organizations and is thus a culprit of implementation failures. In this paper we use structural contingency theory to identify a set of dimensions of organizational structure and ERP system characteristics that can be used to determine the degree of fit between the characteristics of the adopting organization and the ERP system, thus providing a set of predictors of ERP implementation success. A set of propositions are developed based on these analyses regarding the success of ERP implementations in different types of organizations. These propositions provide guidance for future research that might lead to guidelines for managers of organizations contemplating implementing ERP systems.

Keywords

Enterprise Resource Planning, ERP, ERP implementation, contingency theory, organizational design.

INTRODUCTION

Enterprise Resource Planning (ERP) information systems have become increasingly popular in organizations across the world (Al-Mashari, 2003; Klaus, Rosemann and Gable, 2000; Soh, Kien and Tay-Yap, 2000). According to AMR Research, the total ERP market is expected to grow from \$19.8 billion in 2002 to \$31.4 billion in 2006 (Surmacz 2002). ERP systems are essentially software packages that integrate information flow across business functions and unit boundaries. When implemented successfully, ERP systems reduce cycle time, enable faster information transactions, facilitate better management, and lay the groundwork for e-commerce (Davenport 2000). However, the successful implementation of ERP systems has proven to be a very difficult task. Over half of ERP implementations are judged to be failures (Appleton, 1997; Scheer and Habermann 2000).

Implementing ERP often affects organizational design, which has been attributed as a major cause of implementation failures (Al-Mashari 2003). In particular, the implementation of an ERP system generally requires adopting the standardized business processes embedded in the software and moving away from a functional-based organizational structure (Davenport, 1998; Gattiker and Goodhue, 2000; Valacich, George and Hoffer, 2001). Researchers have long recognized that a critical determinant of an information system's success within an organization is the match or "fit" between the design of the system and that of the organization (Leifer, 1988; Markus and Robey, 1983). The organizational design embedded in the ERP systems are likely to fit well with certain organizational structures, and poorly with others. Because of the promising competitive advantages and strategic possibilities of ERP systems, top management of organizations often rush to adopt ERP systems without first considering the potential fit of the system with respect to organizational characteristics, resulting in implementation failures and significant financial losses. Notable examples of such failures include Dell computer, Dow Chemical, and FoxMeyer Drug (Davenport 1998)

Multiple streams of research exist on the critical success factors of ERP implementations and the impact of ERP implementation on company performances (Al-Mashari, 2003; Laughlin, 1999; Markus and Tanis 2000; Hitt, Wu and Zhou, 2002), yet few have addressed the critical issue of fit between ERP and organizational design. We argue that it is important for both researchers and practitioners to understand which organizational designs fit well with ERP systems. This paper draws from Mintzberg's (1979, 1980) work on ideal structural types and Donaldson's (2001) work on structural contingency theory in order to identify dimensions of fit between organizational design and ERP systems.

THEORETICAL DEVELOPMENT

Technology and Organizational Design

The most fundamental relationship being examined in this study is in essence the relationship between technology and organizational design. Leavitt and Whisler (1958) were among the first to analyze the effects of technology on organizational structure. They argued that technology would have significant impacts on the shape of organizations and the nature of managerial jobs, predicting that entire levels of middle management would be eliminated, and centralized decision making would reside at the highest levels of the corporate hierarchy.

The subsequent literature has produced largely contradictory findings about nearly all aspects of information technologies impact on organizational design (Attewel and Rule 1984). Leavitt and Whisler's (1958) prediction of centralization has proven true in some instances, while greater decentralization has been shown to occur in others. Some researchers (e.g., Schultz & Whisler, 1960; Reif, 1968) have shown that the accurate information produced by the use of computers promotes control by upper management because it makes information more readily available to high levels of authority. Other researchers (e.g., Huber, 1990; Markus and Robey, 1988) have shown that the computer's ability to take over routine decision making enables lower and middle levels of the organization to handle less routine decisions, resulting in decentralization.

The literature on technology's impact on formalization (much use of rules and documents) reveals mixed results as well. In the early 1960's, Woodward found that more complex technologies lead to organizations moving away from mechanistic structures toward unformalized or organic structures (Woodward 1965). In contrast, others found that production technology leads to more formalized bureaucratic structures (e.g., Blau, Falbe, McKinley and Tracy 1976). Huber (1990) finds that technology will initially lead to high levels of formalization, but over time will have little effect on the degree of formalization of an organization.

The literature on information technology's effects on organizational design is largely inconclusive. Perhaps this is not surprising given the vast differences in both technologies and the organizations in which they are implemented. The implications of technology with regard to organization design are likely to vary considerably depending on how well the technology is implemented, and on the structure and strategies of the organizations in which the technology is utilized.

Dimensions of Organizational Structure

The characteristics of organizational structure can be described in a number of dimensions (Fry 1984). Commonly cited structural dimensions include centralization, specialization, standardization, formalization, hierarchical levels and span of control (e.g., Hage and Aiken, 1967; Ouchi and Dowling, 1974). Given the number of proposed structural dimensions and the variety of their definitions (Fry 1982), identifying a definitive set of organizational dimensions is difficult (Blackburn 1982). The structural dimensions of formalization, centralization and complexity have generally been used in assessing technology-structure relationships (Fry 1982). The structural contingency theory literature has used specialization-formalization, structural differentiation, and decentralization (Donaldson 2001). However, further analysis of the literature reveals that the dimensions used by the structural contingency literature (Donaldson 2001) and the structure-technology literature are very similar.

For our study, the dimensions utilized by the contingency theory literature are adopted except that formalization-specialization is simplified to formalization, as is used in the technology-structure literature. Formalization is defined as the standardization of documentation of work processes (Donaldson 2001). Structural differentiation is defined as the difference in goal orientation and in the formality of structure of organizational units (Lawrence and Lorsch 1967, p. 10). Decentralization is defined as "the extent to which power over decision making in the organization is dispersed among its members" (Mintzberg 1980, p. 326).

In order to identify the fit between organizational structures and ERP systems, it is useful to group the dimensions of structure into the common types generally found in organizational design literature. Mintzberg (1979) conducted a synthesis of research on organization design from which he developed a typology of five basic organizational structures. These five basic structures represent a good typology of ideal types of organizational structures for purposes of this research. The ideal types and their pertinent characteristics are presented in Table 1.

Ideal Types of Organizational Structure	Salient Characteristics
Simple Form	• Small, simple • Low formalization • Highly Centralized • Unsophisticated technical systems
Machine Bureaucracy	• Perform routine operating tasks • Highly formalized • Relatively centralized decision making • Automated and integrated technology • Highly differentiated structure • Standardized work processes used for coordination • Operate in stable environments
Professional Bureaucracy	• Decentralized decision making • Standardization of skills used for coordination • Highly skilled workers who value autonomy • Decentralized decision making
Divisionalized Form	• Centralized headquarters • Semiautonomous, loosely joined divisions • Little interdependence or close coordination among divisions • Main goal of headquarters is to coordinate goals of divisions with that of its own without sacrificing autonomy • Standardized outputs of divisions used for coordination • Divisions are generally machine bureaucracies
Adhocracy	• Operates as a cohesive group working together • Mutual coordination and cooperation • Innovative • Workers are trained experts from different specialties • Ad –hoc project teams • Low formalization • Decentralized decision making • Operate in dynamic environments

Table 1: Ideal Types of Organizational Structures (Adopted from Mintzberg, 1979)

Structural Contingency Theory

Contingency theory posits that organizational effectiveness is achieved by matching the organizational characteristics to contingencies, where a contingency is defined as "any variable that moderates the effect of an organizational characteristic on organizational performance." (Donaldson 2001, p. 7). The structural contingency theory of organizations (Donaldson 2001) argues that the performance of an organization is dependant upon the fit between organizational structure and contingencies. There are three main elements that form the core paradigm of structural contingency: 1) there is an association between contingency and organizational structure; 2) contingency determines the organizational structure; and 3) there is a fit of some level of the structural variable to each level of the contingency, where high fit leads to high performance and low fit leads to poor performance (Donaldson 2001, p. 7).

A number of potential contingencies have been identified in the literature (e.g., technology, innovation, environmental change, size, diversification). Donaldson (2001) argues that size, environment, and technology, are the underlying contingencies in the structural contingency literature. While size is relatively straightforward, the way researchers operationalized the environment and technology contingencies has been a source of confusion (Pennings 1975). Donaldson (2001) suggests that many contingencies, excluding size, can be divided into two aspects of organizational tasks; task uncertainty and task interdependence. Task uncertainty stems mainly from technology, technological change, innovation, and environmental instability. Task interdependence refers to the degree that activities in an organization are connected to each other. Thompson (1967) identified three levels of task interdependence: pooled (indirect connection), sequential (direct

one-way connection), and reciprocal (direct two-way connection). Along with size, task uncertainty and task interdependence make up the underlying contingencies of the structural contingency literature (Donaldson 2001).

Research Framework

From the discussions of organizational types and structural contingency theory presented above, the core research framework of this study emerges. We posit that the fit between organizational structure and characteristics of ERP systems has significant implications for the success or failure of ERP implementation in organizations. Organizational designs that have low levels of business integration and relatively non-standardized work processes will face significant organizational changes and encounter high resistance from within, as ERP pushes the organizations to integrate functions and units and adopt the standardized business processes embedded in the systems. An organization that already uses a cross functional design will still likely face resistance as it is forced to make some changes in its businesses processes. However, the resistance may be less significant than the resistance encountered in organizations forced to integrate functions and units as well as business processes. The greater the change the system imposes, the greater the resistance (Marcus and Robey 1983). Resistance to change from ERP implementation will substantially affect system success. Organizational resistance to change has been identified as a critical success factor for ERP implementation (Al-Mushari, 2003; Laughlin, 1999; Markus and Tanis, 2000). These ideas are presented in Figure 1.
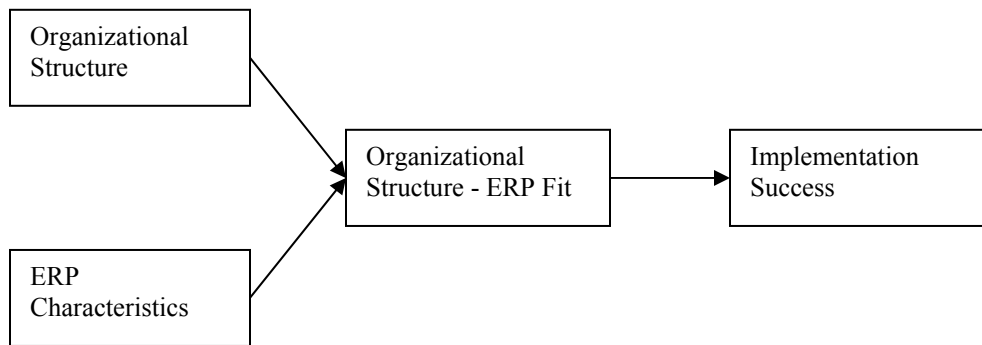

Figure 1: Organizational Fit and ERP Implementation Success

Using this framework as our guidance, we next develop the propositions that establish the relationship between characteristics of ERP systems and organizational types and attempt to predicate the likelihood of ERP implementation success based on the structural contingencies.

ERP Characteristics, Structural Dimensions and Contingencies

In this paper, for the benefits of theory development and discussion, we make the strong assumption that the ERP systems and their implementations in organizations are in their pure forms, similar to the comprehensive category of ERP described by Parr and Shanks (2000). In its pure form, the full functionality of a single ERP package is implemented throughout an organization. In reality, however, ERP vendors usually offer certain degree of customization to clients and not all modules in an ERP package need to be installed in a particular implementation.

Several researchers have suggested that the cross-functionality of ERP enables a unified view of the firm, pushing an organization to move away from a functional-based system towards integration (e.g., Al Mashari, 2003; Davenport, 1998; Valacich et al., 2001). ERP systems allow organizations to integrate all their information flows and to automate much of their operations, including inventory control, manufacturing and scheduling production, sales support, customer relationship management, financial and cost accounting, human resources, and almost any other data-oriented management process (Hitt, et al. 2002).

The business integration imposed by ERP likely reduces both the autonomy of individual functional areas and increases interdependencies between units. Information systems increase interdepartmental coordination (Saunders 1981), and this phenomena is likely relatively more pronounced for ERP systems. McCann and Ferry (1979) define interdependence as a condition where actions taken within one unit affect the actions and work outcomes of another unit.

The cross-functional integrated nature of ERP has significant impacts on business processes (e.g., Hitt et al., 2002; Scott and Vessey, 2002). Standardization of business processes is necessary to enable ERP software to handle business processes and data storage across the various functions and units of an organization (Gattiker and Goodhue 2000). Therefore the implementation of an ERP system requires an organization to modify its internal processes to match the standardized processes reflected in the ERP software (e.g., Hammer and Stanton 1999; Davenport 1998). A number of researchers have pointed out the link between the implementation of ERP and the need to change business processes (Al-Mushari 2003).

Both of the primary effects of ERP identified above, standardization of processes and integration, fit the definition of a contingency, a variable likely to moderate the effect of an organizational characteristic on organizational performance. Standardization of processes and the integration of information and processes correspond to task uncertainty and task interdependence respectively.

Task Uncertainty. The standardization of processes imposed by ERP imposes strict adherence to predefined work processes (Davenport 1998). Forcing strict adherence to predefined work processes significantly reduces the task uncertainty of the activities that an organization performs. Thus, the standardization effect imposed by ERP is essentially a task uncertainty variable.

Task Interdependence. Task interdependence refers to the degree that activities in an organization are connected with each other (Donaldson 2001). The integration of information and processes imposed by ERP requires interdependence, close coordination and cooperation among the functional departments and units of an organization in order to efficiently and effectively perform tasks. Thus, the integration effect of ERP is essentially a task interdependence variable. Indeed, Sharma and Yetton (2003) note that ERP systems are characterized by high levels of task interdependence. The task interdependence imposed by ERP fits the sequential form of interdependence defined by Thompson (1967). Sequential forms of task interdependence are characterized by high levels of task interdependence (Thompson 1967).

The low task uncertainty associated with ERP is predicted to be a good fit with organizational structures that have a high degree of formalization and low levels of decentralization (Donaldson 2001). This is consistent with the literature that highlights the formalized work procedures imposed by ERP (Davenport 1998). The argument that ERP is associated with low levels of decentralization is also supported by the literature (Davenport 1998). Organizations that possess mainly limited horizontal decentralization are considered overall to be relatively centralized (Mintzberg 1979). Only direct supervision is associated with lower levels of decentralization than is standardization through work process (Mintzberg 1979). Interestingly, Dell Computer attempted to implement an ERP system, but found that it would not fit with its decentralized management model (Davenport 1998).

The fairly high degree of task interdependence imposed by ERP is predicted by contingency theory to be a good fit with organizational structures characterized by low formalization, low structural differentiation, and low levels of decentralization. The prediction that ERP will fit relatively unformalized structures is inconsistent with the task uncertainty prediction. However, task uncertainty is considered to be a stronger contingency factor than is task interdependence (Donaldson 2001). Furthermore, the standardized processes of ERP are by nature highly formalized. Standardization of processes necessitates the formalization of many organizational rules, policies, and procedures (Umble, Haft and Umble 2003).

The literature and the task interdependence and task uncertainty contingencies suggest that ERP systems will be a better fit with organizations possessing the structural dimensions of: high formalization, low structural differentiation, and low decentralization. Mintzberg's ideal types possessing the structural dimensions above are a good fit with ERP systems and will thus face relatively low levels of change, will face relatively low resistance to change, and will have relatively high likelihoods of system success. On the other hand, Mintzberg's (1979) ideal types that do not possess the structural dimensions characterizing ERP will face relatively high levels of change, will face significant resistance to change and will have relatively low likelihoods of system success. Summarized in Table 2, these arguments are developed more fully in the next section.

Organizational Type	Structural Dimensions			Degree of Fit	Likelihood of Implementation Success
	Formalization	*Structural Differentiation*	*Decentralization*		
Machine Bureaucracy	High	Medium	Low	High	High
Professional Bureaucracy	Low	High	High	Low	Low
Divisionalized Form	Medium	High	High	Low	Low
Adhocracy	Low	High	High	Low	Low

Table 2: Contingency Fit between ERP Systems and Organization Types

FIT BETWEEN ERP SYSTEMS AND ORGANIZATION TYPES

Machine Bureaucracy. The organizational structure that most closely represents the dimensions of high levels of formalization, low levels of decentralization, and low levels of structural differentiation is the machine bureaucracy. The machine bureaucracy satisfies the criteria of formalization because it is already characterized by high levels of formalization. The machine bureaucracy is relatively centralized because it has limited horizontal decentralization, so it fits the decentralization contingency as well. The machine bureaucracy fits moderately well with structural differentiation. The organizational structure of a machine bureaucracy is only moderately differentiated because there is an emphasis on following formal programs and plans, and integration is effected mainly through these programs (Miller 1986). Still, the functional responsibilities are only brought together at the highest levels of the organization (Mintzberg 1980), so ERP will likely push towards lower levels of structural differentiation, causing moderate but not severe resistance to change.

> *Proposition 1: The organizational structure of machine bureaucracies will have a positive impact on ERP implementation success.*

Professional Bureaucracy. The professional bureaucracy does not fit well with ERP systems. Professional bureaucracies have little formalization and little task interdependence. Moreover, professional bureaucracies have high levels of structural differentiation, because professionals work relatively independent of their colleagues who are more or less free to set their own goals and to structure their work as they see fit. Imposing formalization on a professional bureaucracy would likely draw significant resistance from professionals. In contrast to the utilization of formalized procedures, the standards established by professionals are formalized by their professions, not the organizations for which they are employed (Fredrickson 1986). Increasing interdependence among professionals would also be met with significant resistance. The highly trained professionals demand considerable autonomy in their work (Mintzberg 1979). Professionals not only work relatively freely from other divisions, but also their own colleagues (Mintzberg 1980). Thus, professional bureaucracies are a poor fit with ERP in all dimensions, and those that attempt to implement ERP are likely to encounter significant resistance.

> *Proposition 2: The organizational structure of professional bureaucracies will have a negative impact on ERP implementation success.*

Divisionalized Form. The focus thus far has been on organizational structures at the business level. However, Mintzberg (1980) describes the divisionalized form as more of a superimposition of one structure on others rather than a complete structure unto itself. For this reason, the focus for the analysis of the divisionalized form is structure at the corporate level. The divisions of a divisionalized form generally serve different markets and thus receive relatively little close coordination and a fair amount of autonomy (Mintzberg 1980). However, despite granting a fair amount of autonomy to individual divisions, the head office of a divisionalized form seeks to formalize the behavior of divisions through standardized procedures and methods to improve control over divisions whenever possible (Miller 1986). The result is a moderate level of

formalization. Structural differentiation is high, and the divisional form is relatively decentralized (Hax and Majluf 1981). Increased formalization may be an attractive option to headquarters, but will likely draw fierce resistance from divisional managers who control the divisions. Similarly, decreased structural differentiation and decreased decentralization will not be opposed by headquarters, but will be opposed significantly by the divisional managers. In fact, headquarters is likely to view favorably the opportunity to increase centralization and reduce structural differentiation. A primary task of headquarters is coordinating the goals of the divisions with that of its own (Groves and Loeb 1979; Mintzberg 1980). Moreover, an important problem for headquarters is getting accurate information so that it may make better decisions (Groves and Loeb 1979). Increasing centralization and reducing structural differentiation are attractive ways to accomplish this. However, the resistance by divisional managers combined with the relatively poor fit of ERP with the structural dimensions of divisionalized organizations will make successful implementation difficult in the divisionalized form.

> *Proposition 3: The organizational structure of divisionalized form will have a negative impact on ERP implementation success.*

Adhocracy. The adhocracy is a structure that is not a good fit with ERP. Adhocracies have very little formalization, high structural differentiation, and high decentralization. There is very little formalization of behavior or standardization of work processes in adhocracies. Imposing formalization on an adhocracy would result in significant resistance. Adhocracies have high levels of structural differentiation because people with vastly different goals and time horizons work together (Miller 1986). Reducing this structural differentiation would likely draw significant resistance from members of an adhocracy. Imposing centralization on an adhocracy would also draw significant resistance because the power in an adhocracy is decentralized (Miller 1986).

> *Proposition 4: The organizational structure of adhocracies will have a negative impact on ERP implementation success.*

CONCLUDING REMARKS

In this paper, we have developed a set of propositions about the relationships between the characteristics of ERP systems and dimensions of organizational design based on structural contingency theory using Mintzberg's (1979) ideal structural types of organization. It is suggested that a particular class of information systems, ERP, are a good fit with organizational structures that resemble machine bureaucracies and divisionalized forms that operate in markets that are relatively similar. On the other hand, it is suggested that ERP systems are a poor fit with organizational structures that resemble professional bureaucracies, adhocracies and divisionalized forms that operate in relatively diverse markets. Organizations adopting ERP systems whose structures are a good fit with ERP are likely to have successful implementations that result in good performance. Organizations adopting ERP systems whose structures are a poor fit with the ERP are likely to face organizational resistance to the system and thus increase the chances of unsuccessful implementations.

These findings suggest that organizations implementing ERP without considering the fit with their organizations, the consequences of changing their business processes, and the likelihood that they will face resistance from within may fail to recognize that the system is likely to induce conflicts within their organizations and consequently impose difficulties and even failure in the implementation processes. These findings should be of interest to practitioners. Managers within an organization must be able to determine if the proposed ERP system is a good fit with their organizational structure, or if it may only be a good fit with certain parts of the organization.

Some caution should be used when observing these findings. The proposed relationships between organizational structures and ERP are not yet empirically tested. Empirically testing the proposed relationships will be the focus of our future research, and should add significantly to the validity of the propositions and the proposed model. Also, this paper studied ERP in its pure form and compared it to Mintzberg's structural types in their pure forms. In reality, however, both ERP and Mintzberg's ideal types rarely exist in their pure forms. Mintzberg himself pointed out that actual organizational form may represent multiple combinations of the ideal types (Mintzberg 1979). With this caveat, the proposed relationships between ERP systems and organizational structures still provide insight as to what types of organizations are likely to benefit from ERP, on what scale ERP should be implemented, and how much change and resistance an organization may face from ERP implementation.

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