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Behavioral-Based Model to Investigate ERP Usage

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Abstract

Enterprise resources planning systems (ERP), commercial software packages also known as integrated enterprise computing systems, can be viewed as currently one of the most challenging issues surrounding practitioners and researchers in the IS field. The ERP implementation is characterized by a long-term and complex process with high degree of interdependencies and a mandatory context for its users. Its consequences depend largely on the intensity and nature of its actual usage. This process can be analyzed under a structuration perspective, where the ongoing interaction between ERP and its users shape organizational changes and consequences over time. A synergy was sought combining in a single study the contribution of two distinct streams of thinking: the struturaction theory and the behavioral-based theories. The main objective of this paper is to provide a tool to investigate relevant factors affecting the ERP actual usage in organizations.

Introduction

Enterprise resources planning systems (ERP), commercial software packages also known as integrated enterprise computing systems, can be viewed as currently one of the most challenging issues surrounding practitioners and researchers in the IS field. According to Davenport (1998), this new model of corporate computing has been synonymous with huge risks and rewards. On one hand, it is expected that ERP allow companies to replace their existing information systems (IS), which are often incompatible with one another, with a single, integrated system. On the other hand, these systems are expensive and difficult to implement, often imposing their own logic on a company's strategy and existing culture.

As a relatively recent phenomenon, ERP can be understood as technological innovation. The diffusion of innovation theory deals with underlying processes (actions and choices) by which an adoption/rejection decision is reached. Introduced by Rogers (1983), the developments of the initial theory have been providing tools for assessing the likely rate of diffusion of a new technology and for identifying numerous factors that facilitate or hinder technology adoption and implementation (Fichman, 1992). The diffusion innovation theory is one potential approach that can be

adopted to investigate ERP adoption and implementation. Other lines of research have been used to identify determinants of IS adoption and usage. Examples are the intention-based theories as theory of reasoned action (TRA), the theory of planned behavior (TPB) and the theory of acceptance model (TAM) (Taylor and Todd, 1995); the cognitive social theory (Bandura, 1977); and the social behavior theory (Triandis, 1979). These theoretical models have been criticized, tested, changed and improved over the last couple of decades and the result is that we have a repertory of models with well-known requirements, strengths and weaknesses. We aim take advantage of these cumulative research results, composing an ERP usage model to help a qualitative investigation.

Most of the behavioral-based models mentioned above place the person's *intention* to adopt or use a new technology as a central concern and the context as voluntary and independent use. That it is not the context of ERP. The decision of to adopt an ERP has deep business implications in a broad scope. Its implementation is characterized by a long-term and complex process, with high degree of interdependencies and a mandatory context for its users. While the ERP adoption is a corporate decision, the consequences of ERP implementation depend on its users, and largely on the intensity and nature of its use. This process can be analyzed under a structuration perspective, where the ongoing interaction between ERP and its users shape organizational changes and consequences over time. A synergy may be found combining in a single study the contribution of two distinct streams of thinking: the struturaction theory and the behavioral-based theories. The first has its origins in Giddens (1984), who proposed an integrative meta-theory that recognizes and accommodates both subjective and objective dimensions of social reality. The behavioral-based theories are the set of theories and models previously mentioned that rely exclusively on a objective dimension and quantitative research.

The primary object of this study are not the factors affecting ERP adoption, which is the result of top or corporate decisions, but the factors affecting the ERP actual usage, which depends on users-systems interactions over time. Our purpose is to identify those factors, combining a structuration perspective with a behavioral-based model. The results of the literature review and the framework development are exhibited in the next

sections. First of all, brief review of the most well known theoretical behavioral-based models that have been applied to study IS adoption and IS usage are presented, focusing on its essential elements and differences. Such a review enables to compose the model that will help the investigation of ERP usage. The last block focuses on the application of the resultant model under a structuration approach.

The behavioral theoretical models

In this section, our objective is to produce a brief literature review, describing and evaluating the most important contributions found in the cognitive behavioral literature, in order to collect relevant elements to guide our research. We divided the existing theoretical models in four major groups, joined in function of conceptual foundation similarities: Rogers's innovation diffusion theory; Fishbein and Azjen's TRA and its developments (TAM and TPB models); Triandis' social behavior theory; and Bandura's social cognitive theory. The essential elements as well as the main distinctiveness of each group are emphasized below.

Rogers's innovation diffusion theory

The perspective proposed by Rogers (1983), which decomposes the innovation decision process in five stages, has provided a useful framework for IS researchers to investigate how to improve technology evaluation, adoption and implementation. However, the complex organizational processes that constrain and mold choices have not been taken into account. Introducing an organizational learning perspective, Attewell (1992) suggests that individual insights and skills become embodied in organizational routines, practices and beliefs. To understand such a structuration process is fundamental to develop institutional mechanisms for reducing knowledge barriers and increases the success of adoption and implementation. The context of ERP implementation is a complex process characterized by a mandatory context of adoption and high-level interdependencies across departments and individuals. Analyzing studies that examine organizational adoption of technologies with high user interdependencies and high knowledge burden applying classical diffusion framework, Fichman (1992) concluded that the results were disappointing and suggested the need for more variables related to the organizational context and the need of longitudinal studies using replicated case studies or ethnographic research methods.

Fishbein and Azjen's TRA and its developments (TAM and TPB)

The historical importance of TRA, as proposed by Fishbein and Azjen (1975), was not related to the ideas themselves but largely to its developments. TRA activated an important line of research characterized by an intention-based rationale. The foundations of such a stream of research were provided by conceptual distinctions among beliefs, attitudes, intentions and behaviors (Fishbein and Azjen, 1975). Two extensions of TRA occupy an important place in such a pre-dispositional-based stream of research: TAM and TPB. Both TAM and TPB frameworks propose additional or distinctive elements in order to improve the original model. TPB differs from TRA in its addition of *perceived behavioral control*, a component that takes into account variations across situations and actions through the resources and opportunities available to each potential adopter (Azjen, 1991). TAM is described as a model specifically designed to predict use of an IS (Mathieson, 1991) and to represent the antecedents of system usage (Taylor and Todd, 1995). TAM proposes two IS-related factors, the *perceived ease of use* and the *perceived usefulness* of an IS. Its practical utility is that the two factors above are factors over which a system designer has some degree of control. In consequence, the model provides direction to designers as to where efforts should be focused (Taylor and Todd, 1995).

Triandis' social behavior theory

The theoretical framework proposed by Triandis (1979) is introduced as an attempt to encompass a larger number of relevant variables in a broadest possible context. Accordingly, his model consists of networks of interrelated hypotheses around the constructs of attitude and behavior (Triandis, 1980). Triandis introduces variables related to the environment, which influence each individual's personality, as history, ecology and culture. Considering all these factors, the comprehensiveness of Triandis' framework makes them complex and difficult to operationalize. In our evaluation, the more valuable contribution of such a framework is its broad scope, embracing social and cultural factors commonly forgotten or neglected.

Bandura's social cognitive theory

From the IS research perspective that aims to understand the factors that influence an individual's use of information technology (IT), the Bandura's (1977) contribution was to introduce three inter-related dimensions referred as "triadic reciprocality". He recognizes an important explanatory variable to the behavioral process: self-efficacy. Compeau and Higgins

(1995) discussed the role of self-efficacy in computing behavior, arguing that the individuals' perceptions of his or her abilities to use computers in the accomplishment of a task should affect the individual behaviors when confronted by a new IT. In the context of ERP, keeping in mind its complexity, its higher degree of interdependencies and its mandatory nature, it seems relevant to be aware of the concept of self-efficacy and the means of encouraging it. The four sources of self-efficacy information, as defined by Bandura (1977), merit investigation: guided mastery, behavior modeling, social persuasion and physiological states. Such a factors are related to activities carried out during an IS deployment such as training, support and customization.

The study's underlying premises

First of all, the perspective adopted to investigate the factors influencing the interaction between organizational members and ERP is inspired in Giddens' structuration theory. During the 1990s, IS researchers noticed the emergence of several studies looking for alternative perspectives to investigate IT-organizations interactions. Among them, researchers such as Orlikowski and Robey (1991) and Sahay (1997) have been applying the Giddens' ideas to guide their investigations about how new computerized systems are deployed and institutionalized within organizations. What are the main implications of such a choice? In terms of potentialities, the IT structuration model, as proposed by Orlikowski (1992), takes advantage of two fundamental assumptions. The first is the concept of duality of IT, under which the deployment of new IS is analyzed as both antecedent and consequence of organizational action. The second assumption is the belief that the consequences of IT depend on the context in which they are applied. According to such logic, contradictory findings can be viewed as natural consequences in organizational change, indicating evidence of widely divergent IT consequences (Robey and Boudreau, 1999). In summary, the adoption of Giddens' ideas to study ERP phenomenon means exploring the ongoing interaction that informs the structuration process of ERP deployment; it means embracing each context and its inherent complexity; it means attempting to identify key factors and patterns, the understanding of which can enhance the entire process.

Despite its potential methodological richness, structuration theory is not free of serious limitations. One of the most important is the difficulty of empirically applying the ideas developed by Giddens. According to Barley (1986) and Orlikowski (1992), the difficulty of specifying how institutions and actions are related and evolve over time often leads scholars to analyze both dimensions separately. Addressing this issue, Langley (1999) proposes the temporal bracketing strategy as a direct reference to Giddens' structuration theory's

methodological needs. The temporal bracketing strategy will be described later. For now it is important to stress that such a strategy characterizes a longitudinal research design. The choice of a longitudinal approach meets not only the methodological needs of the structuration approach but also the recommendations found during the literature review on IS behavioral studies. Most of them strongly suggested the need for longitudinal investigations to better understand innovation adoption and systems usage, typical phenomena involving changes over time (Compeau and Higgins, 1995).

The full majority of behavioral-based studies reviewed can be characterized as quantitative, applying causal models, using cross-sectional design and statistical analysis. The result is a repertory of theoretical models empirically tested and improved throughout the last twenty years. Even if findings are often contradictory, the cumulative knowledge about IS adoption and usage cannot be neglected. However, the final explained variance, in all studies revised, rarely surpasses 30%. This is a strong indication that the research strategies being used do not capture most of the factors involved in real situations. Probably, the phenomena being investigated are simply too varied and subtle to be usefully studied with cross-sectional survey methods (Fichman, 1992). Studies of organizational change can be best conducted through extensive participant-observation over a period of time, which is commonly provided by techniques of organizational ethnography (Orlikowski, 1996). These comments suggest that a qualitative strategy will be complementary to previous quantitative strategies in the identification of relevant factors affecting ERP's user behavior.

The behavioral-based model's construction

The first contribution to our framework was the model proposed and tested by Taylor and Todd (1995). The decision to use this model as the point of departure of our model was based on two main reasons. First, Taylor and Todd carried out a careful comparison between TAM and TPB, trying to take advantage of potentialities of both. Second, they proposed a decomposed model, i.e., the monolithic structures were decomposed into multi-dimensional structures, increasing the ability of understanding specific factors that interact and affect IS usage.

Having as point of departure the model proposed by Taylor and Todd (1995), we were concerned with the identification of factors that can potentially constrain or facilitate the complex process of ERP usage in an organization. Giving the qualitative and longitudinal nature of the proposed study, it is expected that the initial set of factors will change during the empirical work, i.e., some factors may be added, others eliminated or

modified. Figure 1 summarizes the factors selected and created (underlined) to compose the research model. Table 1 (annexed) presents each factor, its definition, the measurement that have being applied and suggested by previous researchers and the measurement that we propose, adapted to a qualitative inquiring. The protocol that will guide the semi-structured interviews will be available if required but is by now in development.

Figure 1 - ERP Usage Model
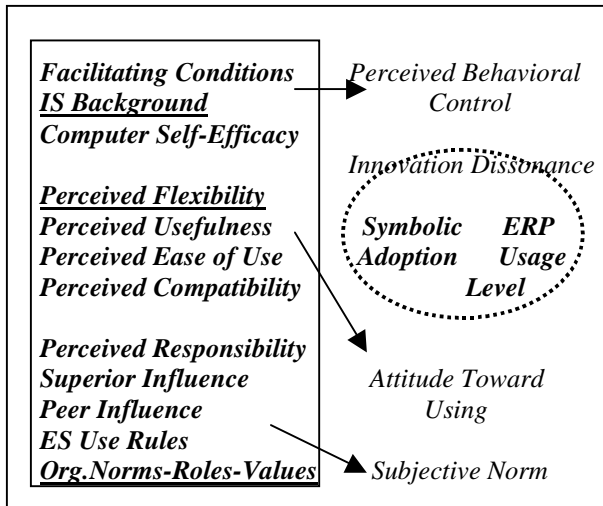
Some remarks are important to support the construction of our model. First of all, all measurements suggested by the literature review were quantitative. Our study is of qualitative nature. In consequence, quantitative scales were used as the source of the content of the qualitative semi-structure interviews. The adaptation of quantitative scales into qualitative questions revealed itself to be risky and difficult task. We found some guidelines in Glesne (1999) and Berg (1997).

The second point is related to the utility of this model to our research. The reader could ask: why construct a model based in a stream of research marked by a quantitative approach to apply to a study of qualitative nature? What is the validity of such an effort if the exploratory nature of a qualitative study is exactly to explore factors affecting a given phenomenon over time? Our objective is not to test a model, but to use a model to assist our investigation. Instead of arriving in the field without any previous model, we will arrive with a model based on intensive previous research, and which will help us in the evaluation of the role of each factor in a specific context as well in the identification of other factors that can influence the levels of ERP usage.

ERP usage level and symbolic adoption

Rawstorne' et al. (1998) embrace purposely the problem of mandatory environments, arguing that *a measure of user intention is inappropriate*, because the adoption of a

new system is independent of the intention in such a condition. As alternative, they suggest the concept of symbolic adoption to distinguish adoption in two parts: *symbolic adoption* and *actual adoption*. Rawstorne et al. (1998) will be used as point of departure to integrate symbolic adoption into the semi-structured interview. Identifying differences in *symbolic adoption* is likely to help predict initial resistance or lack of acceptance to new technologies. In consequence, an analysis of levels of *ERP usage* in relation to *symbolic adoption* can be an interesting alternative in investigating the use of new technologies. These concepts require further literature review to allow a more precise conceptual definition.

Innovation Dissonance

The term *innovation dissonance* was borrowed from Rogers to refer to a situation in which symbolic adoption is at odds with actual adoption. In a mandatory adoption environment, a potential end-user may have little desire to utilize the new IS (low symbolic adoption) but is forced to comply, through implicit or explicit rewards or punishments (Rawstorne et al., 1998). When a person is experiencing dissonance, they are inclined to relieve their discomfort by changing either their behavior or their cognition. Analyzing the actual usage of an ERP over time, one can observe and distinguish which factors are more relevant to decreasing innovation dissonance.

Perceived Flexibility

The *perceived flexibility* is a new factor, initially defined as the degree to which its users perceive the new system or the context surrounding the new system as changeable. It is the result of the combination of the ideas of refraction and re-invention discussed by Rogers (1983), and that of interpretive flexibility discussed by Orlikowski (1992). When adoption is compulsory, what can vary from one user to another is not the behavior of adoption or not, but the degree of use in terms of intensity and quality. In such a process, the degree to which an innovation can be changed or modified by a user seems be important. Re-invention can reflect the degree of flexibility in the process of an adoption an innovation and may reduce mistakes and encourage customizations of the innovation to more appropriately conform to local and/or changing conditions. As a result of re-invention, the same innovation may be decided on by individuals and organizations with a wide variety of different needs, problems and situations. These differences shape the actual innovation that is implemented, even though it may still be called by the same name as the mainline innovation while also departing from the original models in several important aspects. Refraction is the degree to which an innovation or the context of the innovation is changed when it is introduced into a new setting or situation (Rogers, 1983).

The same technology is appropriated in diverse ways and comes to have different meanings and effects for different users. According to Orlikowski (1992), what is critical in discriminating between more or less rigid technologies is the capacity of users to control their interaction with the technology and its characteristics. The interpretive flexibility is an attribute of the relationship between humans and technology and hence is influenced by characteristics of the technology, the agents and the organizational context. In summary, we included the factor *perceived flexibility* as potentially one of the most important in a context of ERP usage. However, as a new concept, it requires a further literature review in order to be defined more precisely.

Combining the behavioral-based model with a structuration approach

In this section, we focus on the use of the resulting model from a structuration approach. Giddens' structuration theory has been used in numerous recent studies of the interaction between IT and organizations (Boczkowski, 1999; Sahay, 1997). The mutual shaping framework provided by such a stream of research offers a powerful analytical tool for investigations on new systems adoption. Viewed from the perspective of an innovation adoption, the deployment of ERP requires some consideration: the context of ERP adoption is compulsory; the degree of interdependencies is high; the implementation process is complex. The process is costly and characterized by mutual customizations: both, system and organization must be adapted to match ERP operational requirements. Facing such a multifaceted object of study, we adopted a perspective that takes advantage of two potentially complementary perspectives. On one hand, to profit from years of research efforts using behavioral-based models, characterized as quantitative nature, which have applied causal models, cross-sectional design and statistical analysis to predict and explain the IS usage behavior, we characterize the result of this cumulative effort as a consistent repertory of theoretical models empirically tested and improved over the last twenty years. However, even the promoters of these streams of research admit their research strategies do not encompass most of the factors involved in real situations and that a qualitative strategy will be complementary to previous quantitative strategies in the identification of relevant factors affecting user behavior when facing a new system.

From our point of view, the structuration approach is one of the most promising emergent perspectives in IS. Regarding the complex and mutable character of IT innovations, its interaction with organizations can be analyzed from a structuration approach, which states that any structuration process can only be observed over time and in terms of their effects. The study of context is

viewed as inherent in investigations of social phenomena and involves the time-space dimension and the co-presence of actors, among others (Giddens, 1984).

The structuration approach

Two main premises characterize the structurational model of technology as proposed by Orlikowski (1992): (a) the duality of technology and (b) the interpretive flexibility of technology. The first relies on the assumption that agency and structure are not independent. Human actions are enabled and constrained by structures, which can be the IS implemented in organizations; but such IS are a result of previous choices and actions of its users. In this ongoing interaction, agents change the technology - physically or interpretively - each time they use it. The second premise is the interpretive flexibility of technology. The same technology is appropriated in diverse ways and comes to have different meanings and effects for different users. What is critical is discriminating between more or less rigid technologies is the capacity of users to control their interaction with the technology and its characteristics (Orlikowski, 1992). That point is a serious concern regarding ERP implementations. The greater temporal and spatial difference between the construction of a technology and its application, the greater the likelihood that the technology will be interpreted and used with little flexibility. ERP are an example of system not built internally. Rather, they are acquired from other organizations - with varied degrees of customizability. The institutional conditions and human agents involved in technology development are different from those involved in technology use. What are the consequences of such a temporal and spatial diachronic?
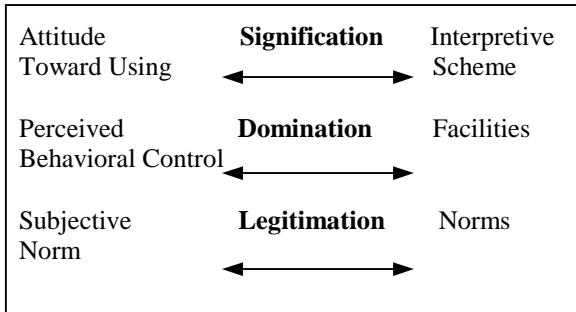
The structuration framework proposed by Orlikowski and Robey (1991) directs attention to the process though which a developed technology is deployed, objectified and institutionalized within organizations and the conditions within which human action reinforces or changes the form and functioning of an institutionalized technology. Organizational changes may occur gradually, through incremental patterns of use or nonuse of designed systems features. Modifications of original features may become institutionalized and sanctioned as proper patterns or use. The structuration perspective draws special attention to contextual and historical factors involved in the interaction.

The ERP usage model over time

In order to design a longitudinal research that embraces the structuration perspective, we adopted a temporal bracketing strategy as proposed by Langley (1999) and Barley and Pamela (1997). We started by observing the initial organizational context, paying attention to how the

introduction of a new technology, in this case ES, affects the pattern of interaction among organizational members and how these patterns evolve. Identifying the moment when the change took place becomes the point of departure for the structuration process. The data gathered about the process are analyzed and compared across successive periods. The periods are the units of analysis for replicating the emerging theory, which permit a compelling understanding of the role of technology in the evolution of structure.

Figure 2 - IS Usage categories matching Giddens's modalities

Attitude Toward Using	**Signification** ←→	Interpretive Scheme
Perceived Behavioral Control	**Domination** ←→	Facilities
Subjective Norm	**Legitimation** ←→	Norms

Examining the adequacy of the temporal bracketing strategy in the present study, we perceived an interesting fit or match between the three broad categories recognized in the ERP usage model (*perceived behavioral control, attitude toward using and subjective norm*) and Giddens' modalities in structuration theory (*facilities, interpretive scheme and norms*) (Figure 2). Such a conjunction was unexpected a priori and means an increase in the potential power of the use of a behavioral-based model as a guide in the enterprise of identifying the factors affecting ERP usage under a structuration approach.

Conclusions

This paper had two initial objectives: to combine in a single framework contributions of two distinct streams of thought: the struturaction theory and the behavioral-based theories; and to provide an ERP usage model as a tool for the investigation about relevant factors affecting the actual ERP usage in organizations. In order to carry out such an enterprise, some well-known theoretical behavioral-based models that have been applied to study IS adoption and IS usage were presented and the criteria applied to construct the ERP usage model were described. The result is a twofold synergy. On one hand, the research design as a temporal bracketing strategy, which meets the premises stated by structuration theory as well as responds to a need in the behavioral theories for the study of IS adoption and usage over time. On the other hand, we identified an unexpected synergy between two apparent antagonistic streams of research, Giddens' meta-theory and the behavioral-based theories.

This paper is not free of some limitations. Based on distinct underlying assumptions, risks were taken where converting quantitative measures into qualitative ones and applying an originally causal-deterministic model in a structuration approach. Looking for factors specific to the ERP context being investigated, new factors as perceived flexibility are still in development, which require further literature review and exploratory investigation.

Acknowledgements

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Annex 1

Factors and Sources	Definition
ES usage level (Davis et al., 1989; Taylor and Todd, 1995)	The actual level of ES usage.
Symbolic adoption (Rawstorne et al., 1998)	Mental or cognitive acceptance of an idea (ES usage)
Perceived behavioral control (Ajzen, 1991; Davis et al., 1989; Taylor and Todd, 1995)	The perceived ease or difficulty of performing the behavior (ES usage)
Computer self-efficacy (Compeau and Higins,1995; Bandura, 1977)	Judgment of one's capability to use a computer, more specifically, to use the ES.
Facilitating conditions (Paré and Elam, 1995; Bergeron and Higgins, 1995; Taylor and Todd, 1995; Triandis, 1980)	Objective factors, out there in the environment that several observes can agree make an act easy to do (Es usage).
IS background (Triandis 1980; Jasperson et al., 1998; Fishbein and Ajzen, 1975) (** New Factor **)	The previous experience and the knowledge about computerized systems in general and ES in particular.
Attitude toward using (Ajzen , 1991; Davis et al., 1989; Taylor and Todd, 1995)	The degree to which a person has a favorable or unfavorable evaluation or appraisal of a given behavior (ES usage).
Perceived usefulness (Taylor and Todd, 1995; Davis et al., 1989)	The prospective user's subjective probability that using ES will increase job performance (in-context).
Perceived ease of use (Taylor and Todd. 1995; Davis et al., 1989)	The degree to which the prospective user expects ES to be free of effort.
Perceived compatibility (Taylor and Todd, 1995; Davis et al., 1989; Rogers, 1983)	The degree to which ES fits with the users' existing values, previous experience and current needs.
Perceived flexibility (Rogers, 1983; Orlikowski, 1992) (** New Factor **)	The degree to which ES or the context of ES is perceived as changeable by its users.
Subjective norm (Ajzen, 1991; Davis et al., 1989; Taylor and Todd, 1995)	The perceived social and personal pressure to perform or not perform the behavior (ES usage).
Superior influence (Taylor and Todd, 1995; Ajzen, 1991)	The likehood that superior approve or disapprove the performance of ES usage.
Peers influence (Taylor and Todd, 1995; Ajzen, 1991)	The likehood that peers approve or disapprove the performance of ES usage.
Perceived responsibility (Ajzen, 1991)	The feelings of moral obligation or responsibility to use ES.
Organizational norms, roles and values (Triandis, 1980) (** New Factor **)	Organizational characteristics way of viewing the human-made part of the environment, composed of norms, roles and values.
ES use rules (Fichman, 1992)	The set of rules guiding ES use and its interaction with organizational routines.