USING INFORMATION SYSTEMS TO STRATEGIC DECISION: AN ANALYSIS OF THE VALUES ADDED UNDER EXECUTIVE'S PERSPECTIVE

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Abstract

The impact of the Decision Support Systems (DSS) on the organizational intelligence and structure and on the strategic decisions was examined in the paper. Nowadays there is an increasing demand for investments on Information Technology (IT) due to the higher complexity of this field in the global market. Nevertheless, measurement of that perception, especially for the Brazilian reality, is little known. This study aims to analyze the relation between the use of DSS by executives of highest organization levels and their perceptions of the quality of information delivered, decision making speed, enhancements in organization learning and strategic management, and differences in involvement with subordinates. The theoretical model proposed by Leidner, Elam and Corrales (1995) and Leidner and Elam (1999), the main theoretical foundation of the paper, was adapted to the Brazilian reality and extended. We conducted a survey with executives of the 1200 biggest companies in Brazil, evaluating the executives' perceptions. The main results of the paper confirmed past studies and added new dimensions to the benefits provided by the use of information systems, such as the organization learning principles and the strategic planning process. The paper contributes to the theoretical development of information systems and decision-making fields and with organization management, providing knowledge to support the evaluation of the values created by using Information Systems (IS).

Keywords: Decision Support Systems; Executive Information Systems; Business Intelligence; Analysis and Decision Making

1 Introduction

Technology has always aroused feelings that the current existing problems would be solved quicker and more effectively in the near future. In particular, the increasing demand for greater organizational efficiency and competitiveness in the global business requires a structuring of the planning process and decision making in strategic levels, so that it can provide quick and adequate responses to changing markets and competition. Thus, the sustainable competitive advantage in an organization is strongly related to anticipatory and interpretive capacity of the decision maker to develop the formulation and implementation of company strategies.

It has been perceived that intuition, feeling and common sense are not enough to guarantee organizational decision-making efficiency. Exploratory studies show that higher performance firms have more efficient data analysis, which is associated with less reliance on subjective unstructured judgments (Davenport and Harris, 2007; Klatt et al., 2011, Lavalle, 2011). These data-driven decisions guide important developments of Information Systems (IS) initiatives in many industries. To this end, leaders and managers seek to design and implement Information Systems (IS) and controls that support the decision-making process and ensure more efficient business strategies. Thus, several authors have advocated investments on ISs as an important approach for companies seeking competitive advantage (Brown. 1995; Rackoff and Wiaeman, 1985; Segars and Grover, 1999; Popovič a et al., 2012; Chen, 2012; Öykü Işika, 2013, Sharma, 2014; Peters, 2016). These systems support the process of decision-making at the operational, tactical and strategic levels (Simon, 1997). Researchers have adopted different approaches to assess the contributions of ISs in gaining competitiveness. Rackoff and Wiaeman (1985) present a methodology relating investments on IS to different strategies of cost reduction, differentiation, innovation, growth and strategic alliance. A different approach was proposed by Segars and Grover (1998), who claim that the quantification of ISs benefits cannot be reduced to financial measures, such as return on investments and internal rates of return. The measurement should also incorporate intangibles contributing to the decision-making processes, such as ability to identify problems and new business opportunities, and ability to generate new ideas and to adapt to unexpected changes.

Like every other organization initiative, in general, IT implementation also takes time to realize their full potential to create real increments in innovation processes (Roberts, 2016). Any evaluation of IT benefits must recognize this time-lagged aspect and asses benefit over a temporal horizon of analysis (Devaraj, 2002), even mitigating economic inefficiencies in the business dynamics (Sanches and Albertin, 2009). Therefore, it is necessary to specify a rigorous method to measure the business value created by IS implementation. Some frameworks consider the specificity of contexts of IS use by designing performance measurements for these IT-intensive systems (Delone and Mclean, 1992; 2003; Elbashira, 2008; Sanches, 2009).

Marchand et al. (2001) study some capabilities that influence the information use in companies. He believes that the use is more effective if the company can link capabilities: people behavior and values for the decision-making process, information management practices and information technology practices. According to this perspective, Leidner et al. (1995) and Leidner and Elam (1999) linked the use of ISs by executives with gains in decision making speed, improvements in problem identification, and the advancement of analytical capacity of users, characteristics that contribute to the strengthening of cognitive models and learning of executives.

Following the intangible aspects that contributes to IS' progress, Öykü Işıka (2013) studies the relationship between some specific IS capabilities and its successfulness. The results pointed to an insightful picture of the factors influencing the IS successfulness, showing that some capabilities' effects were also moderated by the decision environment characteristics of the organization. Similarly, Petter, DeLone, and McLean (2013) identified variables possibly influencing IS successfulness. These variables were: user expectations, extrinsic motivation, organizational role, user involvement, domain expert knowledge, management processes, and organizational competence.

Although results of previous studies demonstrate the benefits of ISs to improve the performance of companies, these systems very often do not meet the needs of individuals who require the information (Crockett, 1992; Watson and Frolick, 1993). The complexity of the systems, the time required by decision-makers for their use and the high cost of implementation often deter the system to provide effective results (Gorry and Morton, 1989). Furthermore, even analyzing more revolutionary IS, recent researches pointed out that there is no evidence that ISs can promote cost reduction (Kwon and Lee, 2014; Hazen and Boone, 2014). Many costly and complex initiatives undertaken to implement these IS technology have experienced high rates of failure (Foshay, 2015; Kwon and Lee, 2014). However, there is no clear presentation of how these failures are measured. Failure is then defined by the absence of proven success (Schlaefke and Silvi, 2013), rather than more tangible factors. In this sense, the studies of models to access the maturity of the business analysis capacity in organizations (Foshay, 2015) to validate the effectiveness of information management practices (Kettinger and Marchand, 2011), and to relate business analysis to decision making (Schlaefke and Silvi, 2013) have become even more frequent and relevant.

In fact, most people have mixed perceptions of the contribution of IT for the decision-making process (Devaraj, 2002; Petter, 2008; Popovič a et al., 2012; Sharma, 2014), finding decisions on infrastructure investments difficult to implement because they often do not know what they are receiving or what business capabilities will be provided and how it will lower costs or facilitate new business development (Marchand et al., 2000). Analysts believe that efficient decision-making process gathers information differently, depending on their orientation and cognitive style (Lee and Chem, 1997, Rai and Bajwa, 1997; Fetzner and Freitas, 2011). Enhancing the idea that the IT practices themselves do not result in higher organization performance (Marchand, Kettinger and Rollins, 2001), although these many systems that support decision making and information management are applied globally, their benefits are perceived differently, as a consequence of these multiple perspectives, orientations and styles. Therefore, the constant dissociation between the information generated and demanded in the various organizational levels can be explained by the different characteristics of the decisions to be taken and the diversity of individuals responsible for them.

In this sense, the objective of this paper is to present an analysis of the extent to which senior leaders of Brazilian organizations realize that the use of the Systems Decision Support (DSS) contributes to the process of making the involvement of subordinates in decision-making process more effective and to ameliorate the strategic planning and organizational learning processes. To this end, the article is divided in 4 sections, besides this introduction. Next section presents the theoretical foundation and hypotheses of the paper. Third section describes the methodology and the following section presents the results. Finally, last section concludes the paper.

2 Theoretical Background and Hypothesis

The study aims to relate the greater or lesser use of DSS by senior executives with the perceived benefits for the intelligence and organizational structure and strategic decisions in the Brazilian largest firms. Organizational intelligence would be the result of the organization effort to acquire process and interpret internal and external information (Porter, 1980). It refers to the ability of a corporation as a whole to gather information,

innovate, create knowledge and act effectively based on the knowledge it has generated. Thus, an organization needs quality information availability that can be used for strengthening and sharing mental models that best enable it to make strategic decisions, directions and planning in order to keep a virtuous learning cycle.

Gains in efficiency of decision-making process in relation to their subordinates, and in strengthening the mental model of managing were reported by Leidner et al. (1995) and Leidner and Elam (1999). A general discussion of the theory presented by these authors concerning the ISs as tools to support strategic decisions and organizational aspects that influence the greater or lesser use of these systems, known as the Leidner theoretical model, is presented in sections below.

2.1 Information systems for policy making

The study aims to relate the greater or lesser use of DSS by senior executives with the perceived benefits for the intelligence and organizational structure and strategic decisions in the Brazilian largest firms. Organizational intelligence would be the result of the organization effort to acquire process and interpret internal and external information (Porter, 1980). It refers to the ability of a corporation as a whole to gather information, innovate, create knowledge and act effectively based on the knowledge it has generated. Thus, an organization needs quality information availability that can be used for strengthening and sharing mental models that best enable it to make strategic decisions, directions and planning in order to keep a virtuous learning cycle.

The term "DSS" first appeared in the text of Gorry and Scott Morton (1989), who built a framework for improving the ISs using Anthony's category (1965), and activity management, and the taxonomy of types of decisions proposed by Simon (1960). Anthony (1965) developed a model that divides the management activity in three categories: operational control, management control and strategic planning. The crossing of this study with Simon's view (1960) on structured, semi-structured and unstructured knowledge generates a rich framework of analysis of the extent of ISs interaction in supporting decision-making (Anthony, 1965). Figure 1 (Appendix) shows the result of the contribution.

According to Anthony (1965), decisions occur at three levels in the organization. Understanding them contributes to the adhesion of an IS applied to the process of decision making in an organization. The first level consists of strategic decisions as setting the company positioning in the market, when the objectives and goals, success factors and external threats are scaled from the information pool and processed. The second level, the management control, is the implementation of these decisions, representing a tactical level, involving the use of information technologies for development of activities of collection, analysis and synthesis of information. And the third, represented by a more operational decision level, involves the integration between the various areas of the organization, requiring more detailed information in order to monitor the firms 'activities. Notice from the details of figure 1, that these levels are further divided by types of structured, semi-structured and unstructured activities

Besides the three classical levels of company division defined by Anthony (1965), Laudon and Laudon (1996), an additional layer is included between the operational and tactical/management levels called the level of expertise (knowledge level). At this level, there are engineers, lawyers, scientists, analysts, and marketing, finance and controlling officers, whose work is the creation of new information and knowledge, by creating systems of knowledge and information: knowledge work systems (KWS), office automation systems (OAS) and office information systems (ISO). These systems are shown in figure 2 (Appendix).

Laudon and Laudon (1996) call Transactional Processing Systems (TPS) the systems that meet operational needs. The TPSs are linked to transactions and day-to-day support to the company business. Systems are highly structured and are represented by existing Enterprise Resource Planning (ERP).

At the tactical level, in which operational activities are monitored and controlled, there is the Management Information Systems (MIS). The MIS provides summaries of operational transactions carried out in TPSs, allowing managers to monitor their progress and compare their performance against established standards.

At the strategic level, decisions are less structured and related to the positioning of the organization when facing changes in their environment and associated with the planning of the internal consequences of this positioning. Information systems that support managers and directors in this hierarchical level are known as Executive Support Systems (ESS) (Laudon and Laudon, 1996).

Thus, the DSS are classified according to the hierarchical level at which decisions are made (Laudon and Laudon, 2006). The focus of this study is the DSS at the top of the organizational pyramid, that is, the systems for decision support aimed at managers and directors.

2.2 Decision Support Systems (DSS): concept and history

Decision-making is the process of choosing a course of action over another, looking for appropriate solutions for the new problems that arise in a changing world (Cyert, Simon and Trow, 1956; Simon, 1965). Decisions are made in internal and external situations of a particular business with a certain level of experience and

skill, in a particular culture or organizational structure and in a particular set of technologies.

Management Information System (MIS), the first system to support management decision, emerged in late 1960's. MIS was used to generate a limited range of predefined reports, including reports of economic results, balance sheets and sales. However, the role of information support to decision-making was not substantially implemented yet. This system was superseded in 1970 by the information system called the Executive Information System (EIS), which is under the umbrella of the Executive Support System (ESS), and provided assistance for specific tasks of decision-making (Watson, 1991). The EISs were classified by many researchers as DSSs (Van Den Hoven, 1996; Petrini and Pozzebon, 2004; Arnott and Pervan, 2005; 2008; 2012), and are enterprise reporting and analysis systems.

The promise of information support to decision-making, first attempted in information systems management in the 60 and 70's, have been gradually successful. The big bet was made in the 90s, after the introduction of decentralized computing, the personal computer (PC), with the arrival of new databases. Among them, the Business Intelligence (BI) tool aims to manage relevant information in order to make the decision-making process more efficient and agile for business leaders (Petrini and Pozzebon, 2004; Petters, 2016). The role of information systems in business has been expanding since the 60s and includes more than the strategic support. Some researchers consider that IS covers managerial and strategic decisions, supporting senior professionals under this umbrella (Arnott and Pervan, 2012).

BI is a set of methodologies, processes, architectures, and technologies that transform raw data into meaningful and useful information (Lönnqvist and Pirttimäki, 2006; Turban, 2009), acquiring, analyzing and disseminating information relevant to business activities. Thus, BI is a comprehensive strategy that supports reporting, analysis and decision making these actions operational and strategic in organizations (Hannula and Pirttimaki, 2003; Sharma, 2011; Popovič a et al., 2012), providing a consolidated review of data and reports in a suitable format that helps users to make wiser decisions. Consequently, it improves the firm competitiveness (Chou and Bindu, 2005), making decision-making more efficient, increasing productivity (Rainer and Watson, 1995; Vries, 2004) and saving costs of distributing information (Bajwa et al., 1998).

The definition of DSS used in this study approaches the concept of Arnott and Pervan (2005) and Leidner et al. (1995). Arnott and Pervan (2005), broadly define DSS as the area of "information systems", which focuses on supporting and improving management decision-making. This definition of DSS, ESS and EIS includes the Online Analytical Processing (OLAP), Data Warehouse (DW), BI and more lately the Big Data Analytics (BDA), as recent researches has pointed out that the future of the DSS is somehow related to Big Data Analytics. Chen (2012) and Loebbeck and Picot (2015) consider that Big Data Analytics is an evolution of BI, because it amplifies the BI scope. Under that perspective, BI would not only focus on integration and communication of structured and semi-structured data inside enterprise databases. It would also try to retrieve value from treating unstructured data, which constitute 95% of Big Data Analytics applications (Gandomi and Hairder, 2015). Moreover, some researchers identified DSS types that are separated by technology, theoretical foundations, user types, and decision tasks (Arnott and Pervan, 2008; 2012).

The DSS defined by Leidner et al. (1995) is a computer system that includes most, but not necessarily all, of the following: a single database, in which internal financial data and operational and external data can be found; a friendly interface with the end user, with the ability to generate trends; analytical reports highlighting the critical information to executives and the capacity to obtain data from multiple sources.

Even if all these components of the DSS mentioned by Leidner et al. (1995) and Arnott and Pervan (2005) are present in information systems, companies are presented in different stages of evolution, and might not be able to fully implement all of them. In this vein, the literature presents some models that address the maturation process of ISs in organizations (Mcgee and Prusak, 1994; Choo, 2003; Hatcher e Prentice, 2004; Kettinger and Marchand et al., 2011). With the objective of better categorizing the levels of development of DSS in organizations, we used the model of developmental stages of IS proposed by Hatcher and Prentice (2004).

The maturity model proposed by these authors enables an organization to objectively evaluate the use of information resources in five levels: operations, consolidation, integration, optimization and innovation. At the operational level, the company emphasizes the activities required to support the day-to-day operations and the decisions are made in a chaotic information environment, which is internally competitive, with scarce evaluation criteria and lack of consistent performances. At the consolidation level, the company has combined information in a database for functional or departmental decision-making, but there is little information control from the perspective of the organization, as there is no automatic integration and access to data. At the intermediate level, integration, there is recognition of the importance of data and consistent information for the achievement of the firm goals. The result is that information is widely accepted as an essential tool for success and competitive advantage. At the optimization level, the company begins to look for ways to maximize performance to

meet market demands. They seek to ensure constant alignment of the information system with the market and to quickly optimize the entire business process and value creation. On the last level, innovation, the company starts to realize that it is achieving decreasing returns of its optimization efforts and technology investments. It recognizes the need to leverage their knowledge by introducing innovative and differentiated products and services.

Recently the Kettinger and Marchand's (2011) model also defines levels or stages of maturity (detection or perception, collection, organization, processing and maintenance) for the use of information in decision-making. However, the stage of greater maturity does not foresee increases in the process of organizational innovation, as in Hatcher and Prentice Model (2004). Davenport and Harris (2007) developed a similar model presenting the following stages or levels of maturity: structure, singularity, research, access and governance.

This study considered that a company had an implemented DSS if it could be classified in the integrated levels of consolidation, integration, optimization or innovation (Hatcher & Prentice, 2004). Only those in the level of operation, which involves activities with very little systematic operational use of information, were not considered in this study. Thus, Brazilian companies were classified according to these categories with the intention to standardize the inferences originating from results.

2.3 The use of DSS and organizational intelligence

Information-oriented companies tend to better understand the value of integrity in the formal use of information (Marchand et al., 2001). Integrity in terms of shared values – honesty, candour, and openness – where people trust the formal information sources inside the company. According to Marchand (2001), the information orientation of a company can be strengthened with the interaction between people's behavior and values, information management practices and information technology practices. Thus, this information orientation constitutes the key link to business performance, which is related with the ability of taking successful decisions. Based on this model, companies with higher information orientation will excel in business performance.

Leidner et al. (1995) and Leidner and Elam (1999) studied the benefits of the use of DSS and identified the effect of this use in the organization intelligence. The authors proposed that the strengthening of the executive's mental model increased by the information availability and enhanced analytical power, will promote improvements in the effectiveness of problems identification and choice making. As a result, the use of information systems for decision-making, both frequency and time in use, would have impacts on organizational intelligence.

More broadly, the impacts on organizational intelligence can be seen through the availability of quality information, strengthening and sharing of mental models and virtuous learning cycles generated in the organization.

2.4 Aspects of the availability of quality information

The intrinsic characteristics of IS influence its use if there is a relationship with level of difficulty in the use of information. A relationship of pleasure or annoyance in searching necessary data for decision-making or a relationship of freedom and constraint in how these relationships are established also influence IS use. Therefore, the characteristics of information systems influence their usability in different perspectives. Although the understanding of this fact is almost intuitive, the measurement of this influence or its direction is problematic (Pozzebon, Freitas and Petrini, 1999). This is because the cause-effect relationships that involve the use of ISs and their resulting benefits perceived may be tied to a very large number of factors, since these may influence the behavior of their users, changing its application in the work place.

Studies on the effectiveness of ISs suggest a positive relationship between perceived quality of information and their use (Auer and Reponen, 1997, Burton, 2001; Chenhall and Moris, 1986; Delone and Mclean, 1992; 2003; Khalil and Elkordy, 2005; Petter , 2008). The quality is also intimately linked with the potential value it can create. Poor data can directly affect negatively in business decisions and thus promote tangible and intangible loss to firms (Hazen and Boone, 2014; Isasi , 2015). The quality is assessed on the following criteria: intrinsic (accuracy and reliability), context (relevance, timeliness, and completeness), representativeness (consistency, ease of interpretation, conciseness) and accessibility (access, security). Moreover, Leidner et al. (1995) and Leidner and Elam (1999) show that users tend to spend more time in ISs that reduce the uncertainty of decisions (Burton, 2001).

2.5 Increases in the process of organizational learning

Increases in the process of organizational learning can create knowledge and act effectively in organizational intelligence. Recent evidence indicates that DSS can enhance executive's mental models (Leidner et al., 1995; Vandenbosh and Higgins, 1995, Rai and Bajwa, 1997; Elbashira, 2008) And Lead To Faster Decisions (Leidner et al., 1995). It is believed that the effectiveness of management decisions is largely dependent on the quality of their mental models (Van Den Hoven, 1996). Thus, by improving the understanding of executives through better mental models, the use of IS may lead to better responses to problems. Leidner et al. (1995) and Leidner and Elam (1999) reported that increasing the

extent of the analysis based on the use of DSS can increase the mental models of executives.

Both individual style and organization idiosyncrasies may be related to different responses regarding the use of information systems for decision-making. Thus, the greater or lesser use of ISs may be a reflection of different approaches of making decisions. What stands out is the ability to learn from the process of decision making, whether individually or organizationally. Therefore, learning has become a new and critical concept in the development of strategies for IS (Senge, 1994; Stein and Vandenbosh, 1996; Audy, 2000; Petters, 2016).

Additionally, the ISs promote greater information and communication flow between organizational units and individuals contributing to the learning process (Balasubramanian, 1995; Argote and Miron-Spektor, 2011). In that way, this process is facilitated by supporting the acquisition of knowledge, distribution and interpretation of information and of organizational memory. There are aspects of organizational learning that benefit from the use of ISs: sharing and distributing information, and better management of knowledge (Balasubramanian, 1995, Stein and Vandenbosh, 1996; Petters, 2016).

2.6 Increases in the strategic planning process

Based on learning principles, it is believed that the availability of multiple information in real time basis and in different forms supplied by the DSS can speed decision making, by the acceleration of problems or opportunities identification (Leidner et al., 1995). However, the perceived improvement in the performance of the decision-making process may increase the time spent in IS searching for more founded analytical decision (Sharda and Barr, 1988; Popovič et al., 2012). Additionally, it is argued that the easiness of data manipulation can provide more extensive analysis.

Relying on a larger distribution and ability to interpret information acquired by the ISs, the strategic planning process of an organization can be strengthened by greater use of IS. Strategic planning is undertaken in organizations to reduce uncertainty, to coordinate efforts to establish dialogue and communication lines, and to pro-actively seek for business opportunities in a competitive area (Lederer and Burky, 1988; Sharma, 2014). Strategic decisions allow the company to develop and pursue their goals in more effective ways, better considering its relations with the environment in which it operates (Ansoff, 1990). The set of decisions to be conducted determines the behavior in a given time and defines the strategic planning for the period (Simon, 1965). In an organizational decision arena, information is influenced by both external and internal business and by their different organizational levels (Mintzberg, 1976). Therefore, ISs that support the decision-making process will directly affect the process and the generation of the company strategic planning, contributing to the company development in a constantly changing environment.

2.7 The use of DSS and the organizational structure

The size and heterogeneity of decision-making units and the frequency and duration of meetings vary according to Huber (1991), and technologies that support decisions may affect this. As a result, the centralization of decision-making and the number of organizational levels involved may also be affected by the use of ISs. For that reason, the use of DSS in various decision levels can restructure the organizational structure. In the long term, the DSS can lead to the elimination of staffing levels (Bajwa et al., 1998) and innovation in administrative tasks in the organization (Elbashira, 2008; Roberts, 2016).

Although executives enjoy considerable independence, they rely heavily on their subordinates to report their problems and provide them with recommendations to solve problems (Blankenship and Miles, apud Leidner et al., 1995). According to Leidner et al. (1995) and Leidner and Elam (1999), there are indications that the use of DSSs possibly diminishes the role played by subordinates in these tasks because of greater availability of information outside the realm of the relationship between executives and subordinates.

Because of this, the use of DSS is expected to influence the organizational structure as it changes the process of decision making in the various organizational levels, the dependency on subordinates and, consequently, the information flow throughout the organization.

3 Methodology

We applied a survey as instrument to obtain primary and specific data collection in order to test the hypotheses described in the previous section. With the method, we sought empirical validation of the model proposed by Leidner et al. (1995) and Leidner and Elam (1999). We used the same conceptual framework of these researchers, expanding it when possible. Figure 3 illustrates the research model and its assumptions.

The use of the proposed method aims to address how the organizational intelligence (availability of information, strengthening of the mental model, an increase of the learning process and strategic planning), the organizational decision-making (speed of decision-making and extension of the analysis) and the organizational structure (involvement with subordinates in decisions) correlate with the DSS use. Thus, the question arises about the relationship between the independent, “frequency of use” and “time in use”, and the dependent variables (organizational intelligence, organizational decision-making and organizational structure).

In applying the Leidner model to the Brazilian case, the research had a confirmatory nature, since the hypothetical model is pre-specified and the new variables, learning process and strategic planning were not tested, given that they represent extensions of the model. The extension of the model, which added these two new variables, had explanatory nature.

Thus, the study measures the extent to which the use of DSSs influences organizational intelligence, considering the strategic planning and learning, decision making and involvement with subordinates in the largest companies based in Brazil. It is expected that the greater the use of DSS, the more significant these impacts are perceived by executives. Therefore, organizations would, in a sense, be more effective due to the implementation of DSS.

3.1 Variables

Independent Variables

The term "usage frequency" of DSS considers not only the direct use of the system by the executive but also the use of information by the subordinates. The frequency with which this information system is accessed to support the process of decision-making is measured by this variable. It starts from the assumption that the use of ISs depends on the user's belief in the benefits and quality of information provided (Burton, 2001; Giovinazzo, 2009; Popoviča et al. et al., 2012; Öykü Işika , 2013). Even at the individual level, the use of DSS may have organizational consequences and, thus, affects organizational decision-making.

The "time in use" of DSS is related to the period the system is already available for use in the company. We consider the time frame in which the executive is using the system: if the tool is new and has been recently implemented or if it is already known by users and is being improved. Huber (1991) states that when users of advanced information systems reported that the use is leading to higher levels of effectiveness in the fulfillment of organizational objectives, such use tends to increase. As a result, the effects of long-term use are also as important as the frequency of use. Leidner et al. (1995) and Leidner and Elam (1999) emphasize that, over time, executives may develop optimal ways of using the DSS, requiring, consequently, less frequent use than when they started using these tools.

Dependent Variables

The variable of organizational intelligence is related to the use of DSS in many aspects, such as increased awareness of information availability, a more developed mental model and the enlargement of the processes of strategic planning and learning of the organization. The last two variables were not studied by Leidner et al. (1995) and Leidner and Elam (1999) and, as mentioned, represent additions to the model.

The increase of speed in decision-making and the extension of issue analysis are dependent variables that represent the organizational decision-making process by using DSS. The level of use of such systems affects the monitoring and operation of internal and external environments of the organization so that the rapid detection or identification of potential problems can accelerate counter reactions from the company.

The involvement with subordinates is defined by the frequency the analysis and evaluation of business issues are conducted in conjunction with subordinates and the intensity of interactions between executives and subordinates. Traditionally, decision makers rely on subordinates or depend on them for acquiring a better knowledge of problems. Leidner et al. (1995) and Leidner and Elam (1999) state that there are indications in the literature that the use of systems can reduce the role of subordinates in decision-making. Huber (1991) suggests that access to information can change the units of decision if the role of subordinates in decision-making process changes. This could change the decision-making levels of the organization, as believed by Bajwa et al. (1998). In the long run, the ISs can eliminate levels in organizations. The operationalization of the variables exposed in this section is summarized in Table 1, which describes the assumptions of the application of the model illustrated in figure 3 (Appendix).

The higher is the DSS usage frequency by executives	*The longer is the time in of DSS by executives*
the larger the increments in the learning process	the larger the increments in the learning process
the larger the increments in the planning process	the larger the increments in the planning process
the greater is the perception of information availability	the greater is the perception of information availability
the larger the increments in mental model	the larger the increments in mental model
the faster is the decision making	the faster is the decision making
the greater is the extension of issues analysis	the greater is the extension of issues analysis
the greater is the involvement with subordinates	the greater is the involvement with subordinates

Table I. *Hypotheses of the Model.*
Source*: Adapted from Leidner and Elam (1999).*

3.2 Sampling procedures and administration of questionnaires

The questionnaire was pre-selected in a similar manner than those used by Leidner et al. (1995) and Leidner and Elam (1999). These authors applied the questionnaires to American, Swedes and Mexicans executives. It was adapted to the Brazilian reality concerning aspects of the strategic planning process and organizational learning.

The use of structured interviews prior to the application of the survey was important to increase the reliability and adequacy of the instrument. The test of the questionnaire was initially administered to selected executives with similar characteristics than the target population.

After that stage, the actual questionnaire was set in three parts. Instructions for completing the questionnaire and contact phone number were provided in a letter of invitation. The first part of the questionnaire contained the DSS definition. It was important to familiarize the respondent to the research topic and to explain the concept of DSS considered. The second part contained questions regarding the categorization of the respondent and the company, which could identify the profile of the respondent, such as age, education and job issues, and could describe the company in points, such as the level of IT investment as a percentage of revenue and the intensity of competition in the business environment in which the company operated. The last question in this part classified the DSS of the company based on the Hatcher and Prentice model (2004) discussed previously. If the company did not have a formal system of decision support, the respondent was asked to ignore the other questions, which correspond to the third part of the questionnaire. In this third part, there were questions related to the benefits perceived with the use of DSS. Seeking a better apprehension of the characteristics of the phenomena being measured, the second and third parts of the questionnaire were composed mainly by multiple-choice questions or by a Likert scale. The biggest benefit of the Likert scale is to measure graduated degrees of agreement or disagreement to a set of statements (Lakatos and Marconi, 2006).

The universe of this research included the 1,200 largest companies operating in Brazil, taken from the records of Dun & Bradstreet (2006). Executives e-mail addresses were supplemented by a customer relationship database of Fundação Dom Cabral. The universe of larger companies was selected because, potentially, they are more likely to acquire ISs for their management.

The questionnaire was then made available to such companies by e-mail to 1071 executives of this universe. Due to the high turnover of executives, 688 e-mails actually reached the recipient successfully. The administration of the questionnaires was conducted by e-mail and the receiving feedback was accompanied by phone calls. This procedure was also adopted in order to encourage the return of responses. Ninety-seven out of 688 firms that received questionnaires returned them completed, corresponding to the research sample.

The results were analyzed using a series of recognized statistical tools, including testing of hypotheses, parametric and nonparametric significance (Conover, 1999; Norušis, 2003), and multivariate techniques, such as factor analysis (Hair, 2005), canonical correlation (Mingoti, 2007) and cluster analysis (Hair, 2005).

4 Analysis and Results

Only 97 out of the 688 companies returned the questionnaire. However, because aspects such as the distribution of net revenue, sector of economic activity and geographical region did not show statistically significant differences between the sample and population, indicating that the sample was representative.

Among the respondents, 82% were directors, presidents and vice-presidents and 18% senior managers. 70% were between 40 and 60 years-old, and more than 50% hold a graduate degree. Regarding IT spending within surveyed companies, 49% of the respondents spend approximately 2% of net revenues in IT. This follows Mitra (1996) study, where he found that larger companies spent more on IT as a percentage of their sales than smaller companies.

81% of respondents reported using a DSS. The remaining did not have DSS, but only rudimentary information systems. Out of the 79 respondents who had DSS, 54 completed all the questions in the questionnaire and this is the data used to test the hypotheses of the model. Among these 54 respondents, 61% said they always used the DSS and 30% used frequently, showing that a significant portion of Brazilian organizations implemented systems for management support. Most respondents had DSS for over five years (43%). Another 23% of companies had DSS between four and five years.

This research aims to expand the theoretical model proposed by Leidner et al. (1995) and by Leidner and Elam (1999) adapting it to the Brazilian reality, evaluating the relationship of the use of DSSs with increases in decision-making, intelligence and organizational structure.

4.1 Application of the Leidner model for Brazil

The extraction method used in the model variables was the principal component analysis, and the rotation method applied was the varimax normalization with Kaizer. Thus, as discussed by Mingoti (2007), the fit of the factor analysis model can be judged by KMO criteria and Bartlett's tests, which showed that the data is suitable for factor analysis. Using varimax rotation, as suggested by Mingoti (2005), and using as a means of determining the number of factors the criteria proposed by Hair Jr. (2005a), 5 factors were extracted, each with an Eigenvalue above one. The five factors explained 70% of the total variance.

The factors are presented in table 2. The composition of the factors considered only loads greater than 0.65 to increase the power of the results (Hair, 2005). Cronbach's alpha was used to access the internal reliability of the scale items. All reliability values for the

variables were above 0.69, which is considered acceptable (Nunally, 1967, apud Leinder and Elam, 1999).

The model variables found for the Brazilian case are very similar to those presented by Leidner et al. (1995) and Leidner and Elam (1999), which shows its high degree of reproducibility. Due to the similarity in the generation of factors, the names given by these authors to the new variables were retained.

N	*Factor*	*Conbach's Alfa*	*Load Factor*
1	*Mental Model*	*0.814*	
L6	Better understanding of the projections		0.745
L7	Best view of the problems / opportunities		0.69
L4	Clearer perception of the process		0.679
2	*Information Availability*	*0.696*	
L1	Accessibility		0.788
L2	Availability		0.759
L3	Importance of the Information Content		0.672
3	*Extension of analysis*	*0.719*	
L8	Increased alternatives decision		0.887
L9	Diversification of sources of information		0.737
4	*Decision making speed*	*0.882*	
L12	Reduction of the time of decision making		0.887
L11	Speed in decision making		0.861
5	*Involvement with subordinates*	*0.691*	
L15	Need for assistance in the subject		0.831
L16	Confidence in the subordinate		0.759

Rotation converged in 20 iterations. KMO = 0.724. Test Bartlett's sphericity = 638 with follow p <0.001.

Table 2 - *Load factors and reliability test for the Brazilian case.*

Following the guidelines of Leidner et al. (1995) and Leidner and Elam (1999), the mean values of the variables related to each factor were estimated, and they were the dependent variable of the model. The normality of the five variables of the model presented was tested and no data require correction, as occurred with Leidner et al. (1995) and Leidner and Elam (1999).

Although all these factors are perceived benefits for Brazilian executives of the existence of DSS, its relation to the use is still unknown, as discussed in the hypotheses. In order to establish this association, the canonical correlation was applied between the independent variables of use and the five dependent variables. The validation of the results was performed by two criteria: level of significance of the role and magnitude of the correlation. Pillar's, Hotelling's, Wilks' and Roy's significance level tests were applied, indicating that the correlation model is appropriate.

As shown in table 3 (Appendix), the result of canonical correlation shows that the increase in the frequency of use is correlated with increased perception of information availability, enhanced mental models and the speed of strategic decision making, since the obtained positive coefficients were significant. However, the result of canonical correlation for the variable time in use of ISs does not show significance to any variable of the model. Figure 4 summarizes these results of the Model when applied in Brazil.

4.2 Expansion of the Leidner model for Brazil

Factor analysis was first applied separately for the theoretical variables that were not included in Leidner et al. (1995) and/or in Leidner and Elam (1999) to test two new possibilities of theoretical dimensions. The KMO test and Bartlett test showed that the data was suitable for factor analysis. Thus, using the same procedure of factor analysis described above, we obtained two factors. Cronbach's alpha was above 0.7, which shows high internal reliability of the scale. Table 4 shows that the factors detected confirm the dimensions theoretically constructed with eight variables with loads greater than 0.65.

The composition of each of these factors increased the theoretical dimensions of the DSS influence in the decision-making process because it grouped the factors as expected. Thus, the nominations given to the new dimensions could be maintained: increases in the strategic planning process and in the learning process.

Finally, the 12 variables with factor loading greater than 0.65 in the analysis presented in table 2 in Appendix and the eight additional variables of table 4, which also showed load values greater than 0.65, were evaluated together. The result of factor analysis appears in table 5.

	Factor	*Conbach's Alfa*	*Fatorial load*
1	*Increase in the strategic planning process*	*0.831*	
	Reduction of unexpected situations		0.809
	Reduction of potential problems		0.802
	Identification of non-predicted problems		0.753
	Perceptions of factors affecting outcome		0.727
	Implementation planning		0.675
2	*Increase in the learning process*	*0.791*	
	Increased collaboration		0.826
	Increased commitment		0.808
	Support to the development of individual competences		0.808

Rotation converged in 9 iterations. KMO = 0.724. Test Bartlett's sphericity = 638 with .p < = 0.001.

Table 4 - *Load factors and reliability test for the variables added.*

The criteria for fitting the model, as previously stated, were again satisfactory, even though the number of variables was above the recommended, because as suggested by King (1997) and Hair Jr. et al. (1990), the number of observations must be at least five times the number of variables. Thus, this analysis should be done with at least 100 observations. However, according to the authors, this technique can be used in smaller samples, provided that the sample has no less than 50 observations.

The analysis of table 5 points out that the factor previously called mental model was incorporated in two new factors, the increments in the learning process and increases in the strategic planning process. These two components not directly addressed in Leidner et al. (1995) and in Leidner and Elam model (1999) could explain 47% of total data variability. Thus, we defined a new set of factors that measure the benefits perceived by Brazilian executives using DSS. The factors availability of information, extension of analysis and speed of decision-making remained, as the model suggested by Leidner et al. (1995) and Leidner and Elam (1999).

	Factor	*Conbach's Alfa*	*Fatorial load*
1	*Increase in Learning Process*	*0.8*	
L9	Increased source of information		0.806
Y27	Increased commitment		0.784
Y28	Support to the development of individual competences		0.727
Y24	Increased collaboration		0.651
2	*Increase in the Strategic Planning process*	*0.775*	
Y18	Implementation Planning		0.784
Y19	Identification of non-predicted problems		0.755
Y21	Perceptions of factors affecting outcome		0.712
Y20	Reduction of unexpected situations		0.673
3	*Speed of Decision Making*	*0.882*	
L12	Reduction of time making the decision		0.892
L11	Speed in decision making		0.843
4	*Information Availability*	*0.694*	
L2	Availability		0.745
L3	Importance of Information Content		0.726
5	*Involvement with subordinates*	*0.688*	
L15	Need for assistance in the subject		0.858
L16	Confidence in the subordinate		0.696
6	Extension of analysis	0.78	
8	Increase in alternatives decisions		0.78

Rotation converged in 3 iterations. KMO = 0.727. Test Bartlett's sphericity = 204 with p < = 0.001

Table 5 - *Rotated factor matrix of model variables*

The canonical correlation analysis was applied in conjunction, having these six factors as dependent variables and the same two variables, frequency and time of use of DSS, as explanatory. The goal is to determine which of the six dependent variables were significantly correlated with the use of DSSs. However, Pillar's, Hotelling's, Wilks' and Roy's level of significance found for the model was below the value considered satisfactory, indicating that the data was inadequate. Because of that, one of the variables of the model, the time in use of DSS, which was not significant

in the previous analysis, was not considered in the application of the technique in this last study. Additionally, dropping this variable from the model reduced the number of variables, benefiting the ratio number of variables versus the sample size, as recommended.

The results for this analysis considering only the independent variable named frequency of use, showed acceptable level of significance for the tests described above. As shown in table 6 in Appendix, the results of canonical correlation show that the increase in frequency of use is positively correlated with increased perception of the learning process and strategic management, information availability and the extension of analysis. Figure 5 summarizes these figures (Appendix).

5 Conclusion

The results of the model proposed by Leidner et al. (1995) and Leidner and Elam (1999) applied to Brazilian companies suggest that only the frequency of use is positively associated with the mental model, the availability of information and the extension of analysis. The strengthening of the mental model accounted for 40% of total variance explained by the five factors. This may indicate that Brazilian leaders realize that a better understanding of problems can influence their mental models. The availability of information, also considered important, explained 15% of total data variance. The other three factors, extension of analysis, speed of decision-making and involvement with the subordinates, together explained less than 9% of the total variance. The variable named involvement with the subordinates had the smallest power to explain total variance, as found by Leidner et al. (1995) and Leidner and Elam (1999).

The findings of this research and those of Leidner et al. (1995) and Leidner and Elam (1999) are compared in Table 7, contrasting the Brazilian scenario to the Swedish, American and Mexican scenarios. The positive correlations are represented by "YES" and the hypotheses with correlation without statistical significance are expressed by "NO".

We observed many difference between Brazil and the other countries, with greater similarity between Brazil and Mexico. The organizational behavior includes decision and communication styles and cultural issues, implicating in different perceptions of the benefits DSS use. Additionally, some of the criteria for perceived quality of information such as availability, reliability and relevance of content can be more or less relevant according to environmental uncertainty and organizational characteristics of the company (Bajwa et al., 1998; Weill and Oslon, 1989; Elbashira et al., 2008). The time in variable used in Brazil, as well as in Mexico, showed no significant association with the measured benefits.

The higher is the DSS usage frequency by executives	*BR*	*USA*	*SWE*	*MEX*
the greater is the perception of information availability	YES	YES	NO	YES
the larger the increments in mental models	YES	YES	YES	NO
the greater is the extension of issues analysis	YES	YES	YES	YES
the faster is the decision making	NO	YES	NO	YES
the greater is the involvement with subordinates	NO	YES	YES	NO
The longer is the time in use of DSS by executives	*BR*	*USA*	*SWE*	*MEX*
the greater is the perception of information availability	NO	NO	YES	NO
the largest the increments in mental models	NO	YES	YES	NO
the greater is the extension of issues analysis	NO	YES	NO	NO
the faster is the decision making	NO	YES	NO	NO
the greater is the involvement with subordinates	NO	NO	YES	NO

Table 7 - *Comparison of results with the model proposed by Leidner in different countries.*
Source: *Adapted from Leidner and Elam (1999).*

In the extension of the Leidner model proposed here and summarized below in table 8, the significant relationship found between frequency DSS use and the learning process may have been influenced by the increased importance of teamwork. The cultural aspect of collectivism, characteristic of Brazil, could also contribute to this finding. The association between frequency of use and the increase in the strategic planning process can be related to the need to anticipate future scenarios. The positive correlations with these two variables (organizational learning and strategic planning) were considered the most important by executives, as they account for 47% of the total variance among the six factors. It is believed that the strengthening of the mental model is directly related to the learning process (Senge, 1994), which may explain why the mental model variables have become less relevant when we include the new variables in the model. Thus, hypotheses empirically verified were: the larger the increments in the learning process, the greater is the perception of information availability and greater the extension of analysis. Conversely, for the hypotheses

associated with time in use variable we did not observe any significant result.

The higher is the DSS usage frequency by executives	*Results for Extended Model*
the larger is the increase in learning process	YES
the larger is the increments in the Strategic Planning process	YES
the faster is the Decision Making	NO
the greater is the perception of information availability	YES
the greater is the involvement with subordinates	NO
the greater is the extension of issues analysis	YES
The longer is the time of DSS by executives	*Results for Extended Model*
the larger is the increase in learning process	NO
the larger are the increments in the Strategic Planning process	NO
the faster is the Decision Making	NO
the greater is the perception of information availability	NO
the greater is the involvement with subordinates	NO
the greater is the extension of issues analysis	NO

Table 8: *Results with the extended model applied for Brazil.* Source: *Adapted from Leidner and Elam (1999).*

The use of systems for decision support has also been related to cognitive styles of managers. The cognitive style can be seen as a set of consistent and differentiated strategies that progress gradually to the processing of specialized information and learning environments (Vries, 2004). Although many tools to support information management are globally applied, the derived benefits from the use of DSS can be differently perceived. Cultural differences or cognitive skills that may influence these perceptions have not been considered in this study; however, it is a venue for future research.

Notes

(1) The acronym ERP - Enterprise Resource Planning - is the information system established by the evolution of MRP - Material Requirements Planning, now the MRPII - Manufacturing Resources Planning and arrived on Enterprise Resource Planning - ERP (Stair and Reynolds, 2002).

(2) "Mental models are considerations deeply rooted, widespread, or even pictures and images that influence the understanding we have of the world and how we act" (Senge, 1994, p. 8).

(3) "Cognitive style refers to the process behavior that individuals exhibit in the development or acquisition, analysis or interpretation of information or the expected value of data for decision making" (Huber, 1983, p.567)

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Appendix

Figure 1

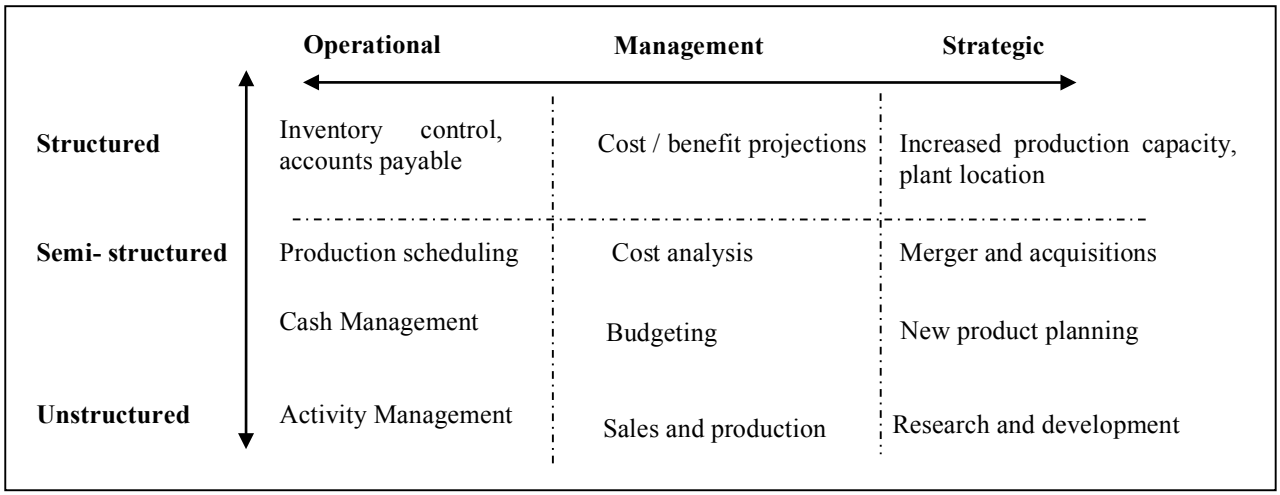

Figure 1. *Information Systems diagram*

Source: *Gorry and Scott Morton (1989).*

Figure 2

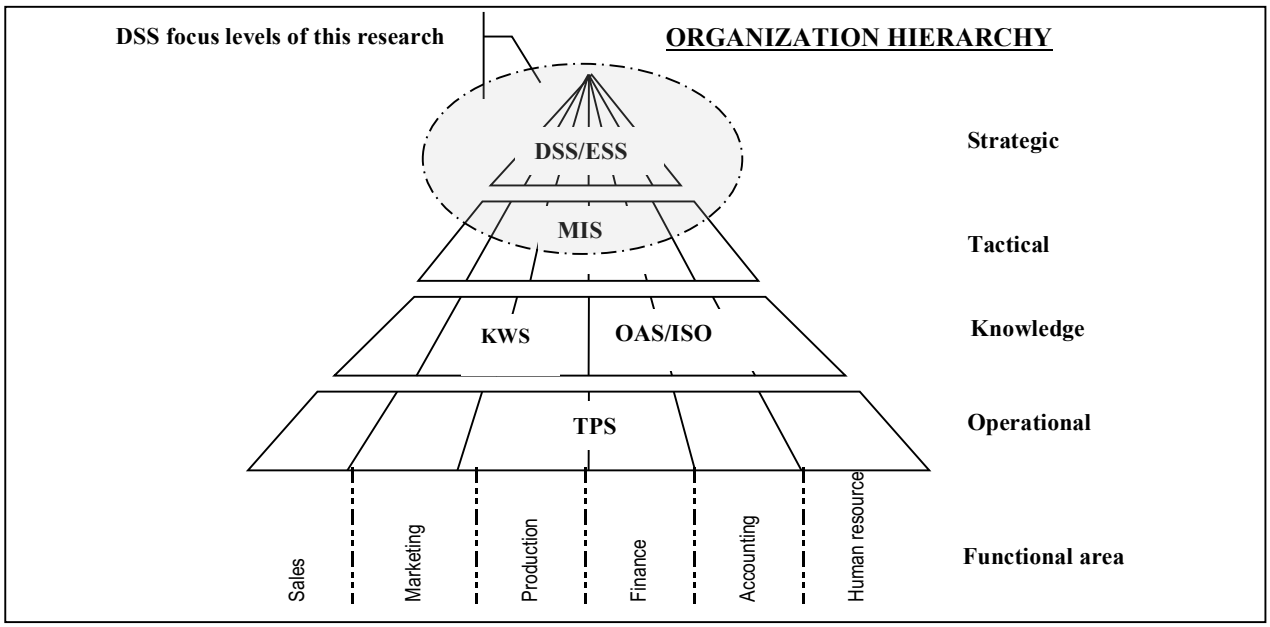

Figure 2. *IS distribution throughout the hierarchy levels of the company.*

Source*: Adapted from Laudon and Laudon (1996).*

Appendix

Figure 3

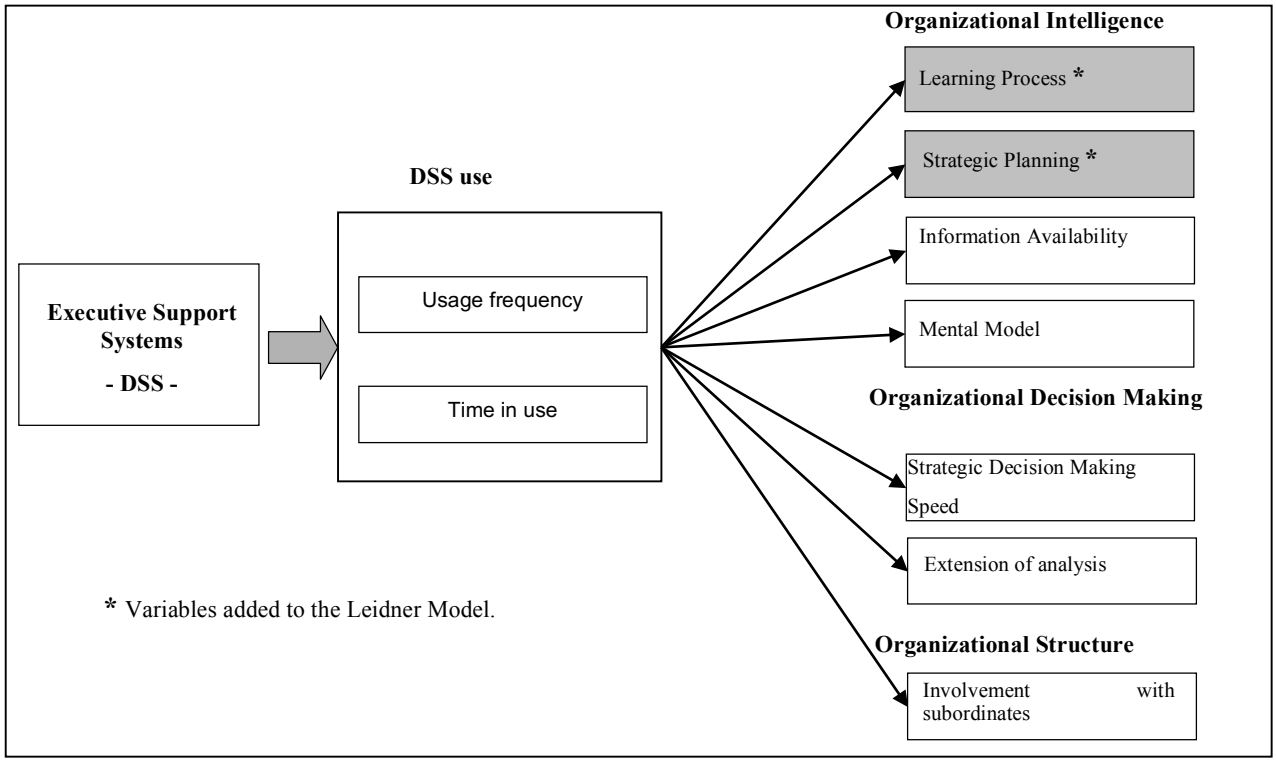

Figure 3. *Research hypotheses*

Source*: Adapted by the authors, from Leidner and Elam (1999)*

Figure 4

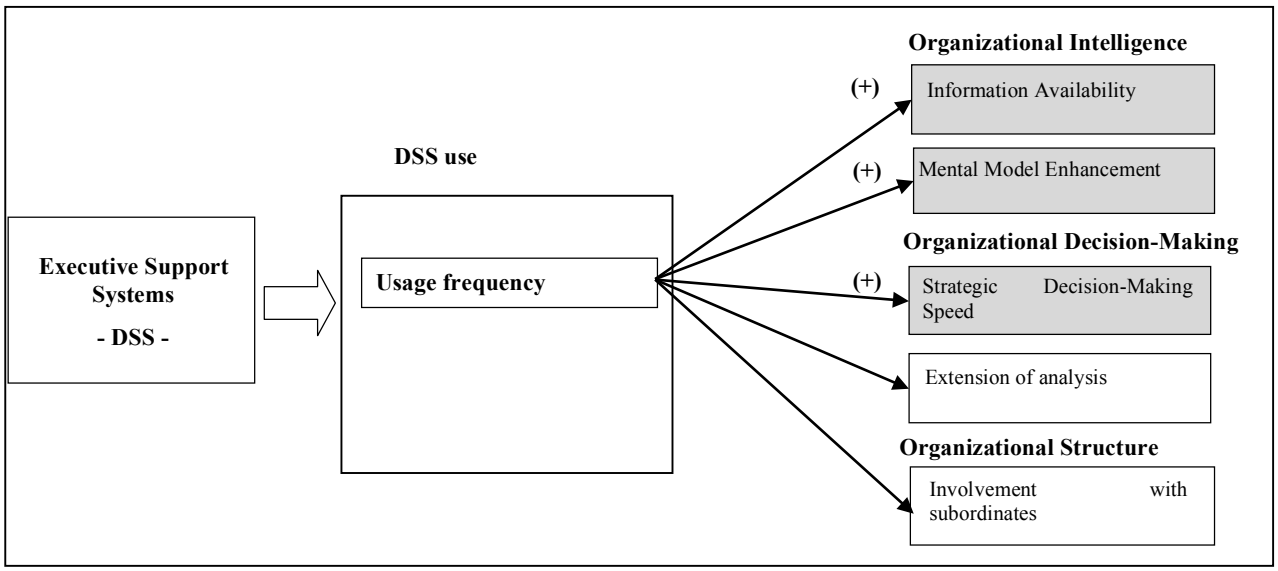

Figure 4. *Results of the Model applied for Brazil*

Source*: Adapted by the authors, from Leidner and Elam (1990)*

Appendix

Figure 5

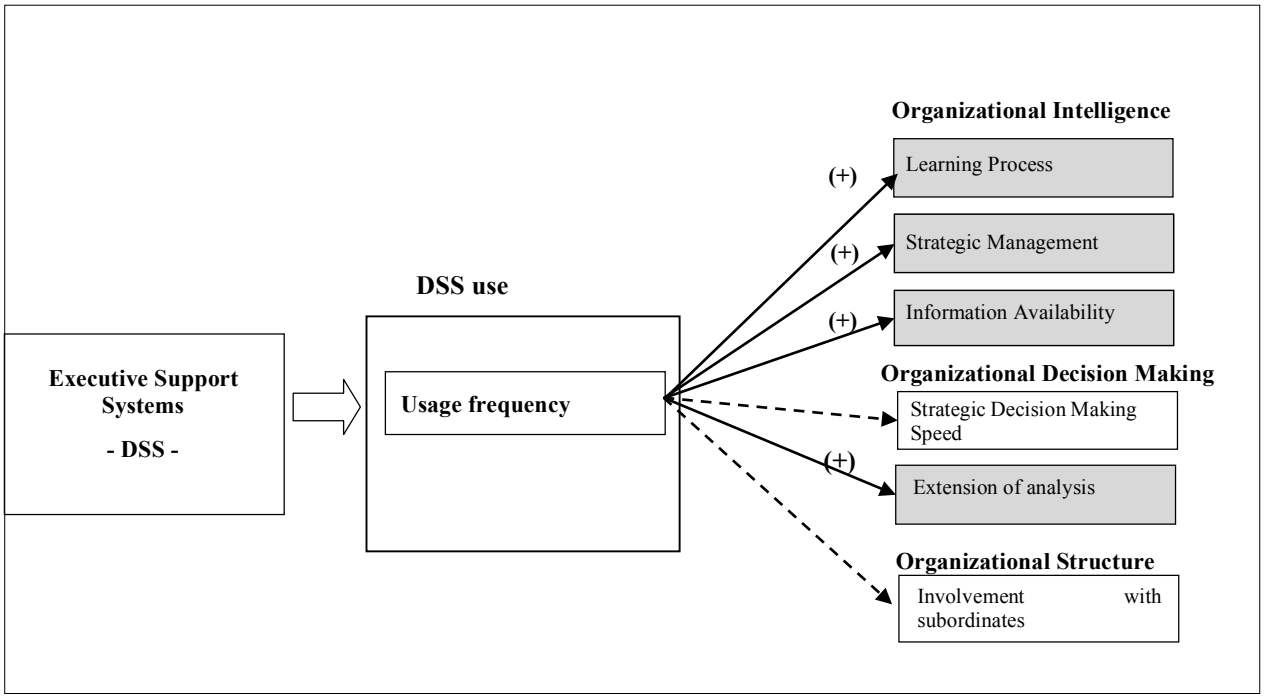

Figure 5. *Results of the model expanded in Brazil*

Source*: Adapted by the authors, from Leidner and Elam (1999)*

Appendix

Table 3

N	*Factor*	*Beta*	*Std.Err.*	*t-Value*	*Sig. of t*
1	*Mental Model*				
	x1 - Usage frequency	*0.373*	0.107	2.829	*0.007*
	x2 - Time in use (years)	-0.104	0.073	-0.789	0.434
2	*Information Availability*				
	x1 - Usage frequency	*0.446*	0.093	3.493	*0.001*
	x2 - Time in use (years)	0.125	0.064	0.981	0.331
3	*Extension of analysis*				
	x1 - Usage frequency	*0.302*	0.141	2.207	*0.032*
	x2 - Time in use (years)	0.006	0.097	0.042	0.967
4	*Decision Making Speed*				
	x1 - Usage frequency	0.223	0.123	1.592	0.118
	x2 - Time in use (years)	0.026	0.084	0.188	0.852
5	*Involvement with subordinates*				
	x1 - Usage frequency	0.005	0.17	0.035	0.973
	x2 - Time in use (years)	-0.080	0.116	-0.563	0.576

In *italics* are the correlations with statistical significance.

Table 3. *Canonical correlation of the factors for the Brazilian case*

Table 6

N	*Factor*	*Beta*	*Std.Err*	*t-Value*	*Sig. of t*
1	*Increase in Learning Process*				
	X1-Usage frequency	*0,290*	0,121	2,145	*0,037*
2	*Increase in the Strategic Planning process*				
	x1 - Usage frequency	*0,395*	0,118	3,038	*0,004*
3	*Speed of Decision Making*				
	x1 - Usage frequency	0,212	0,122	1,536	0,131
4	*Information Availability*				
	x1 - Usage frequency	*0,330*	0,097	2,475	*0,017*
5	*Involvement with subordinates*				
	x1-Usage frequency	0,030	0,167	0,212	0,833
6	*Extension of analysis*				
	x1 - Usage frequency	*0,257*	0,134	1,878	*0,066*

In *italics* are the correlations with statistical significance.

Table 6. *Canonical correlation of the factors for the Brazilian case, when extending Leidner Model*