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Otavio Sanchez  
*FGV - EAESP*

Alberto Albertin  
*Fundação Getulio Vargas - EAESP*

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# Proposition of an Economic Theory Based Model (MAITEF) to Guide to Effective Firm-Level Information Systems Investments Decisions

**Otavio Sanchez**  
FGV - EAESP  
otavio@fgvsp.br

**Alberto Luiz Albertin**  
FGV - EAESP  
[albertin@fgvsp.br](mailto:albertin@fgvsp.br)

## ABSTRACT

The discussion about the effectivity of Information Systems (IS) investments often leads to the central question about the possibility of accurately measuring the business benefits of the IS implementations.

Instead of identifying what kind of benefits are measurable and what are not, this work proposes a model (MAITEF) to reveal ex-ante effective IS investment opportunities at the firm level, based on the managerial economics theory, and grounded on the simple thesis that applying IS at the firm level, to solve economic preexistent inefficiencies, automatically will lead to effective results on those investments.

By applying the MATIEF, it is possible to improve the decision process by enhancing the perception of value, since it helps the identification of the business situations where the inefficiencies can be observed and so IS application is desired. The study also presents the main results of the model's pre-test performed to provide an example of its potential.

## Keywords

IS payoff; Managerial Economics theory based model; business value of IS; MAITEF.

## AN OVERVIEW OF THE MANAGERIAL ECONOMICS FIRM MODEL

Several works have been done by authors that ground the analysis of the business use of Information Systems (IS) upon economic theories. However, the extent of its coverage has remained somewhat limited to the analysis of specific aspects, such as, for example, the behavior of economic actors and their decisions in goods pricing dynamics over on-line relationship systems (Bakos, 1997); the issues related to actors arrangements in value-chains (Malone, Yates and Benjamin, 1987; Teece, 1992; Bailey, 1997; Chircu and Kauffman, 1999; Evans and Wurster, 2000; Sanchez, 2001), or the analysis of the productivity paradox of the use of IS, bearing in mind the macroeconomic relevance of its effects (Brynjolfsson, 1993; Brynjolfsson and Hitt, 2002; López and Nanclares, 2002).

There are also many authors that use the cost-benefit analysis to build an ex-ante evaluation of IS in firms. These works consider the existence of the intangibility in an expressive part of the benefits (Remenyi, Money, Sherwood-Smith and Irani, 2000). Because of the nature of the intangible benefits, the analysis is conducted based on the perception of benefits value. Although the cost-benefit analysis is widely applicable, some aspects may interfere in the capacity of the analysts to properly perceive the ex-ante benefits. Having a proper perception of these benefits value is, in fact, the key point for succeeding in using this method.

We could say that the effective use of IS also depends on the correct perception of the benefits value. Business situations where economic inefficiencies preexist would have more potential benefits to be obtained since the IS could contribute to reduce those economic inefficiencies. Economic theory defines that where economic allocation inefficiencies are present, by reducing that inefficiency, some value will be liberated.

Our intent is to build a comprehensive economic model of the firm decisions to describe and analyze the issues involved in the use of IS combined with other resources, and map the determinants of effectivity in the use of IS in business dynamics. Thinking in managerial economics theory terms, since business are relationships performed by economic agents that include the firm itself, our first job is to put all the variables involved in this relationship together, some firm internal-oriented and some external-oriented. The external-oriented variables include all the aspects involved in the economic agent's dynamics in the relationship with customers, environment and partners. The internal-oriented variables are considered to manage a vision of the effectiveness issues, once it is a benefit captured into the firm boundaries.

A high-level view of these variables is shown in figure 1. Note that “performance” is here shown as a result of the strategic actions of the firm in allocating the core available resources and capabilities, including IS, in a effective manner to fulfill the requirements of customers, benefiting from appropriate relationship with partners and maintaining the overall risk level acceptable.



Figure 1. High-level firm model (presented by authors)

### Complementary Resources and Capabilities

Edith Penrose established, in the 1950s, the vision of firms based on resources. Her arguments consist in to see firms as collections of certain productive resources, the tangible assets, and other, intangible, resources. (Penrose, 1955; Penrose, 1997). The term resource stands for anything that can be qualified as a given firm’s strength or weakness, such as: human capital, production capacity, professional experience, or skill in the use of IS. A resource is a natural barrier against the entry of competitors, which means that its absence can render a firm vulnerable to competition.

The application of IS at firms can be understood as a resource interacting with other resources in the organization (such as human capital, which can range from highly specialized professionals to users unfamiliar with IS applications) or as capabilities inasmuch as it can redefine value-creating business processes. Therefore, IS can be better described as a widely applicable technology whose main contribution lies in enabling new methods and processes when combined with other complementary investments such as new work systems, organizational restructurings or redesigned processes (Malone and Rockart, 1991; Milgrom and Roberts, 1992; Albertin, 2002; Brynjolfsson and Hitt, 2002).

This combined application of resources tends to offer greater advantages to firms where IS are complementary to other available resources. This can be a deliberate decision under the firm’s strategic proposition, based on the opportunity cost of IS implementation components, and can bear fruits over time. This deferral effect can be construed as temporal variations of the characteristics of scale returns as a result of the deliberate change of the firm’s technical production factors (Brynjolfsson and Hitt, 2002).

In the 1990s, a set of new propositions concerning the theory of resources-based limits to growth appeared, introduced chiefly by Prahalad and Hamel (2000). They argue that a successful firm needs to be able to create an organization capable of producing goods and services endowed with irresistible functionality. According to their proposition, competitive advantage is achieved by means of products generated by the use of a particular firm’s distinctive competencies. These core competencies are described as a collective organizational learning process.

Stalk et al. (1992), in turn, offer an extension of the concept of core competencies, with their notion of capabilities. While competencies emphasize technological and productive specialization at a certain point in the value-chain, capabilities are more comprehensive, spanning the entire value-chain. A corporate strategy’s main building elements do not rest on products

and markets alone, but on business processes whose success depends on the transformation of key processes into value-releasing strategic capabilities.

### **Risk Management in Allocating Resources**

Our view of firm's value proposition building consists on allocation decisions that must be made based on objectives and on the combination of resources and capabilities. Decisions pertaining to resources allocation are always trade-offs, as the budgetary constraint of scarcity is an economic constant (Varian, 1999). Also, these trade-offs are almost invariably resolved under less-than-ideal circumstances of informational fullness, as agents are not well informed of all aspects of the problems to be addressed, in their entire complexity and within the time frame available for making a decision. This phenomenon, known as limited rationality, is characterized by the human behavior of attempting to be rational in all decisions made, but having one's rationality limited by the inability to obtain all of the information required for a complete assessment (Simon, 1978; Williamson, 1986; Williamson, 1996).

Managing firms presumes appropriately allocation of resources in such a manner to consistently achieve the expected outcome of the allocation. Uncertainty makes it difficult to allocate scarce resources when the expected returns are not immediate, as scenarios other than the ones present at the time of the decision can compromise the intended results. Decision-makers are therefore faced with the need to mitigate the risk involved in their decisions, usually by adopting a systemic action approach, under which the environmental factor is considered in the creation of mechanisms to interact with the outside. Some risk-mitigation resources involve reducing information asymmetry, which, as regards the firm, can include performing transactions with customers or suppliers without being aware of certain fundamental aspects that the other party is acquainted with. This results in entering into imperfect agreements, as the complexity of circumstances in the relationship among actors makes it virtually impossible to render all of the desirable clauses. According to Williamson (1986), firms tend to internalize the activities needed to carry out processes that involve uncertainty, in such a manner as to reduce their riskiness.

Application of IS at firms involves several such elements. For example, a situation in which consultants are better acquainted with the details of systems they are supplying to their customer firms (informational asymmetry); or the case of a company that needs to decide whether or not to adopt a specific software without full knowledge of its functionality, scalability or future compatibility with other systems (limited rationality). However, some actions can be implemented by the firm as alternatives to the problems of informational symmetry, limited rationality, and incomplete contracts (Williamson, 1980; Shapiro and Katz, 1986; Teece, 1992; Milgrom and Roberts, 1992; Casson, 1994; Sanchez, 2001).

### **Principles Involved in Customer Relationship**

IS has been applied to a variety of cases in which the firm seeks to attract and retain customers. From the view point of economic theories, customers are particularly interested in the benefit they can extract from the product or service firms provide, which is known as utility (Varian and Shapiro, 1999; Milgrom and Roberts, 1992). Customer perception of the degree of utility offered by goods and services is an individual characteristic, but is regarded in aggregate terms at firms. Firms analyze groups of individual customer preferences in such a manner as to obtain indications of how to combine their resources to create a value proposition to attract and retain consumer segments. These profiles typically indicate that customers value utility attributes such as cost, quality, convenience, speed, reliability, flexibility, simplicity and innovation (Venkatraman and Henderson, 1998).

At firms, the offer of utility to customers depends on meeting these attributes, which relate to customer-specific information (Evans and Wurster, 2000) and to how resources and capabilities are combined (Porter, 2001). The "convenience" utility attribute perceived by the customer can be met where the firm uses its resources and capabilities to reduce the location or search cost incurred by customers in pursuit of solutions or products (Bakos 1997). Disintermediation of the distribution chain, a known effect of the use of IS at firms, contributes to the construction of new opportunities to serve customers, particularly as regards costs, flexibility, convenience and speed (Bailey, 1997; Chircu and Kauffman, 1999; Sanchez, 2001; Albertin, 2002).

### Principles Involved in the Relationship with Partners and Suppliers

There is a growing perception that product quality is no assurance of a firm's competitive advantage. Quite the opposite, many firms are applying IS to better manage their supply chains or partners networks, avoiding the extreme of reverse integration (Williamson, 1996), but still highly coordinated and complementary, with specially selected and committed partners (Venkatraman and Henderson, 1998; Albertin, 2002). Such a level of commitment, leading to cooperation, relates to certain economic organization characteristics such as:

- The volume of transaction with the partner or supplier (Porter, 2001);
- The frequency at which transactions among the partners take place (Chandler, 1997; Williamson, 1986; Williamson 1989; Sanchez, 2001);
- The presence of investment that are useful and specific to both partners, where mutual trust is encouraged (Teece, 1992; Sanchez, 2001);
- The presence of warranties, whether explicit or implied – those that arise from reputation (Milgrom and Roberts, 1992);
- Complementary products or processes (Shapiro and Katz, 1986; Varian, 1999) so that both partners benefit from the relationship;
- Externalities that stimulate maintaining the partnership as a result of positive effects that indirectly benefit the members (Varian and Shapiro, 1999)
- Customers or suppliers concentration (Porter, 2001)

### Effective IS Implementations

The benefits that Information Systems offer are connected to the potential gains their use may add to business processes and strategies, in terms of costs, productivity, quality, flexibility and innovation (Albertin, 2002).

The need of an analysis of the complex interrelationships among the elements involved in the application of Technology and IS at firm level remains high in many cases, despite actions to mitigate the risk of implementations (Malone and Smith, 1984; Venkatraman and Henderson, 1998; Brynjolfsson and Hitt, 2002).

The effectiveness of the implementation involves weighing and deciding on highly uncertain factors with the purpose of attaining tangible and intangible benefits that are not easily measurable in objective terms (Evans and Wurster, 2000; Remenyi, Money, Sherwood-Smith and Irani, 2000; Brynjolfsson and Yang, 2001). In addition, the firm's performance will be highly dependent on its ability to build a value proposition capable of leading to sustainable competitive advantages (Porter 2001). In economic terms, such a proposition may be understood as the ability to choose configurations leading to economies of scale, economies of scope, and transaction costs reductions (Milgrom and Roberts, 1992; Chandler, 1997). Transaction costs include all the costs involved in processing the information required to coordinate the efforts of the individuals and machines that carry out processes (Malone, Yates and Benjamin, 1987; Teece, 1992). However, these costs can also include the expenses incurred in searching for a trade partner, in specifying the product to be traded and, more importantly, in negotiating the price and contract, which is known as ex-ante transaction costs. Ex-post transaction costs, in turn, are incurred after entering into the agreement, but before the transaction is completed. This includes late deliveries, failure to deliver or to pay, and quality control problems (Casson, 1994).

Williamson (1996) suggests that transaction costs include both direct transaction costs and eventual opportunity costs incurred by decisions that can be attributed to inferior governance. The entire framework of Williamson proposes is supported by assumptions concerning to human behavior, such as limited rationality in a complex world and opportunism (Simon, 1978) and in two key dimensions of the transaction that are assets specificity and uncertainty. Since benefits of IS uses are not always clear and measurable, it becomes a possibility that some investments be misclassified, both ex-ante and ex-post, in terms of effectiveness because the distortions of analysts perception. IS Investments could be judged effective when the perceived value is similar to realized value after the implementation. In the same way, IS investments could be judged non-effective when the perceived value is higher than the realized value.

At Figure 2, some possibilities of failures are exemplified based on three values: Potential value – the one intrinsically pre-existent in applying IS in business; Perceived Value – the one that analysts can find before the implementation and the Realized Value – the result of the final implementation. The IS investments will be considered effective in cases (A) and (C). In the cases (B) and (D), however, the difference between Perceived Value and Realized Value will lead to consider these IS investments not effective.

The MAITEF – Model for the Analysis of the Benefits from the Use of IS at the Firm Level was build to deal with the (B) and (C) situations, where are observed differences between Potential and Perceived Values. So, MAITEF will be useful to improve analyst’s perception of value.

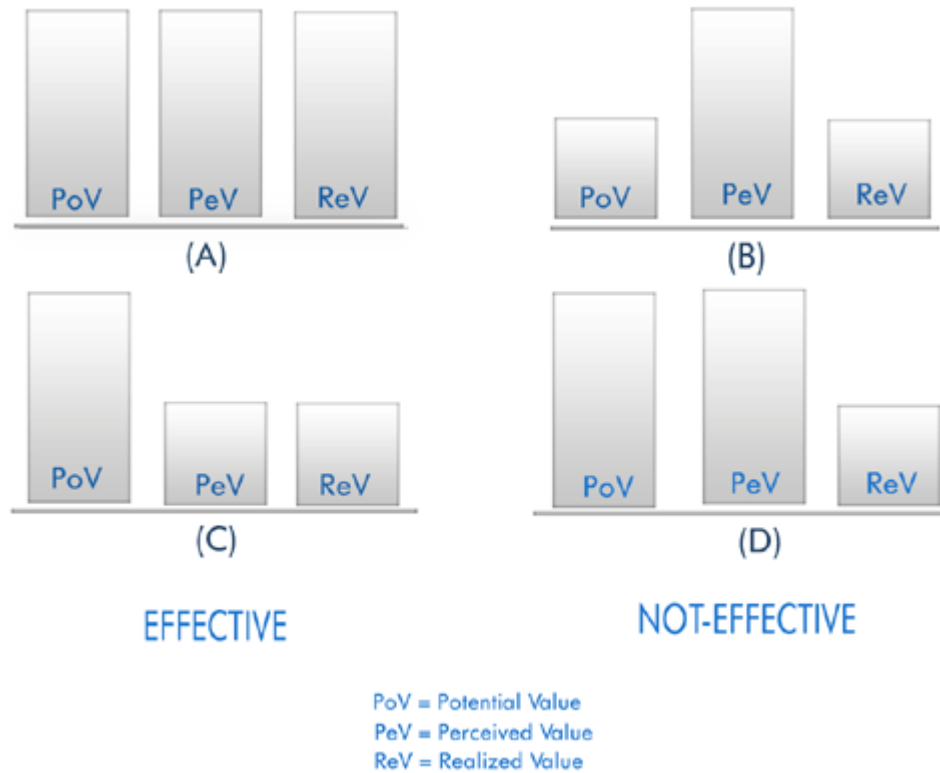


Figure 2. Analysts Perception Failures (presented by authors)

**THE PROPOSED MODEL FOR EFFECTIVE FIRM-LEVEL IS INVESTMENTS DECISIONS (MAITEF)**

MAITEF is represented by two boundaries (Figure 3): the strategic deliberation boundary and the proprietorship boundary. The firm’s effectiveness as regards the combination of the resources results in performance, whose benefits are retained within the firm (within the proprietorship boundary). At the core of the analysis model lie resources and capabilities, among which are IS, a resource that complements the firms other resources at different levels.

The concept we are dealing with pertains to understanding that the firm manager is responsible for the appropriate manipulation of these elements in such a manner as to take into consideration the trade-offs involved in the firm’s operations. Alongside each dimension, we included a reference regarding the perception of how value is associated with the firm’s strategic deliberation dimension. This value can be obtained or supplied by the firm, and we provide a graphic indication of the direction of this value flow. Following is a brief description of the MAITEF forces and some examples of each category:

**Complementary Nature of the Firm’s Internal Resources, Capabilities and IS**

It refers to the intensity and manner of the firm’s internal resources and capabilities can be combined with IS. It assumes that IS are also firm’s production factors, like the human factor, capital, investments, etc. The interactions between factors are exposed, like complementary aspects between IS and other resources, technical substitution possibilities, and increasing, decreasing or fixed scale returns of these resources substitutions.

**Customer Attraction and Retention:**

It refers to the firm’s deliberate action to get benefits in compensation of supplying utility to customers. Utility is, in fact, the economic concept supporting the relationship with customers which includes as determinants, among others, transaction costs, substitution costs, localization costs, reputation, warranties, coordination, standardization. One firm can be aware that not always the customers are welcomed since moral hazard and adverse selection can occur, determining that some managerial decisions can take place considering minimizing these situations.

**Attracting and Retaining Partners and Suppliers:**

It represents the firm’s deliberate action towards extracting the benefit of the value offer that arises from partners’ or suppliers’ cooperation. The economic concept that supports this relationship is that the agents can obtain some resources and capabilities in a complementary fashion from the partners and suppliers. The aspects that can be determinants to the resulting cooperation are, among others, volume and frequency involved in this relationship, the existence of co-specialized assets meeting mutual value needs, warranties, to completed an atmosphere of trust between the parties, complementarities of internal capabilities and resources got from partners, externalities, an involuntary effect that incentives the maintenance of the partnership, and concentration.

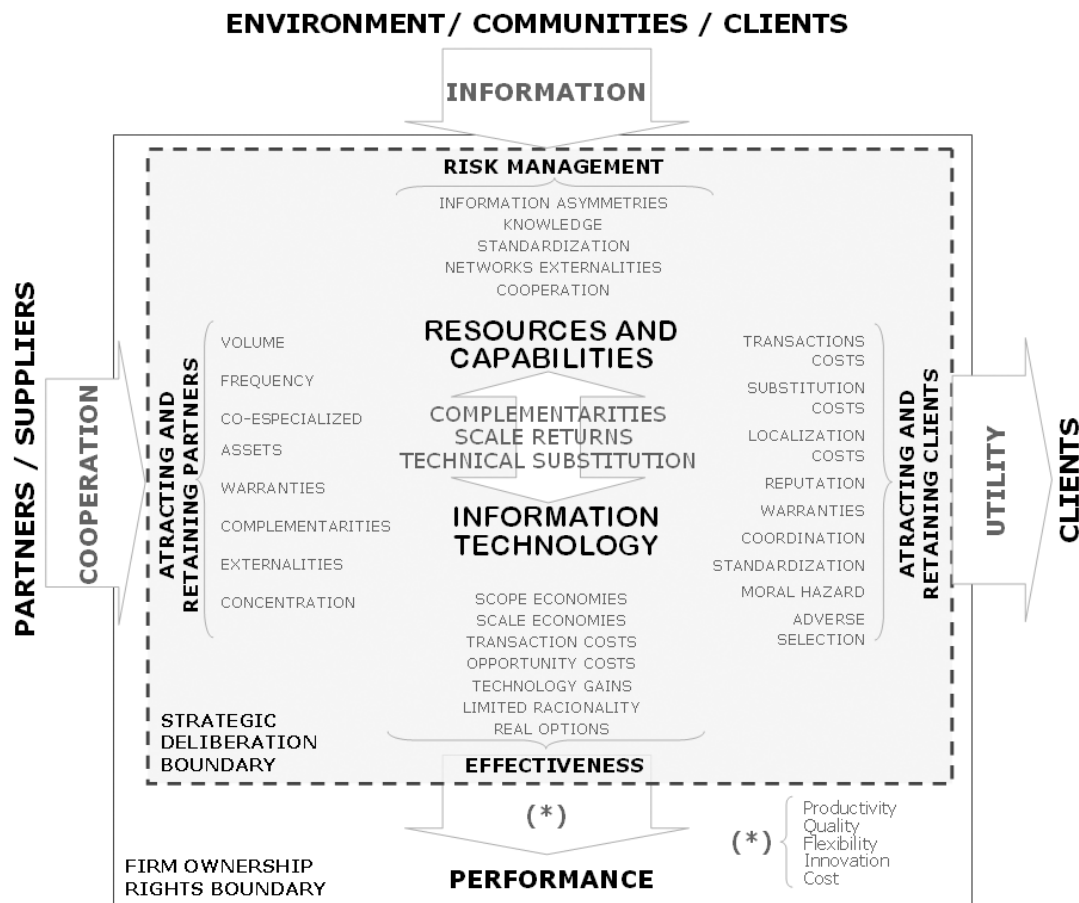


Figure 3. Model to Firm-Level Analysis of IS Investments - MAITEF (presented by authors)

**Risk Management:**

Represents the manner according to which firms carry out actions intended to mitigate the overall risk and specifically risks of adopting new IS. The fundamental element of avoiding risks consists in having perfect information in order to build a completely rational decision. Since it is infeasible, managers mitigate the risk of firm operation, considering some aspects, as

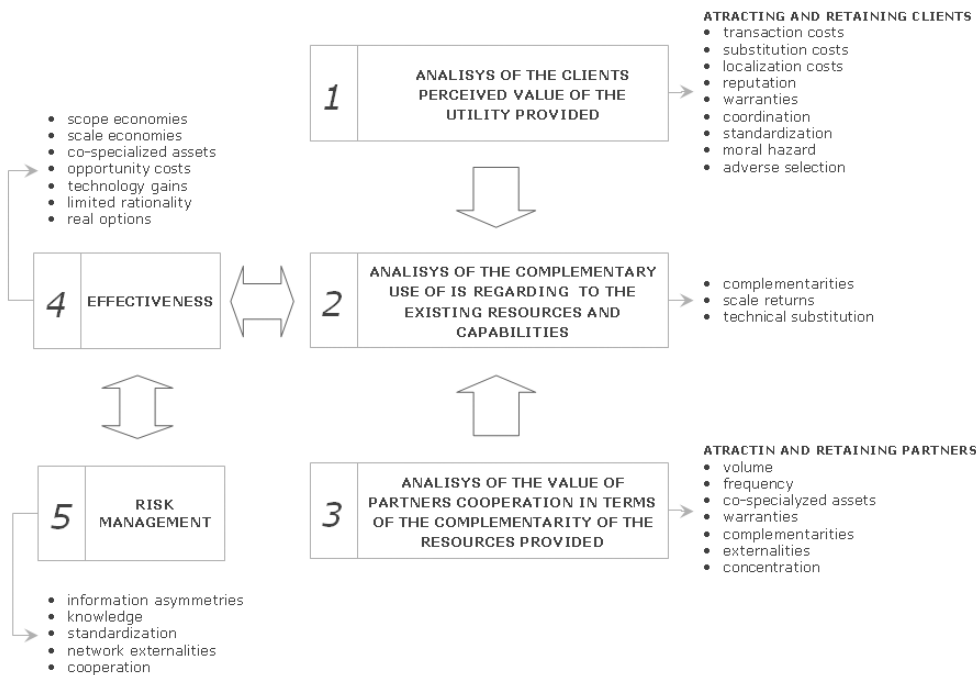
information asymmetries, systematic acquisition and internally developed and stored knowledge, standardization of processes and technologies that make easier to adopt looking for future compatibility and scalability, network externalities, etc.

**Effectiveness of the Use of Information Technology:**

It is considered as a positive outcome of using IS to perform businesses processes. As fundamental thesis here, effectiveness of IS investments will arise only when the proper alignment of IS and the other resources and capabilities were implemented to solve preciously found economic inefficiencies in any of the MAITEF dimensions resulting, in consequence, superior firm performance. This is, indeed, the final result of the utilization of IS at the firm level, got as output of the better understanding of previous economic inefficiencies. It can be shown in terms of economies of scope, economies of scale and reduced transaction costs. The core of a possible effective managerial behavior could involve applying the firm strategy considering the possibility of using IS only in previously inefficient situations identified by MAITEF.

**A USAGE PROPOSAL TO MAITEF**

Although there are some risks in oversimplifying the model, the authors recognize that the MAITEF, as presented in Figure 3, seems cumbersome for immediate application. Below (Figure 4) is a process suggested to make the model easier to use in some case studies.



**Figure 4. Usage Proposal to MAITEF (presented by authors)**

The numbers refer to the temporal sequence of the path to use the MAITEF. The topics reflect the issues to be addressed in each analysis conducted.

**A PRE-TEST IN A CASE STUDY: LABORATÓRIOS FLEURY – MEDICAL DIAGNOSIS CENTER**

Recognized in Brazil as classical example of how IS can be effectively used Fleury - Medical Diagnosis Center - was the choice as unit of analysis for the case study, reflecting the researchers intent to find a significant and revealing case, allowing them to collect relevant evidence (Stake 1994). Fleury Center serves over 2,500 customers a day at its 15 units. Its customer’s portfolio includes close to one million individuals. Each day, the lab performs in the vicinity of 10,000 tests, in a total



3,500,000 tests per year. The tests imply not only customer service, but also support services for associate doctors and labs. The company's direct customers are individuals of both genders and different ages, mostly middle- and upper-class. These are people who have at least one health insurance plan or financial means to choose among service offers, particularly (only 35% are males), well-informed and familiar with the use of technology. For customers such as these, privacy, reliability and convenience are fundamental factors in services qualification.

However, most of the customers are indirect, including close to 150 health-insurance companies, doctors who request tests and other laboratories for which Fleury acts by referral (900 labs in different regions in Brazil), carrying out specific tests other laboratories would not have scale to make them economically viable. These customers demand highly precise diagnosis services, availability, speed and flexibility as to the clearing of doubts and the discussion of specific tests. Fleury Center has an excellent reputation with the society in which it operates, as a result of its 76 years in the market and the excellence of its diagnosis services.

We used the MAITEF framework and noted the presence and relevance of many aspects. In order to face its competitors, Fleury made heavy investments in new technologies, benefiting from technical replacement rate to improve and speed up customer services. Its employees' skills were considered as IS complementary resources to maintain the high quality standards of the services it provides so that training was emphasized.

The complementary nature of resources has been also shown in the case that some ERP modules supplied by Datasul (Magnus) are complemented by customer service systems that were developed internally by the IS team, due to the intent of involving knowledge concerning processes that are considered key to the pursuit of the activity with the available technology.

Regarding to customers utility concept, we found reliability, characterized by strict control over collection, processing, and results interpretation (warranties); speedy customer service and results (replacement costs, transaction costs); technical expertise (coordination); diversification, expanding the range of products offered (location costs); secrecy in the transmission of results and other information (warranties, reputation) and Medical Ethics, as regards the requirements for dealing with information (reputation). The company has had offers to have its Website sponsored by other companies, like ones in the pharmaceuticals industry, but decided not to associate its brand with commercial companies/products. The company also has an EDI system to interact with health-insurance companies for the eligibility process, through which the customer's health plan regularity is checked, as well as available resources, customer credit status, etc. (avoidance of Moral Hazard). With the implementation of the service offered at the Website, which consists in making test results available on-line, the company managed to reduce the cost and time involved in serving customers, as well as the cost of printing out test results (85% to 90% reduction of printing costs) (transaction costs).

The relationship with partners is build through a website that is accessed by customer companies, like associate labs, who access test results over the Internet. The company also has an Extranet that connects it to hospitals in which it operates, like Santa Paula Hospital and Samaritano Hospital, and is also used for interconnection with some labs for which the firm operates a referral laboratory (co-specialized assets). The company uses the Supply-Chain concept in two distinct areas: the back-office (cleaning supplies, office supplies and pantry) and the test inputs area. The firm's SCM includes 100% of back-office products and most of the inputs used to perform tests (volume). The company has EDI/Internet interaction with GIMBA, an office supplies distributor (concentration), using a simplified materials ordering, admission, distribution and accounting process performed over a specific communications module (frequency). The company also has an EDI system to interact with health-insurance companies for the eligibility process, through which the customer's health plan regularity is checked, as well as available resources, customer credit status, etc. (warranties). This process is mediated by companies like Salutia, Net Saúde, Conect Med and Dativa. EDI is also used to send and receive invoices. In this case, these companies act as "infomediaries" for Fleury (complementarities).

One very relevant aspect of the company's risk management deals with the ethics issues it activity involves, under the oversight of the Federal Medicine Council. According to the rules in force, the company is not allowed to encourage tests. The Ministry of Health also restricts certain practices, like performing tests over the Web, for example. The company has relationships with several other regulatory bodies and interest groups, like ABRAMGE –(the Brazilian Association of Group Medicine Companies, who provide a medical procedures codes table) and the ABM (Brazilian Medical Association), who produces the medical and clinical fees and procedures table. These are attempts by the company to reduce informational asymmetry and to manage a knowledge it is sensitive to. Also, cooperative aspects can be perceived in the relationships with these entities. All of the company's servers, including Internet servers, are internal. A large portion of the data on the site is updated in real time, as the site is integrated with the data base by means of ASP (Active Server Pages) technology. The platform is Microsoft, W2000 Server Operating System in a four-layered architecture that use COM+, IIS 5.0 and SQL Server 2000 (standardization). The site-development team is also its own, and includes a designer and programmers (network externalities).

The issue of the company's technological appropriateness is given high relevance, as its processes require reliability, security and availability. In order to accomplish this, the company attempts to employ all of the resources offered by the public infrastructure and all of its own technology resources, on which it makes a significant investment (real options).

## CONCLUSIONS

The main contribution offered by the MAITEF proposition lies in the fact that it enables IS implementations analysis at the firm level, with economic activity organization fundamentals for reference, not only providing explanations for the several aspects observed at business situations, but also serving as a foundation for better managerial decisions.

The implications for the field of Business Administration arise from the availability of a new analysis instrument that is soundly grounded, although yet unexplored. New opportunities may come from the model's evolution and improvement, particularly ones involved in designing a full process and protocol to support IS investments decisions.

Future evolutions of MAITEF include mathematical modeling of the relationships the model contemplates, analyzing time series to check for changes of the effectiveness dimension of IS actions in terms of firm performance, identifying and confirming the Critical Success Factors attributes in several economic activity segments and analyzing the model's external validation, among others.

The limitations identified in the MAITEF proposition pertain to the observation bias of the researchers who judged the characteristics involved. Also, the model will admittedly need to be the object of future studies to effectively confirm its validity, both internal and external.

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