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ORGANIZATIONAL INTEROPERABILITY IN SUPPORT OF COMPETITIVENESS

Elizangela Dias Pereira[a]**;** Maria Inacia Favila Salum[a]; Carlos Manoel Taboada Rodriguez[a]

[a] **Federal University of Santa Catarina** (UFSC) - Florianópolis, SC, Brazil

Abstract

This paper presents a new context in the logistic field of organizations. This concept emerged due to the expansion of the application of the original concept proposed by the area of software development, in which the goal was to enable the exchange of information between different systems in such a way that no extra effort was needed. Therefore, this area of Information Technology (IT) is constituted by the standardization of programming language, commands, data storage format, among others. Eventually, principles that were already quite widespread on the sphere of IT gradually became used in different areas, until? started being used amongst the business field. Thus, in order to make corporate processes interoperable, it has contributed to approach and facilitate the communication between companies based on some of the principles of the software field, such as standardization, form of communication, frequency of orders…etc. On the logistic field, which actually connects industrial and commercial companies through the flux of material and related information, the inoperability has by goal help on the resolution of problems regarding received and sent information management, fulfilling more rapidly the demands and opportunities of the market. In this context, we intend to define the part of interoperability on organizational competitiveness.

Keywords: interoperability, organizational competitiveness, Information Technology.

INTRODUCTION

During the evolutionary process of the organizations, competitiveness assumed a major part, directing any organizational initiative into developing a differential characteristic to increase its competitiveness, and thus, it became a factor which determines its longevity or premature failure.

It is clear that after a long period of production systems fragmentation aiming to lower expenses and focus on essential competences, companies begin to have the need of investigating various links between suppliers, transportations, production, distribution, and finally retail and consumer. Hence, logistic is no longer just operational, it became strategic and managerial; taking into consideration that there is a greater demand for integration between the industrial and commercial processes, starting from suppliers to the final customer (Felizardo, Hatakeyama, 2002).

Bearing in mind the constant shift amid the international scenario and aiming to increase its competitiveness, organizations are rethinking their internal structures, searching through the information flow a new solution to reduce costs and increase their participation in domestic and / or international market. The creation of collaborative networks to facilitate the exchange of data, information and services was always under discussion.

The development of new economic activities with the adhesion of collaborative networks has spawned changes in business models and mainly in operations which add value. These new trading relations are possible because information technology acts as a facilitator in these business relations (Grilo *et* Gonçalves, 2010).

The world is going through a process of human and technology heterogenization as well, which requires a new form of processes and ontologies (new set of concepts), which is based on these heterogeneous relations. However, there is a great lack of ability to link different systems, which ultimately hurts the effective sharing of information.

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According to Lier *et* Hardjono (2011), different heterogeneous systems are capable of connecting to other systems and exchange and share data or information with no effort.

One of the greatest problems faced by organizations regarding establishing efficient collaboration work relations is the lack of cultural compatibility, conceptual, organizational, procedural and technological (Doumeingts *et al.,* 2003). In order to assuage this problem, information technology developed a system that is capable of dissolving this incompatibility, called interoperability.

METHODS AND RESEARCH TECHNICS

The aim is, through emerging issues, raise a number of concepts, models, characteristics and tendencies, related to interoperability, which appear in a disjointed and sparse way in the literature. The main focus is to really capture the diversified scenario with regard to what has been conducted in the field of Corporate Interoperability.

Under those circumstances, publications in the secondary databases about this subject have been studied, such as: Scielo, Science Direct, Scopus, and Emerald. Simultaneously, some works from respected authors in the interoperability area were used, such as: Chen, Lier *et* Hardjono, Chituc, Panetto, among others.

The data collection to elaborate the contextualization of sustainability on the supply chain of this research occurred in the following way: it was used as choice criterion the papers that presented the term "interoperability", "corporate interoperability", "logistics performance" in the title, abstract and/or in the text, and then screening it with all the collected data. Those whose content owned more similarity with this thesis were selected. The focus is in the relation between the authors and the more often cited papers, looking to understand the roles they play, and thus, to be able to complement and refine this literature analysis.

In this context, it is a study of an exploratory and descriptive character, as it focuses on a first attempt of specifics information integration and characteristics of what is being developed in a theoretical and empirical manner.

Organizational Interoperability

At first, interoperability approached the informatics system; the aim was to reduce multidimensional problems that beheld different areas of an enterprise (Naudet *et al.,* 2010). Nevertheless, the use of interoperable systems began to be applied in practice in the military field, because the possibility of safe and effective flow of information were crucial to the conduct of military operations (Panetto *et* Molina, 2008).The interest of the military field is related to the expansion of the forces in combat, where it is possible through interoperability use equipment, resources, capabilities and training procedures of potential partners without having problems with handlings of weapons and ways of combating (Carson 2009, Panetto *et* Molina 2008).

Panetto *et* Molina (2008) emphasize that the application of interoperability has driven this system out of the computing platform, turning to shared services between the military armies. According to Carson (2009), the strong military interest in this area lies on the opportunity of expanding this concept to the logistics operations, where they saw a great opportunity of sharing the provision, distribution, storage of supplies, as well as the troops transport. It was observed the through operational interoperability, the armies maintained their independence, and in the case of war they could relate temporarily without any operational problems.

Likewise logistics developed in the military field, the interoperability, despite having been created to solve business problems, also attracted the interest of the military (Thomas *et al.,* 2007, Brim 2005).

The corporate interest for the system of interoperation is quite recent. Although the concept was quoted in 1987, the search for interoperation business actually began in the late 90's (Thomas *et al.,*. 2007). The greatest misgiving of the organizations today is to have a temporary relationship with their "competitors" sharing their information and operational practices (Carson 2009).

To Escoto *et al.,* (2004), the business interest for interoperable systems has grown significantly in the new economy. Hence, the virtual enterprises, the interconnected organizations, drove the development of this system into enterprises, because these organizations need technology that facilitates and accelerates the effective exchange of information and knowledge.

The development of interoperability may be visible mainly in governmental and defense (military area) institutions, where the exchange and use of information is a key matter of safety.

According to the research script of the European Commission of Interoperability (2006), analyzing the advantages of interoperation related to systems integration, focused on creating a model of "e-government" interoperable. With the use of this system it was possible to develop a new communication system which allows

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cooperation of the different systems (heterogeneous systems). According to the European Commission (2012), the interoperability will help strategically to focus the EU efforts through an appropriate organization of governance and policy of common initiatives, the intentions is to create a safe environment and favorable to the exchange of information between public administrations.

Considering that interoperability is being applied in different branches, it is important to analyze the evolution of the concept interoperable over the years. The following figure (Figure 1) shows an illustration of the main periods of the evolution of this concept.

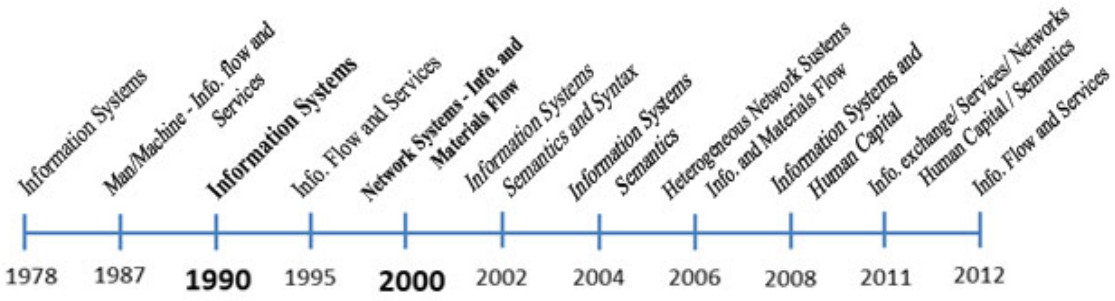

Figure 1 - Chronologic View of the Interoperability Concept

According with Thomas *et al.,*. (2007), one of the firsts concepts ever presented was of Eldridge (1978), which defined the interoperability as "the capacity of only one system to receive and process information of mutual interest, transmitted by other system". It is noticed that the concept is intimately aimed into the IT area, where the base is the information flow.

However, Popel (1987) developed a new concept for interoperability, highlighting the relationship between man and machine. To the author, the interoperation can be defined as "the ability of two or more parts, machine or man, to make perfect exchange of content, with no perceptible distortion and delay between the source of the content, processing and use."

The milestone of the development of the concept of interoperability was in 1990 with the publication of the definition by the Institute of Electrical and Electronics Engineering (IEEE). From this date on there was the growth of interest of companies, and public administrations for the interoperation of their systems. The definition of the IEEE is the most accepted and popularized until today. According to IEEE (1990), interoperability is the ability of two or more systems or components in the exchange and usage information. The interoperability occurs when each of the different information systems can use the information exchanged with other systems.

Heiter (1995) extended the IEEE concept into beyond the information system, covering also service flows. However, in 2000, with the possible millennium bug, interoperability has taken hold. Once more, the IEEE published an evolution of the previous concept.

For IEEE (2000), interoperability is the ability of two or more systems to exchange information that has been exchanged. The ability promoted, but not guaranteed for the joint compliance with a given set of rules, which allows heterogeneous equipment usually constructed by several suppliers to work together in a network environment. For the first time, is quoted as collaborative networks. Even though this concept is quite embracing, the most used is still the one published in 1990.

With the growing interest of organizations for systems interoperability the ISO developed a standard / default to the same. According to ISO 16100 (2002), interoperability is defined as "the ability of dividing and sharing information using common syntax and semantics to accomplish a functional relationship of a specific application through the use of a common interface." Given that it is a rule, the syntactic and semantic issues that should be standardized by the systemstand out. Berre *et al.,* (2004) also considered the semantic issues in his concept of interoperability: "Ability to integrate data, features and processes with respect to their semantics".

According to the North Atlantic Treaty's organization (NATO, 2006), interoperability is defined as the ability to configure the network connections between nations, allowing real-time exchange and sharing of relevant information. This capacity of efficient connections between heterogeneous systems, admitting the sharing of accurate and agile information has resulted in higher survival capabilities of institutions. Basically, interoperability allows the exchange and sharing of information on any system and in any combination possible.

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Chituc *et al.,* (2008) refers to interoperability as a tool that is based on the use of computer to facilitate coordination of work and information flow between organizational interfaces. The focus of this system is to coordinate the operations in a way to carry out the flow of information in real time between different organizations. As for Chen *et al.,* (2008), the interoperability covers beyond the information flows, but organizational and human aspects as well.

Interoperability has as a central point the relation between heterogeneous systems. In other words, it considers the way in which the relations between the different systems are formed, the way in which these relationships allow exchange and sharing of information from different systems in a temporary collaborative network. Every change performed by a particular system, generates a change in the systems environment of others partners; an increase of complexity in an area will increase the complexity of the environment of all other areas. To be interoperable (in the widest sense of the word) is to be able to relate with partners anywhere in the world, ensuring that all the resources have access to the right information at the right time, in brief, a network composed of many separate networks (Lier *et* Hardjono2011).

Finally, for Panetto *et al.,* (2012) the concept of interoperability returns to cover only information and operations flows, failing to consider the human capital in collaborative relationships. To the author, interoperability relates with the exchange and use of information, or in the carrying out of a transaction on behalf of another system.

In spite of having several concepts to define interoperability, the vast majority of authors focused on keeping information system. Collaborative networks are approached, but the role of human capital for the success and development of interoperation is hardly mentioned. Just Lier *et* Hardjoro (2011) and Chen *et al.,* (2008) express the importance of men to the effective developing of the interoperability, because it is through the relationships of trust that the information is shared.

In this way, the information revolution launches questions about the way of traditional relationship of organizations, highlighting the problems of command, control and existing structural. It also raises questions about the changing relationship between man and machine and confidence required among participants in such collaborative networks (Lier *et* Hardjono, 2011).

The major difficulty is still the mistrust of managers about sharing their information. Otherwise, the basis of the action of interoperability is trust, because without it there are no effective collaborative networks, since they do not share the necessary information for proper functioning of the network. Each of the participating parts in the interaction must be aware that the actions taken by the interoperable system is reliable (Carney, 2005). Thus, with the evolution of interoperability, it could be possible to connect several collaborative networks and other entities, creating a unified system.

INTEROPERABILITY IN FAVOR OF LOGISTICS PERFORMANCE

Logistics is understood as part of supply chain management. This plans, implements and controls the acquisition, storage and handling, as efficiently and economically as possible. It includes raw materials, semi-finished materials, finished and parts of products, covering also the flow of information relating to these processes from point of origin to point of consumption in order to meet consumer demands (Lambert,Cooper, 2000; Novaes, 2004; Bowersox *et al.,* 2006).

The logistics' ray of action extends strategically alongside the whole organization, and is the means by which customer's needs are met by coordinating the flow of materials and information which range from market to the company. Among several strategic issues that companies face today, perhaps the most challenging is the high cost flow of information and materials.

One of the fundamental aspects involved to achieve an adequate logistics management, cutting costs, is improving efficiency of the collaborations that the company has with its stakeholders. According to Rosaleñ Corella *et al.,* (2012), this collaboration consists in coordinate and synchronizes resources, decisions, methods, business process, employees and technologies of different stakeholders on the chain.

Thereby, many companies understood the essentiality of information to logistics, and as a result, began to invest in technologies that improve their ability to transportation and warehouse management, as well as forecasting and demand planning, among others (Bowersox*et al.*, 1999).

The term logistics interoperability is something recent. According to Buyukozan (2011), the purpose of a logistics system is interoperable sharing of power between companies or units without loss of independence. Differently from what occurs with integrated systems, logistics interoperability allows systems to interact, exchange services, but keep their logic operation.

Logistics interoperability can be an outstanding opportunity for companies to share supply, distribution and storage of merchandise. Using the same facilities, personnel and transportation could be a way to reduce logistics costs.

The creation of an interoperable system intends to reduce the problems of strategic logistics such as the question of the storage costs and information asymmetry, which may improve its performance as a whole. Logistics, as was

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previously mentioned, is not purely operational - material flow - but also strategic (information flow), which makes it much more complex.

The competence of interoperation between the involved organizations allows them to operate autonomously. There is no need that the interoperating enterprises know in details the functional mode of each other, unlike what happens when there is integration between organizations(Soares, 2010).

In practice, the realization of cooperation relies strongly on the effectiveness of interoperability between participating systems. That is, the systems must be minimally interoperable with each other to complete the objective of this global system (Panetto *et al.,* 2012). Figure 2, below, illustrates the interworking between two organizations of the same network.

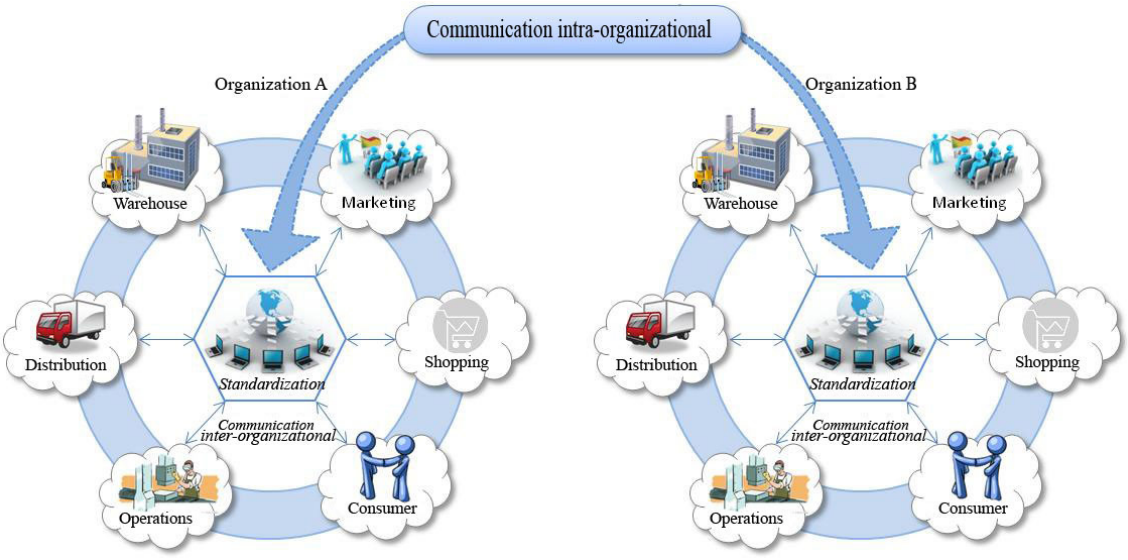

Figure 2 - Example of interoperabilitystructure

Interoperability is achieved by mapping internal parts of each participant application, structuring data for a universal data model and vice versa (Grilo *et* Gonçalves, 2010).

Interoperability efforts are focused primarily on levels of data services. There is a great need to extend technical levels to organizational and operational aspects of creating and managing relationships. That is, one must consider that these levels (technical, semantic and organizational) are entangled with business processes, employees, culture and management of external relations.

To achieve interoperability with success, organizations must address issues of technological connection of systems and applications, as well as the way the connection among the business processes of each organization enables or hinders the establishment of technical requirements (Crave *et al.,*2008).

One should also consider the compatibility of the values of the employees, the culture of trust, mutual expectations of collaboration. Given that these relationships are supported by informal or formal contractual agreements between companies and units of the same organization that are inserted into collaborative network.

According to Brim (2005), interoperability logistics may assist in lowering operational work, providing greater agility and capacity to service the requests, reducing logistics costs and improving management and data integrity.

Interoperability must act directly on logistics and simultaneously in four key areas, namely: command and control, information management, transport system and equipment, and logistical support services (Carson, 2009).

The area of command and control would be the area responsible for joint planning of decision making and execution, requiring anunified logistics planning. The aim is to provide an overview of the assets, operations and transport. Typically, this area is under the responsibility of the leading supply chain. However, the creation of a commission in which the components represent the interest of the entire chain would be more ideal.

The area of information management refers to the control of information flow. The areas of transportation and equipment, as well as logistical support services may be the most problematic at the time of interoperation, since companies present different equipment, procedures, training of personnel and distinct structural capabilities, what can hinder the flow between them.

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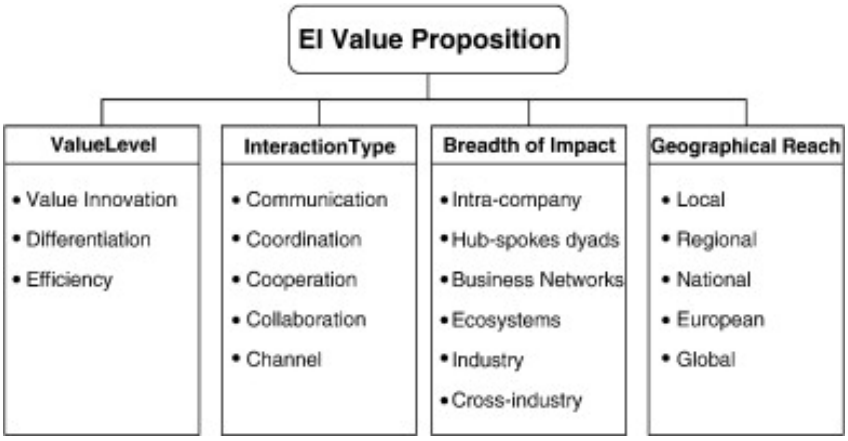
Through an interoperable management with online control of information, updated in real time, management may propose better strategic planning and execution of production. Because it will relate current demand information with the basic features of the company: human resources, materials and equipment.

Crave *et al.,(*2008) presented a framework for companies in order to clarify the theory of value of interoperability. Within the enterprise level, the value depends on different dimensions: interaction, range of geographical reach as well as impact. The figure below is an illustration of these dimensions.



Figure

The sort of interaction shows how interoperability can create value in their interactions. There is a great need for interoperation to improve the strategic competitiveness of enterprises.

The magnitude of impact describes the scope of interoperability, ranging from an initiative within the organization or to broader situations, which are industry-wide or inter-sectorial.

To Grilo *et* Gonçalves (2010) value creation might vary according to interoperation practiced between enterprises. The author emphasizes four main types of interoperation: communication, coordination, cooperation and collaboration.

Communication: The primary purpose is to exchange information. The type of informational interaction has evolved. Nowadays, besides Web pages, organizations have databases available with sophisticated data and information about products, services and trade.

Coordination: Has the role of aligning activities for mutual benefit, prevent gaps and overlaps, and thereby achieve results in an efficient way. One example of this type of interaction is the electronic exchange of data related to electronic commerce, lifecycle transaction, from order, advance quotation, etc. Most of interoperations performed between companies aim coordination.

Cooperation: In this type of interoperability, interaction is used to obtain mutual benefits through partake and sharing work. This type of interaction not only allows for greater efficiency, but also creates the possibility of obtaining some differentiation over time and reduced costs.

Collaboration: By means of this type of interaction a partnership achieves results in which the participants would be unable to perform alone, given that interoperability is the basis for collaboration. This implies common goals, joint responsibilities and joint work to create innovative solutions.

These forms of interoperation can allow the creation of new value propositions for interoperability, seeking value innovation, and not only the efficiency and differentiation.

INTEROPERABILITYBARRIERS IN LOGISTICS

Brim (2005) *et* Carson (2009) present some barriers to the development of logistics interoperability. One of the major problems is logistics structural differences organizations, and language, where each sector calls the same phenomenon in different names, hindering communication. Another obstacle is the lack of a single command for coordination among sectors of the company, which ultimately creates inefficiency. Besides, another great difficulty is making different logistical areas work together, which is necessary to share experiences and scenarios.

Despite the existence of barriers to interoperability if properly applied can generate logistics gains, especially in reducing the lead time. *Panetto et al.,* (2008) points out that relations interoperability between existing systems and products, ensuring coherence between the physical

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and informational flow throughout the entire product life cycle by reducing direct costs of storage, transportation, procurement of raw materials generating greater efficiency for the entire system. Nevertheless, the costs of this system can be significant and longtime of implementation, being that, it should be seen as an investment of return over medium to long term.

INTEROPERABILITY IN THE BRAZILIAN SCENARIO

In Brazil, it is possible to see sharply how interoperability can be applied. For example: the Ministry of Planning, Budget and Management have been developing throughout the years programs of Electronic Government, whose principle relies on use of modern information and communication technologies (ICTs) in order to democratize access to information, broaden discussions and streamline the delivery of public services with a focus on efficiency and effectiveness of governmental functions.

This policy of Electronic Government follows a set of guidelines that operate in three fundamental fronts, namely: by the citizen, to improve their own internal management (organs of the government itself) and integration with partners and suppliers.

Through the transformation of the relations of the Government with these three fronts, the Brazilian Electronic Government Program intends to improve the quality of services rendered; promote interaction with business and industry, and strengthen citizen participation through access to information and more efficient administration.

Thus, according to what Landsbergen (2001) presents, certain benefits are generated through the implementation of interoperability in public administration, for instance, greater effectiveness (interconnection rather than individual solutions), efficiency (reduction of transaction costs) and responsiveness (better access to information, enabling faster resolution of problems).

FINAL CONSIDERATIONS

Nowadays, each one of the links in the supply chain must respond to a series of pressures, including regulations, consumer demands, and limited availability of resources. In response to these pressures, directions for the development of distinct operational models, goals and modifications in processes of organizations are expanding. In this sense, the implementation of interoperability as operational and management tool among current systems and products, ensures consistency between the physical flow and informational flow throughout the entire product life cycle, directly reducing unnecessary costs and impacts caused by activities of storage, shipping, purchase of raw materials, generating a higher efficiency for the entire system.

In this way, interoperability can be a great opportunity for logistics transformation of organizations, sharing supply, distribution and storage of goods, without loss of autonomy. Enable companies provide better services, as well as helping decision making, providing better performance and aggregation of value, being an alternative to reduce logistics costs.

In the contemporary competitive context, organizations need to structure its logistics in a way that it is interoperable. And companies more competitive and interested in growing of the new reality, are already aware and begin to prepare for the future.

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