

## A new concept of Logistics Interoperability

### Un nuevo concepto de Interoperabilidad Logística

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#### Abstract

Organizations are acting increasingly in most competitive business environments in which the responsiveness to business as variables of the business, maintaining a market share, and the balance next to stakeholders are aspects that need to be managed. Therefore, it is necessary to use heterogeneous models of information flows, materials, services, fostering in this way, the interaction capability for a more timely and efficient response to the demands. Hence the importance of understanding the evolution of interoperability, their applications and concepts.

This paper aims to develop the concept of Logistics Interoperability based on corporate scope, organizational level and type of use of interoperability. From the portfolio of papers resulting from the bibliometric research, an analysis of the contents by using a classification study of the works was applied. The gap found in the literature is concerned with the interoperability and applications directly related to logistics.

*Keywords:* Logistics; Interoperability; Organizations

#### Resumen

Las organizaciones actúan en ambientes empresariales competitivos donde la capacidad de respuesta a las variables empresariales del negocio, el mantenimiento de una cuota de mercado, y el equilibrio junto a los stakeholders son aspectos a gestionar. Por tanto, es preciso usar modelos heterogéneos de flujos de información, materiales y servicios, fomentando la capacidad de interacción buscando respuestas más oportunas y eficientes a las demandas. Es importante comprender la evolución de la interoperabilidad, sus aplicaciones y conceptos. Este artículo tiene como objetivo desarrollar el concepto de Interoperabilidad Logística, basado en las áreas concernientes al alcance de las empresas, el nivel de organización y el tipo de uso de la interoperabilidad. Del portafolio resultante de la investigación bibliométrica se aplicó un análisis de contenido por medio de un estudio clasificatorio de los trabajos. La laguna encontrada en la literatura está envuelta con la interoperabilidad y sus aplicaciones directamente relacionadas con la logística.

*Palabras claves:* Logística; Interoperabilidad; Organizaciones

## 1 Introduction

Logistics has a strategic role in organizations. On one side is a cost generator, which in Brazil, according to [1], representing about 13.2% of Gross Domestic Product (GDP). On the other hand, is a way to differentiate a company or at least meet the requirements of the market. The balance between the two extremes involves the appropriation of attributes, such as agility, integration and performance measurement. Because of this, among other things, the logistics need to be fast and flexible, integrate the activities, customers and suppliers and monitor their results, measuring their performance.

However, the differences between companies and between how their own logistics activities are managed, lead to breaks in the flow of materials and information [2,3]. Analyzing interoperability, an attribute desired in the area of information systems, it was observed that its principles can also be applied to logistics.

The literature, in general, considers that the ability of an organization to act in an interoperable way, internally and externally, is an important competitive advantage, as it can reduce costs, improve the response time and allow greater scope of their operations; since interoperability enables the interaction between processes, information sharing, equipment and systems from different organizations [4,5,6].

The advancement of interoperability need occurs from the 90s, with the development and evolution of information systems and an increase in data streams at all organizational levels [7] and between the organizations themselves to obtain greater gains in the production chain.

At the same time, logistics also enables a better relationship between suppliers and customers, by coordinating the material flow and the related information. Thus, logistics acts as a synchronizer element between supply and demand [8].

It is noted, therefore, that the inclusion of elements in the logistics interoperability studies may be relevant to the development area. That is, if on the one hand, companies realize the need to share information, actions and structures with their customers and suppliers and, therefore, make use of aspects of interoperability, and by the other hand logistics is an important connecting link between companies, with regard to the material flow and related information, it can be concluded that interoperability and logistics, together, offer to important organizations elements for the effectiveness of trade relations. Thus, this research aims to establish the constructs Logistic Interoperability (LI) in order to structure this concept to facilitate the study of logistics and its use in business practice. In what follows are the methodological aspects to attain the goal.

## 2 Methodology

This work is characterized as exploratory, since it has as end the systematization of knowledge about the interoperability logistics. As for the media, is a literature review, having been consulted articles published from 1994 to 2014 in the following databases: OneFile, Emerald, Web of Science, Science Direct, Oxford Journals, Springer Link, Wiley, DOAJ, Sage, JSTOR.

The research started from the literature, passed to the development and merging with the results. For literature, was used as a keyword the term "Logistics Interoperability" in any article of the field, without temporal cut with the intention to collect the largest possible number of searches. Initially, were identified 112 journal articles (indexed journals). In the next step, the duplicate articles were eliminated, resulting in 82 surveys. Of these, after reading the titles and abstracts and a consequent adherence analysis, 59 articles remained, becoming the Research Portfolio.

For the portfolio management, was used the EndNote software version 6®, allowing a view of the characteristics of the papers, abstract and keywords more effectively. Having defined the Portfolio, it began the classification of articles, which led to the identification of the main areas where interoperability is applied. Based on this information, was studied the historical evolution of the subject matter, presenting the state of the art on interoperability in logistics.

On this basis, the identification of constructs and to propose a concept of interoperability logistics was possible.

## 3 Interoperability

In the field of information technology, interoperability allows different organizations to provide data without interfering in their technology choices, production processes, or internal culture, can be defined as the ability of a system or its components to share information and applications regardless of their heterogeneity [9,10,11]. Interoperability between components of a distributed system is defined as the ability of these components to exchange information despite language differences and platform [12,13,10].

A broader view is given by [14]: Interoperability is the ability to work together with other companies, acting in the exchange of information and equipment, with minimal impact on them. It is observed that in addition to information, the author also deals with the equipment, perpetuating the concept of the application which was originally restricted to the area of information systems.

Similarly to [13] interoperability is the compatibility of skills and assets with other organizations. By addressing skills, approaches the concept of what is proposed in the field of knowledge management.

According to [15], interoperability is the establishment of mutual connections among two or more systems for sharing information. One aspect to consider is to share the semantics, whose role is to facilitate the understanding of the various stakeholders. And still, to [16] semantic interoperability ensures that the data exchanged are correctly interpreted within the context of a given transaction, culture and terminology adopted by each sector of the company. Thus, semantic interoperability is the ability of two or more heterogeneous systems for working together, sharing information between them with a common understanding of its meaning [17, 18].

## 4 Logistics

Logistics has been recognized as a strategic element to business success. Of all existing settings (many identical), it was used the following:

Logistics is the process of strategic management of the acquisition, handling and storage of materials, parts and final stocks (and the related information flows) through the organization and its marketing channels, such that the current and future returns are maximized through the execution of applications, seeking cost-effectiveness [19].

It is observed that the fundamental activities such as handling and storage are covered and that its goals are focused on business profitability. That is, it is necessary that the logistics act as an element that can contribute to the business strategy and, in consequence, improve the financial performance of the business.

The customer service is critical to the competitiveness of a company. In this sense, information and resource sharing is required, which supports the need to study the subject interoperability in the context of logistics.

In a survey conducted by [20], were identified seven attributes that characterize the development of logistics, among which is the integration. In [21] integration is defined as "the process of interaction and collaboration in which manufacturing, purchasing and logistics work together cooperatively to reach acceptable results for the organization each other." Nowadays, it adds to the scope of integration the relationship with suppliers and customers. The integration and collaboration are aspects also worked for interoperability.

#### 4.1 Logistics Interoperability

From the Portfolio classification was developed to identify the articles that addressed interoperability logistics. It was observed that only 02 of the 59 articles evaluated (Table 1) involved the fact that logistics, which justifies the approach taken in this research.

Table 1.

Interoperability classification according to their application

Author	Year	Application of the classification interoperability		
		Information Technology	Business	Logistics (indirectly)
Beckstead [22]	1994		x	
Manola [7]	1995	x		
Bishr [9]	1998	x		
Sarjoughian and Zeigler [23]	1999	x		
Cavaliere et al [24]; Sinex et al [25]	2000		x x	
Lendermann et al [18] Scholz-reiter and Hohns [26]	2003	x	x	
Buranarach [16] Ducq, Chen and Valespir [27] Heinrich and Chaudhuri [28]	2004	x x x		
Bruzzone [29] Han et al [30] Helo and Szekely [31] Talevski, Chang and Vallespir [32]	2005	x x	x  x	
Liao and Zhu [33] Park et al [34] Fried [35] Skinner (a) [36] Daclin, Chen and Vallespir [5] Brambert [37] Fenies, Gourgand and Rodier [38] Liao, Zhu and Qiu [33]	2006	x  x  x x	x  x   x	
Levjakangas, Haajanen et al [39]	2007		x	
Rogers [40] De la fuente, Ros and	2008	x		x

Cardós [41] Moon, Fewell and Reynolds [42] Ye et al [43] Chituc [44] Panetto [45]		x x	X X	
Lai, Xu and Liu [12] Carson [46] Gottschalk [47] Briggs et al [48] Wang and Wang [14] Inkinen, Tapaninen and Pulli [49] Ma et al [50]	2009	x  x x	X  X	X
Weichart, Feiner and Stary [51] Pan, Zheng and Yan [52] Chen, Yeh and Chen [13] Beheshi, Dado and Van.[53] Smirnov et al [54] Smirnov and Shilov [55]	2010	x  x x x	X  X	
Kawtrakul et al [56] Khalifa, El Kamel and Yim [57] Paviot, Cheutet and Lamouri [17] Scherer and Schapke [58] Zacharewicz, Deschamps..[59] Mauro, Leimeister and Kremar [60] Johnson et al [61] Buyukoskan [62] Lier and Hardjono [15]	2011	x  x x x x	X  X  X	
Azevedo and Carvalho [63] Schilk and Seemann [64] Malhene [65] Anand [10] Blatter [11] Verdecho [66] Lin et al [67]	2012	x  x x x	X X X X	X

Source: the author's Research

Although there are only 02 studies addressing the interoperability logistics, there are researches that focused on interoperability in some specific aspects of logistics, such as transport (09 searches), storage (02 studies), distribution (03 studies), and management supply chain (15 surveys).

In the field of production, where logistics is an important interface, only from 2005 are papers related to interoperability, dealing with: simulation platforms [30] or oriented systems orders [40], or in manufacturing systems [45], on construction sites [48] [68], and city logistics [69].

The perception obtained in the literature, combined with the rating of the papers shows the use of interoperability indirectly in logistics, as performance support, demonstrating existing conceptual gap in the studies [18, 31,41,5, 11].

## 4.2 Logistic Interoperability – a definition (LI)

From the literature, there has been an approach of interoperability with logistics regarding relations established in certain activities, such Storage and Transport for example. However, there is still no definition that allows a comprehensive look at the LI. Given this gap, we propose the following definition: Logistics Interoperability refers to the logistical capacity that an organization has to share, interact, collaborate, and make its structure compatible with other business functions, and especially with customers and suppliers, without losing the independence of decision and action.

Logistics by its very definition has an interoperable feature, since through integration allows this interaction, collaboration and sharing between the different elements of the organization.

The LI is manifested at various times within the logistics systems, so it results necessary to dismember the general concept of LI defined above. One way would be by Material flow, essence of logistics, which identifies the LI in each of the main logistics subsystems, namely: Supply Logistics, Internal Logistics and Physical Distribution Products.

Supply Logistics in the LI is manifested as the necessary interoperability between the supplier and the client company (the quantities and the time will be provided); between the supplier and the carrier (quantity to be shipped and product mix, in correspondence with the type of vehicle and its capacity); between the carrier and the raw materials warehouse (quantity, timing, frequency of deliveries etc.)

Internal Logistics in the LI is manifested as the necessary interoperability between the raw materials warehouse and production lines (supply lines, frequency, amounts and times); between the different sectors of production that have technological sequence (productive capacities and synchronization of activities); and between the lines / production sectors and finished products warehouse (quantities are delivered in stock and mix thereof, corresponding to the capacity of the warehouse, turning their products etc.).

In Physical Distribution Products, LI manifests itself even more significantly to a lot of companies, the necessary interoperation between some areas of the finished products warehouse (between the storage area itself, and the areas of picking or order picking, between these areas and the shipping docks etc.); between the shipping docks and transport vehicles (capacity and capabilities of these shipping docks, documentation with the information necessary for the delivery of products); between transportation and distribution centers if there are (transport capacity, delivery time, capacity of warehouses or distribution centers), and equally, with the customer warehouses for the finished products.

In figure 1 is illustrated the manifestation of the LI. From it is also possible to observe the constructs of this concept (share, interact, collaborate and compatible).

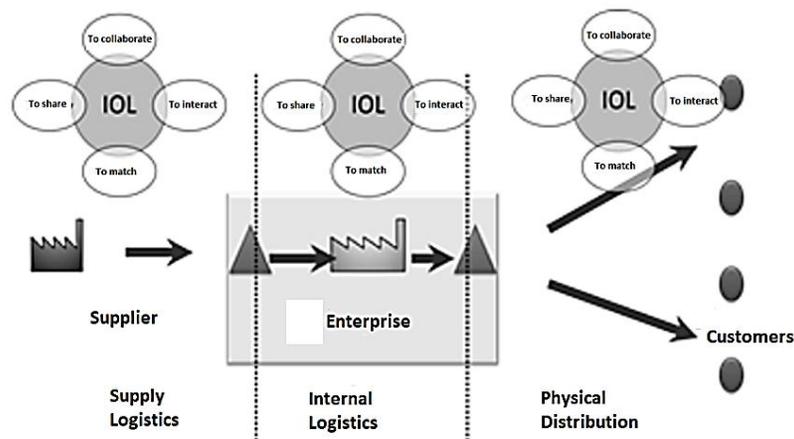


Figure 1. The interoperability in the logistics  
Source: The authors

Another way to elaborate the concept of LI in this paper would be based on the main parameters associated with a material flow: space and time. In this way, power would identify a spatial LI (interoperation in places, collection of raw materials and delivery thereof; the specific local delivery of components and parts in production lines and warehouses, delivery of finished products to customers and spatial routes of vehicles etc.) and a temporal LI (interoperation in time between the request for an order to buy raw materials and their arrival in the company, between the time of arrival of the cargo vehicle and the time of completion of preparation of orders, etc.).

## 5 Conclusions

The subject Logistic interoperability is emerging which to fill gaps with respect to a more extensive treatment in logistics area. Its application and treatment is given in a large majority in the area of information systems. Thus, at this study a treatment for the logistics system was given.

The concept of Logistic Interoperability (LI) contributes to reduction of operational work, increased agility and service capacity, reduced logistics costs, improved management and data integrity, promoting greater coherence between the physical flow and information flow, and a greater efficiency for the entire system, since permeates all levels of the organization.

By offering constructs and a concept for LI allows a breakthrough in the discussions on the subject. The quantification of the contribution of the constructs with the effectiveness of LI, the relationship of the constructs with each other and the measurement of business results on the use of the approach, turn out to be opportunities for future research.

Finally, the structure of the research methods proves to be a logical potential for application in other research on interoperability and logistics, as well as in other areas of knowledge. This is based on the process a solid literature and results consistent with the proposed objective, expanding the field of knowledge.

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