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Garrido Azevedo, Susana and Ferreira, João and Leitão, João

University of Beira Interior

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**THE ROLE OF LOGISTICS'
INFORMATION AND COMMUNICATION TECHNOLOGIES
IN PROMOTING COMPETITIVE ADVANTAGES OF THE FIRM**

Susana Garrido Azevedo, Ph.D., in Management
University of Beira Interior
Pólo IV – Edifício Ernesto Cruz, 6200-209 Covilhã, Portugal
E-mail: sazevedo@ubi.pt, Telef: 351 275319651, Fax: 351 275319601.

João Ferreira, Ph.D., in Management
University of Beira Interior
E-mail: jjmf@ubi.pt
Pólo IV – Edifício Ernesto Cruz, 6200-209 Covilhã, Portugal

João Leitão, Ph.D., in Economics
University of Beira Interior
E-mail: jleitao@ubi.pt
Pólo IV – Edifício Ernesto Cruz, 6200-209 Covilhã, Portugal

ABSTRACT

With the rapid growth of technologies, our economic society and life are changing significantly in the 21th century. The way to capture their competitive advantage has become the most important issue for enterprises in the rapidly changing and uncertain business environments. Many researches have pointed out that the adoption of technology is the most important tool for enterprises to keep their competitive advantage. The survival of an enterprise in the age of knowledge-based economy depends on how to improve their technological capability.

In this sense, firms should develop adequate methodologies, in order to adopt, in a successful way, new technologies in the logistics field, and also to integrate logistics into the corporate strategy for becoming even more competitive.

Growing number of firms are under pressure from their partners to change their traditional management style, both operationally and organizationally, replacing them with integrated systems that help increase the speed and fluidity of physical and information flows. In order to reach this kind of integration they are investing on new Information and Communication Technologies (ICT). In this paper we consider that the ICT are the devices or infrastructures to make more efficient the communications of business information among organizations (Dawe, 1994).

Being so, the present paper aims: (i) to highlight the importance of ICT on logistics; and (ii) to understand the impact of ICT on the firms' competitiveness.

In this paper a conceptual model for the adoption of Logistics' ICT is presented, by taking into consideration four determinant factors: individual, organizational, technological or innovation, and environmental. The interaction established between the referred determinant factors may be identified through the computation of the predominant factor, by using a selected set of adequate indicators and a simple geometry methodology. These procedures may provide the identification of the sources of firms' competitive advantages that adopt Logistics' ICT. The Logistics' ICT analysed in this paper are grouped into four types, such as, the identification, the data communications and the data acquisition technologies.

With regard to the identification technologies, firms may appeal to barcoding, Radio Frequency Identification (RFID). The barcoding (Chapman *et al.*, 2003; Ellram *et al.*, 1999), and RFID (Kumar *et al.*, 2006; Twist, 2005; Choy *et al.*, 2007), are identification technologies that facilitate logistics information collection and exchange.

Nowadays, as regards the data acquisition technologies, the firms usually deal with a large amount of goods and data which means that data collection and exchange are critical for logistics information management and control. Good quality in data acquisition can help firms deliver customers' goods more accurately and efficiently. To attain this goal firms could appeal to some data acquisition technologies in logistics field, such as the optical scanning, the electronic pen notepads, (Lin, 2006), the voice recognition and the robotics (Dawe, 1994).

1. Introduction

Since the beginning of computerization, ICT have assumed supporting role for the organizational functions. During the 80's, ICT have been more studied as instruments for implementing strategic initiatives (Gratzer and Winiwarter, 2003).

Several authors show that with the success of ICT organizational transformations are taking place in industries and firms (Timmers, 1998; Torbay *et al.*, 2001; Porter, 2001; Gratzer and Winiwarter, 2003). The ICT have created some new industries, such as, on-line auctions and digital marketplaces. However, this greatest impact has enabled the reconfiguration of

existing industries, which are constrained by high cost for communicating, gathering information, or accomplishing transactions (Malhotra, 2000; Porter, 2001).

The modern business is characterised by the growing capacity of supply, global competition and even the increase on the consumers' expectations (Filho, 2001). Business strategies built upon single competencies are abundant in today's fast changing, information and technology driven environment (Kirlidog, 1996; Raymond, 2005; Olson, 2006). Nevertheless, the most successful firms of the current decade and century are learning to become highly flexible, operationally integrated, and delivering value to customers, partners and alliances in revolutionary new ways that are not easily imitated. These leading firms look very different from many high-tech firms of the past whose strategies were built upon foundations of product technology excellence (Olson, 2006).

An underlying structure is developed to provide a deeper understanding of the way in which ICT are diffused in global firm's context. Innovative applications of ICT have created an environment where the old ways of operating, no longer apply and new rules have been developed. These new rules set the conditions within which firms can not only operate but also to make strategic choices (Gharavi, *et al.*, 2004).

New ICT are changing the economy and the way business is conducted in various forms. ICT force firms to find new ways to expand the markets in which they compete, to attract and retain customers by customizing products and services, and to restructure their business strategy to obtain competitive advantage (Gratzner and Winiwarter, 2003).

A strategy specifies how a business intends to compete in the markets it chooses to serve. Today's business strategy model should be integrated, consisting of a market and a policy component (Baron, 1996). The market strategy is a concerted pattern of actions taken in the market environment, in order to add value for the firm, through the improvement of its economic performance, as is the case when firms compete with its rivals, through the launching of a new or innovated good, or by implementing adequate pricing strategies. A policy strategy is a concerned pattern of actions taken in the policy environment to create value for the firm by improving its overall economic position (Porter, 1985). The first opportunity is to understand the emerging policy landscape in states, countries, and different regions of the world, as well as the institutional context. These new policies appear to offer

better opportunities for not only regulated competition but also intensified competition in the market and to obtain competitive advantages, on a sustainability basis.

Porter and Millar (1985) argue that ICT affect the competition in three distinct ways: (i) ICT may change the structure of an industry, and modify the rules of competition; (ii) ICT may be used to create sustainable competitive advantage and provide firms with new competitive instruments; and (iii) ICT new business may be developed within a firm's existing activities.

In this context, ICT application may be a useful tool that allows a firm to achieve this aim because of the potentially high information intensity in the firm value chain (Hinton and Tao, 2006). According to Porter (2001) the basic tool for understanding the influence of ICT on firms is the value chain – the set of activities through which a product or service is created and delivered to customers. When a firm competes in any industry, it performs a number of discrete but interconnected value-creating activities, such as operating a sales force, producing a component, or delivering products, and these activities have points of connection with the activities of suppliers, channels, and customers. For Porter (2001) the value chain is a framework for identifying all these activities and analysing how they affect both the costs face by firms, and the value delivered to buyers. Because every activity involves the creation, processing, and communication of information, ICT has a pervasive influence on the value chain.

The special advantage of the Internet is the ability to link one activity with others and make real-time data created in activity widely available, both within the firm and with outside suppliers, channels, and customers. Today, firms frequently integrate Internet technology to redesign processes in ways that strengthen their competitive advantages (Phan, 2003). Business firm can gain competitive advantage by operational effectiveness, doing the same as your competitors do but doing it better, and by strategic positioning, doing things differently from competitors in a way that delivers a unique type of value to customers (Porter, 2001).

2. Information and Communication Technologies and E-Business Models

Several classifications have been proposed in the literature to categorize E-Business models. According to Torbay *et al.* (2001) most authors suggest two dimensions in order to rate the business models: functional integrations and degree of innovation; type of relationships and degree of externality; power of sellers and buyers. This authors identified in literature, as

principal dimensions for classifying the business models the follow: (i) the user role; (ii) the interaction pattern; (iii) the nature of the offerings; (iv) the pricing system; (v) the level of customization; (vi) the economic control; (vii) the level of required security to monitoring and verify purchases in your system; (viii) the level of value integration; (ix) the value/cost offerings; (x) the scale of traffic; (xi) the degree of innovation; (xii) the ownership of the bargaining power (that is, the buyer or the seller).

Torbay *et al.* (2001) suggest a model to classify and compare the business models. They exemplify the way how to translate the core processes of the business models into a set of relevant measures for each component of the adopted framework. The model is divided into four main components:

- (i) *The set of products and services that is offered by firm and that represents a substantial value to a target customer (value proposition):* This element refers to the value the firm offers to a specific target customer segment. ICT have their most important impact on new ways of creating and delivering value. Customization is another common value proposition proposed by the authors enabled by the rapid development of ICT.
- (ii) *The relationship capital the firm creates and maintains with the customer, in order to satisfy him and to generate sustainable revenues (Customer relationship management):* ICT offer a whole new range of opportunities to exploit existing customer relationships, and to identify the customers needs in order to establish and develop a long relationship with him;
- (iii) *The infrastructure and the network of partners that are necessary in order to create value and to maintain an adequate partner relationship management:* The infrastructure component describes the value system configuration that is necessary to deliver the value proposition; that is, the relationship between in-house and/or partners' resources, assets and activities and a network;
- (iv) *The financial aspects that can be found throughout the three former components, such as cost and revenue structures:* Financial aspects embrace the costs required to make the productive get the infrastructure add value, and also the revenues that are generated through sales. The difference between revenues and costs determine the profitability of a firm.

According to Rashid and Al-Qirim (2001), four factors interact within a firm and serve as an evaluative structure to determine the propensity of innovation adoption specific to the firm and thereby directly impacting the CEO's decision process:

- (i) *Individual factors*: incorporate the decision maker's innovativeness and their knowledge of technology that affect innovation adoption;
- (ii) *Organisational factors*: influencing adoption cover such aspects as the size of the firm, the quality of the existing information systems, the intensity of the information being processed, the level of specialization of the firm as well as the level of adoption that is provide by the CEO's;
- (iii) *Technological or innovation factors*: include issues such as the relative advantages of the innovation, the complexity, the compatibility, cost and the image surrounding the innovation;
- (iv) *Environmental factors*: impacting adoption include the pressure from competition and within the supply chain, public policy as well as the role of government.

Rashid and Al-Qirim (2001) indicate that any or all four factors may impact on the process of ICT adoption. The organisational factors collectively impact on the resources of the business in relation to adoption of ICT innovation. Environmental factors provide significant impetus for adoption where the issues relating to market climate and the firm's standing in the market directly influence the uptake of technology. Increases in the incorporation of ICT within firm directly impacts on the functionality of the firm, increasing productivity and profitability of the business. Individual factors incorporate the management aspects attributed to the business and thereby influence significantly any decision to enhance the performance of the business.

According to Allan *et al.* (2003) the levels of ICT adoption by firms need to be addressed in terms of an evolutionary process. The evolution of E-business for firms has been described in the contemporary literature illustrating the transition from email use, website, online store, then to a digital basis for fully e-business commonly identified as progress. The evolution of a firm is established in evolution stages starting with limited use of technology through to the full integration of business automated processes as seen in the digital firm.

3. Information and Communication Technologies on Logistics

In the knowledge-based economy, the rapidly changing and uncertain environment makes firms face the biggest challenge that how to break the current situations and to capture their competitive advantage.

The works of Parsons (1983), Porter and Millar (1985), and also Porter (1985) pointed out the importance of the ICT, in the determination of the firms' competitive advantage. According to Bowersox and Closs (1996) this is due to the potential that ICT seem to have on lower cost and better services that could be offered (Bowersox and Closs, 1996).

According to Langley (1986), the ICT are important to logistics, since they make available the right information, at the right time and at the right place. This popular logistical paradigm, which most often refers to physical goods, is shown to have equal relevance in the management of information. Introna (1991) demonstrates that while the logistical system converts materials into products, through the creation of value for customers, the information and communication systems convert data into information, in order to facilitate managerial decision making. Both authors infer that information is a resource to be used for decision making that subsequently enhances logistical effectiveness, efficiency, and flexibility. For its turn, these factors provide the possibility of firms becoming more competitive.

The investment in state-of-the-art ICT could be the main differentiator between leading edge logistics firms and average ones (Bowersox *et al.*, 1989). The Global Logistics Research Team (1995) determined that ICT is one of seven capabilities that combine for logistics process integration and world class performance. Adoption and successful implementation of ICT is intended as a prerequisite for logistics success.

Many researchers have found that ICT are the most important tool for firms obtaining competitive advantages (Kimberly and Evanisko, 1981; Damanpour and Evan, 1984).

Nixon (2001) reinforces the precedent vision, by suggesting that firms should employ ICT to raise their service capability in an E-business context. Mason-Jones and Towill (1999) and Sauvage (2003) also defend that firms improve their operation efficiency, through the continuous implementation of information or automation technologies according to their business characteristics.

There is no doubt that the ICT is playing an important enabling role in logistics. Several surveys have been conducted to investigate the use and importance of ICT in supporting logistics operations (Hardaker *et al.* 1994; Gutiérrez and Durán 1997; Piplani *et al.* 2004). Firms need to be able to manage information effectively, and to integrate several logistics

activities by including inbound and outbound transportation, distribution, warehousing, and fleet management, in order to streamline the physical product flows of their customer firms (Lai *et al.*, 2005).

The ICT that may be used by firms in order to improve their competitiveness may be classified into three categories: (i) identification technologies, (ii) data communications technologies; and (iii) data acquisition technologies.

In what concerns the identification technologies, firms may appeal to barcoding, Radio Frequency Identification (RFID). The barcoding (Chapman *et al.*, 2003; Ellram *et al.*, 1999), and RFID (Kumar *et al.*, 2006; Twist, 2005; Choy *et al.*, 2007), are identification technologies that facilitate logistics information collection and exchange.

As regards data communications technologies, firms may appeal to the electronic data interchange (EDI), the fax, (Dawe, 1994; Ellram *et al.*, 1999), the Internet, the Value Added Network (VAN) (Power and Sohal, 2002), the point of sales systems (POS) (Ellram *et al.*, 1999), the electronic ordering system (EOS) (Closs and Xu, 2000), the logistics information system, the computer telephony integration, and the enterprise information portals (Lin, 2006). Among data communications technologies, seems that the fax and the EDI are the ones with high levels of logistics usage (Dawe, 1994).

In terms of data acquisition technologies, firms usually deal with a large amount of goods and data. This way, the collection and the exchange of data are critical for logistics information management and control. Good quality in data acquisition can help firms deliver customers' goods more accurately and efficiently. To attain this goal firms could appeal to some data acquisition technologies in logistics, such as the optical scanning, the electronic pen notepads, (Lin, 2006), the voice recognition and the robotics (Dawe, 1994).

3.1. The impact of Information and Communication Technologies on logistics

In the ICT logistics approach embrace the hardware, the software, and the networks investment and the design to facilitate processing and exchange of data (Global Logistics Research Team, 1995).

The successful implementation of ICT to support the several logistics processes is expected to bring a number of benefits to the firms (Lai *et al.*, 2005). According to Gutiérrez and Durán

(1997), Hammant, (1995) and Piplani *et al.* (2004) these benefits could be translated by a reduction on errors from the entry of data and improvements in customer services (Gutiérrez and Durán 1997; Hammant, 1995; Piplani *et al.* 2004).

Lai *et al.* (2005) points out also that the use of ICT makes possible that firms monitor the inventories, improve the utilization of their transportation and warehouse assets, and eliminate duplication of effort in performing different logistics activities for their user firms. Many logistics managers consider ICT as a major source of improved productivity and competitiveness. They are also presented as a key component in the logistics systems (Dawe, 1994).

Closs *et al.* (1997) showed that ICT capabilities significantly influence the overall competence of logistics. According to experts, no single factor seems to have greater potential to improve logistics operations than information communication technologies.

In fact, ICT not only improve the effectiveness and efficiency of logistics processes, the successful implementation of ICT may have also a significant impact on logistics strategies and on organizational structure (Bowersox and Daugherty, 1995).

Examples of recent benefits reached by firms from the use of ICT include: (i) quick response and access to information; (ii) better customer service; (iii) increased competitiveness; (iv) reduction on data and data re-entry (Lai *et al.*, 2005); (v) faster data collection, processing and faster communication (Dawe, 1994).

The use of ICT on logistics brings also an important impact on firms' competitive advantage (Closs and Xu, 2000). Stock (1990) illustrates examples of firms using logistics' ICT to gain competitive advantage. Bourlakis and Bourlakis (2006) defend a successful integration process between the logistics and the ICT, since this kind of integration confer a competitive advantage upon retailers' distribution operations.

Drucker (1988) believes that the ICT and networking will be the key to organizational coordination. The direct impact upon logistics organizations of the future may be a reduction in formal structure with an increase in the networking of specialists. Executives at many firms have realized that it is no longer necessary to maintain total internal control over all phases of operations. Logistics strategies can be implemented and performance goals realized through closer interactions and boundary spanning relationships with trading partners. The adoption of adequate ICT could make it possible.

Much of the growth in outsourcing and external alliances will result from advances in communications capabilities including Electronic Data Interchange (EDI). The availability of timely, accurate information will allow firms to coordinate inter-organizational activities (Lin, 2006).

However, the process of ICT adoption could be quite difficult to firms because of its requirements. The adoption of ICT is, usually, associated with a large investment and firms may not have sufficient financial resources to support the high investment in hardware and software technology that is required (Lai *et al.*, 2005). Another factor that becomes difficult the ICT adoption, form the part of the firms is the lack of expertise and technical support for implementing ICT (Yeung *et al.* 2003).

Particularly about the EDI, it is necessary to convert languages standard as way of making possible the dissemination of information through business partners. In this way it was created dominant standards such as Accredited Standards Committee (ASC) X12 and UN/EDIFACT . They need to be converted between competing standards. To surpass this situation, both the government and the private sector should make efforts to resolve it by developing valued added information exchange platforms, as for example, the Digital Trade and Transportation Network (Lai *et al.*, 2005).

4. Conceptual model

A conceptual model for the adoption of Logistics' ICT is proposed. The present proposal is original and innovative, since it presents a systemic approach, by representing the interaction established between the previously referred determinant factors, through the proposal of several indicators. The determination of the predominant factor may help to understand the contribution of each factor for enhancing the competitive advantages of firms.

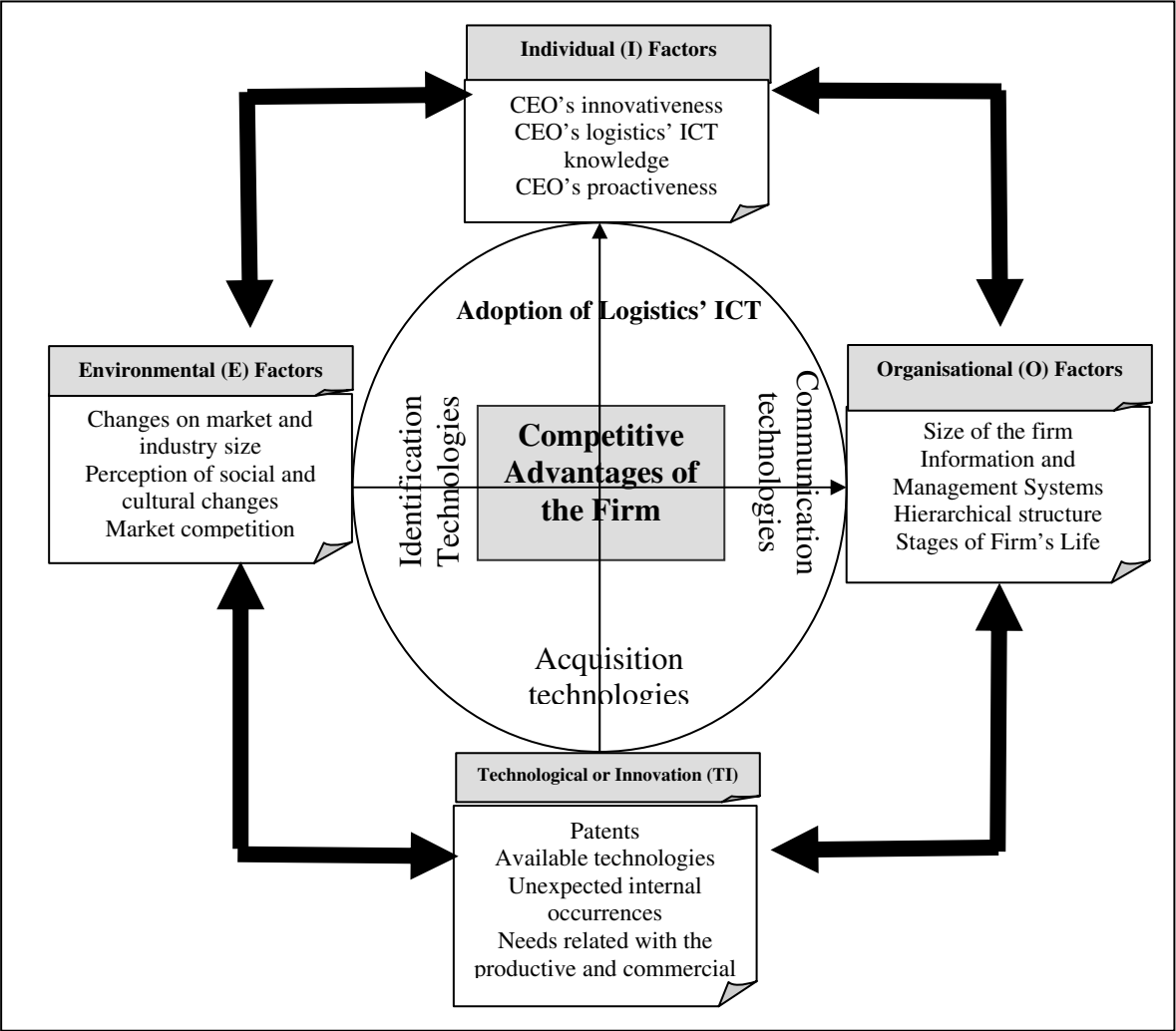
4.1. Model Design

In this section, a conceptual model is designed by taking into consideration a set of four determinant factors: the individual, the organizational, the technological and innovation, and the environmental factors (Figure 1).

In the first place, the individual factors are, basically, related with the profile of the CEO, in terms of innovativeness, knowledge about Logistics' ICT, proactiveness, and risk taking. In

the second place, the organizational factors are characterized by the size of the firm, the existence of information and management systems, the hierarchical structure, and the stages of firm’s life cycle. In the third place, technological and innovation factors are considered, whose measurement may be accomplished by several indicators, namely, the patents, the available technologies, the unexpected internal occurrences, and also the needs related with the productive and commercial processes. Last, the environmental factors are contemplated, such as, the changes occurred in terms of market and industry size, the anticipated perception of social and cultural changes, the market competition, and the public policies that are oriented for further investment in ICT.

Figure 1 - Adoption of Logistics’ ICT: Conceptual Model



Source: Elaboration of the authors.

In order to operationalise the conceptual model previously proposed in this paper, the Indicators of the determinants factors (I_{DFi}) and its Description (D), for the adoption of Logistics’ ICT, are referred in table 1:

Table 1. Determinants and indicators for the adoption of Logistics' ICT

Determinants Factors (DF_i) (i=1, 2, 3, 4)	Indicators (I_{DFi})	Description (D)
1. Individual factors	CEO's innovativeness	The capacity of the CEO for enhancing innovation practices inside and outside the firm.
	CEO's logistics' ICT knowledge	The level of knowledge presented by the CEO, in terms of the state of the art relative to Logistics' ICT adoption.
	CEO's proactiveness	The capacity of the CEO to develop a prospective vision about the business administration and corporate strategy.
	CEO's risk taking	The propensity for facing risky projects and developing entrepreneurial activities. Additionally, the capability to transform an idea into a business opportunity.
2. Organisational Factors	Size of the firm	The dimension of the firm influences the processes of business administration, the number of decision makers, the level of sophistication in technology adoption, namely, in logistics and production activities.
	Information and Management Systems	The external and internal information systems that provide the development of customer and partner relationship management mechanisms.
	Hierarchical structure	The level of formalisation of the decision making process, the level of centralization decision making process and the number of hierarchical levels are critical factors for the successful adoption of new ICT.
	Stages of Firm's Life Cycle	The classification of the present stage of the firm's life cycle intends to identify the growth level of the firm.
3. Technological or Innovation Factors	Patents	The total number of patent applications, which can be split taking into consideration the type of technology and the economic activity developed by the firm.
	Available technologies	The capability to develop new combinations of productive factors that may yield significant technological changes of products and processes.
	Unexpected internal occurrences	The technological changes that are originated from internal occurrences.
	Needs related with the productive and commercial processes	The efficient development and adjustment of productive and commercial processes, taking into consideration the needs identified by the intermediate board and the operators.
4. Environmental Factors	Changes on market and industry size	The number of new productive activities or services that are introduced according to the changes observed in the market and industry size.
	Perception of social and cultural changes	The number of products or services that are introduced or innovated, according to the social and cultural changes that are observed in the external environment.
	Market competition	The degree of competition and rivalry between the firms.
	Public Policies	The level of investment oriented for ICT adoption and dissemination.

Source: Elaboration of the authors

4.2. Model Measuring

Taking as reference the methodology, originally, proposed by Stone and Ranchhod (2006), we propose an adapted procedure for model measuring, in order to position a firm in terms of the enhancement of its competitive advantages that are derived from the adoption of Logistics' ICT.

In simple terms, the spread (maximum – minimum) of each proposed indicator that is associated with the four determinant factors should be computed. In order to determine the relative position of the firm, according to the proposed conceptual model, the following equality should be addressed:

$$I_{DFi} = \frac{(Value - \min)}{\left(\frac{\max - \min}{10}\right)} \quad (1)$$

For the purpose of determining the area relative to the adoption of Logistics' ICT, we propose to compute an average value for the indicators that are associated with each determinant factor. For example, in terms of the individual factors, an average value of the indicators: CEO's innovativeness, CEO's logistics' ICT knowledge, CEO's proactiveness, and CEO's risk taking, should be computed. After that, the average value will be used for representing the upper side of the *y*-axis. The same method should be replicated for the *x*-axis. Afterwards, the sum of the individual areas of each quadrant's triangle should be computed in the following way:

$$\sum A_{DFij} = A_{IO} + A_{IE} + A_{TIO} + A_{TIE} \quad (2)$$

Where:

AIO = Individual*Organizational*0,5

AIE = Individual*Environmental*0,5

ATIO = Technological or Innovation* Organizational*0,5

ATIE = Technological or Innovation* Environmental*0,5

Following the methodology proposed by Stone and Ranchhod (2006), with the purpose of revealing the predominant factor, a line should be drawn from the origin [0,0], to the point of distortion, that is, the pair [average value of *x*-axis, average value of *y*-axis]. The length of this line may be computed through the use of the Pitagoras theorem.

5. Concluding remarks

The literature review suggests that information is a valuable logistics resource. The flow of information has been recognized alongside the importance of materials flows in the logistics channel.

In recent times several changes occurred that have highlighted the importance of logistics either as a source of competitive advantage, or as a crucial strategy. This means higher customer satisfaction and also bigger success for firms. Some of the referred changes are associated with the business globalization, the continuous shortening of products life cycle, the intensification of competition, and the appearance of new competitive priorities.

The importance of logistics and its related functions, which move products, orders, and data along many dispersed points (production plants, warehousing, retailing, and transportation), increases the firms' concern, in terms of accompanying, controlling and managing distinct logistical operations.

Through the intensive use of Logistics' ICT, namely, acquisition, communication, and identification technologies, the information flows are, efficiently, used by firms, in order to reinforce the existent competitive advantages, or alternatively, to create new competitive advantages.

In this paper a conceptual model for the adoption of Logistics' ICT is presented, by taking into consideration four determinant factors: individual, organizational, technological or innovation and environmental. The interaction established between the referred determinant factors may be identified through the computation of the predominant factor, by using a selected set of adequate indicators and a simple geometry methodology. These procedures may provide the identification of the predominant factor that determines the firms' competitive advantages, which are originated from the adoption of Logistics' ICT.

Finally, in terms of guidelines for future researches, we suggest the development of longitudinal studies, which may conjoin three theoretical approaches, namely, the firms' life cycle, the logistics' ICT and competitiveness. In this sense, taking into consideration the conceptual model now proposed, future studies may be developed in order to identify the dominant factors that determine the competitive advantages obtained through the Logistics' ICT adoption, according to each stage of firms' life cycle.

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