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IT APPLICATIONS IN LOGISTICS AND THEIR INFLUENCE ON THE COMPETITIVENESS OF COMPANIES/SUPPLY CHAINS

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Abstract

This paper aims to study the influence of Information Technologies on the competitiveness of companies/supply chains. That is, it intends to analyse if the adoption of Information Technologies contributes to improve costs, time and customer service. To attain this objective a case study and content analysis methodology is used. Results indicate that there is a positive relation between the adoption of technologies, namely RFID, A.R. and the competitiveness of companies/supply chains. By the use of these technologies it is possible to improve several processes across the supply chain, as well as the reduction of costs related to labor, improvement in inventories and management of transport channels as well as an improvement on customer service. The improvement of these indicators has as consequence a gain in competitiveness allowing the companies to respond to the market needs in a differentiated way increasing by this way the customers' satisfaction. As the information technologies have been considered very important for businesses it is crucial to improve our understanding on the main advantages associates with them and their contribution for competitiveness improvement of companies and supply chains, so this paper represents an important contribution for academics and professionals in this field.

Keywords: logistics; information-technology; competitiveness; company, supply chain

JEL classification: E29, F23, M15

1. INTRODUCTION

One of the major vectors responsible for changing the competitive paradigm is the globalization phenomena, generally considered as a process which raises social, political, cultural and economic interdependence (Thoumrungroje, 2004), generating significant

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changes in the business environment. Among those changes, it is most visible the emergence of new opportunities and threats. The opportunities raised from this businesses' globalisation context are the constant raising of potential markets, potential clients, investment capacity and, resources availability. With that, threats focus on the raising of more intensive competition and on the difficulty to foresee the business environment, which derives from the increased complexity and dynamism (Naghi and I., 2013).

In the adaptation process of companies to these environmental changes, logistics has been playing a strategic role being considered as a new competitive weapon on the businesses' service (Waller, 1998). In fact, the definition of logistics throughout time, has been focused on customers' satisfaction during the 1950's. Though, on the 1960's, its focus was on handling and storage from the raw material/product to the consumer, which actually encompasses the full amount of information and material flows. This way, logistics has stopped being seen as a simple operational activity to be seen as a strategic activity (Carvalho, 2004). It is a believe that the pertinent ascertainment that the superb growth rates of markets with similar future tendencies, energy costs increasing day by day and markets' globalization, raised new challenges. Logistics can be a nuclear competence adding value to the company's product/service, differentiating it form the others (Morash *et al.*, 1996), thus being a fundamental element on companies' strategy definition (Visser, 2008) by helping them to reach critical competitive advantages (Bowersox and Closs, 1996; Bowersox and Daugherty, 1995).

A concept which is closely related to logistics is the supply chain, which consists in the entire range of activities involved in the delivery of a product – from the raw product until it gets to the customer –, including the acquisition of raw materials and the components, production and assembly, storage and inventory location, orders' reception and management, channel distribution, delivery to the customer and information systems (IS) required to control all this range of activities (Lummus and Vokurka, 1999).

One of the most common factors associated to supply chain practices is the information technologies (IT), which allow connecting companies to clients, suppliers, regulating agents and strategic partners (Weill and Broadbent, 1998). This way, IT represents a key support to companies in order to create competitive advantages by allowing the centralization of the strategic planning and the decentralization of the daily operations execution (Bowersox and Daugherty, 1995). As it is defined by Porter and Millar (1985), IT's change the industries' structures and competitions' rules, contributing to create competitive advantages and new market opportunities. Thanks to the IT's, it became possible the synchronization of activities and the establishment of continuous flows, without any interruptions or fails, which makes possible the coordination and integration of processes between agents, the tasks rationalization, the inventories' decrease and the client services upgrade (Bowersox and Closs, 1996).

This raising of IT adoption by companies, has motivate the introduction of new technologies like the radio frequency identification (RFID) and the augmented reality (A.R.), which contributed to increase companies and supply chains competitiveness.

Considering the globalization process and the raising competition the companies need to invest on tools which allow them to reach increased competition.

Bearing in mind this, this study intends to analyse the IT's influence on the companies and supply chain competitiveness. In order to understand such influence, several propositions arise from the literature review and they are tested using some case studies and secondary sources are analysed The main goals of this study are to analyse if IT's adoption

allows both cost and time reduction and also client service upgrades. In order to reach the proposed goals the impact of IT's adoption on nine multinationals companies are analysed.

In what concerns the study structure, in the first chapter – introduction – it is intended to contextualize the study and to formulate its main goal. In the second chapter, it is intended to understand the importance of logistics to companies inside this competitive environment, approaching concepts such as competitive advantage and supply chain. In the third chapter, IT's are presented on logistics' services and, as well, the advantages reached by companies and their own supply chains. The fourth chapter presents the methodological framework and in chapter five the cases studies are presented and the main results. At last, the final chapter (sixth) displays the general conclusions of this study and the limitations, as well as future research lines.

2. LOGISTICS IMPORTANCE ON COMPANIES AND SUPPLY CHAINS COMPETITIVENESS

Among the diversity of changes occurred inside companies, it should be given a special highlight to the strategy as a research field because of the importance of customer value concept.

According to Poon and Lau (2000), "value" means: functional benefit of a received product or service, being quantified by:

- Association between total cost and the performance of each produced unity;
- Economized quantity, bearing in mind the use of alternatives;
- Accessibility of a person in charge besides the regular customer support;
- Free support;
- The synergy attained by one product, process or other materials;
- A cultural value presence inside the organization.

Knowing the aspects which create value or not is essential in a competitive environment: in order to be the source of a competitive advantage, the company has to execute a certain activity in a better way than their competition (Popescu and Dascalu, 2011). In order to achieve competitive advantage over its competition, companies should proportionate value to their clients/consumers, performing those activities in the most efficient way and in a way that the result is seen as an effective value addition by the served markets, in order to achieve the highest effectiveness and loyalties.

One of the companies' main goals is to create sustainable competitive advantage which proportionate value for both clients and stockholders, being this the aim of all business activity.

Competitiveness integrates one of fundamental importance of logistics organization, since it is from the logistic service the value that achieves the clients and it is also through that same value that the company acquires the necessary information that the value needs in order to be recognized by consumers (Menezes, 2000).

According to Leitão *et al*. (2008, p. 323):

"The logistic competences which may support/create generic advantages can, in a general way, be nested in the following sources of competitive advantage:

- Advantage in terms of service quality;
- Advantage in terms of time;
- Advantage in terms of cost/efficiency".

Bowersox and Closs (1996) claim that logistics' goal is to provide products or services on the expected local and moment by clients and underline the idea that the implementation of the best logistic practices is one of the biggest challenges faced by organizations on global competition.

Morash *et al.* (1996) stand by the idea that logistics may be a nuclear competence, capable of adding value to the companies' product/service, differentiating it from others towards the client.

The adjoining environment which surrounds companies' actions is unique, turbulent and unstable, characterized by several mutations. Facing that, one of the companies' basic demands is a result of the continuous mutations capacity of their intern reality, facing so to the characteristics of the surroundings (Carvalho, 1999). Markets are, most of the time, of national or international character, by which its logistics are the bridge between production locations and markets separated by time and distances (Ballou, 2004).

So, according to Carvalho (2004), companies need to internationalize, tending to operate on environments both external and internal. Entrepreneurial answers should establish an explicit focus on what concerns to the "GLOCAL" experience, a complex binomial due to differentiations amongst several components and basic markets. According to Carvalho (1999): "Companies constantly seek to adjust to the external mutating context, when daring to remain competitive in the market".

Logistics are vital towards consumers, companies and to the economy in general for a several set of reasons, especially about the huge geographic dispersion between suppliers and customers, with the consequent need to match the offer (this is, to whom? Which amount of product/service will be produced or sold?) with the demanded supply (this is, with product/service will be required? When? How much?), allowing customers the needed goods and services and assuring companies their production outflow, along with raw material supplies and other used inputs on production operations (Moura, 2006).

According to Leitão *et al.* (2008), the rising importance of logistics is mostly a result of a combination between some factors that have been transforming the entrepreneurial competitive environment much more demanding and more complex. These same authors underline eight factors of change that have an impact on logistics importance:

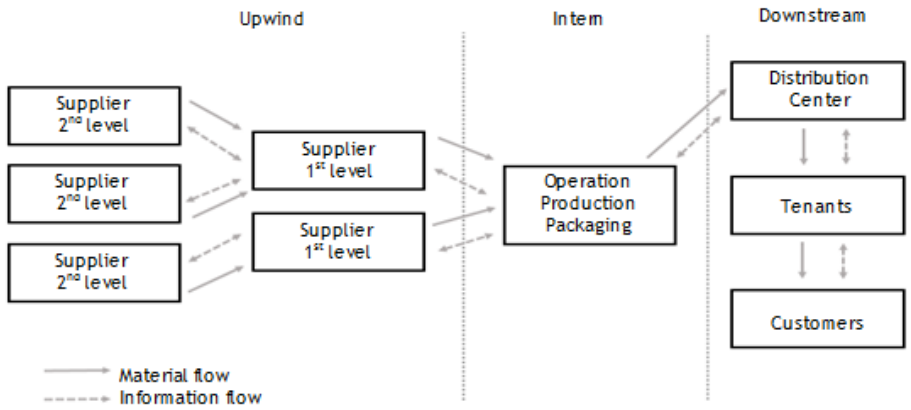
- Economic globalization, depicted, on one hand, by the rising exportations and importations, either on European or Portuguese companies, thus rising competiveness and pressure over costs, and, on the other hand, eases buying policies on a global scale;
- Companies' internationalizing movements and logistics and production units relocations, as well as an existing tendency towards production specialization;
- The quick changes of markets' and market segments' behaviours;
- The rising number of cases in which products'/services' differentiation is achieved by the customer services component;
- The higher demands of customers (higher power on bonds located downstream of the supply chain) conduct companies to offer a wider range of products and services and of a higher added value;
- Pressures to simultaneously improve customer service levels and reduce costs, due to stakeholders pressure, while using only one European coin and while selling online;
- Fashion characteristics are even more present and massified, leading to a demand's higher volatility, to a product's lifecycle reduction and to a time-to-market reduction;

- The environmental risks have been leading to the introduction of legislations on recycling and product packaging, producer's responsibility on their own end of life products and fuel and penalty taxes prices, which challenge the concepts of the actual supply chain.

The supply chain forms a structured manufacturing process in which raw materials are transformed in finished products and, after that, delivered to the final clients (Beamon, 1998). On what concerns to the supply chains' configuration, it does not exist any principle that makes it equal to all products/services, as it is defined by Fisher (1997): each supply chain must be drawn, configured, developed and managed accordingly to the products' competitive requirements or of the service in question.

However, with the result of globalization, of the international commerce, of the outsourcing of productive factors and the consumption of a wide-world range of products, it is notorious the existing interdependence between the supply chain's producers and suppliers on an international level (Janvier-James, 2012). As a matter of fact, today's conception of supply chain is more perceived as a network rather than a chain. According to Christopher (2005), the term "chain" should be replaced for "network", since there exists multiple suppliers and customers from several lines to be included in the entire system and the term "supply chain" should be called "demand chain", since it better reflects the fact that the chain is guided by the market rather than by suppliers.

The following figure represents a generic supply chain with the company connected to the suppliers (upwind) and to their distributers (downstream):



Source: adapted from Laudon and Laudon (2004)

Figure no. 1 – Supply chain

Through Figure 1, it is possible to verify that there are three segments (upwind, intern and downstream), which Laudon and Laudon (2004) define in the following way:

- **Upwind:** includes the company's suppliers (1st level) and the suppliers' suppliers (2nd level), allowing to zoom in until the basic raw material supplier. The main activities in this segment are purchases and deliveries;
- **Intern:** includes the entire range of processes the company goes through to process and transform the received materials into products, since the material's entrance inside the company, to the product's shipping. The main activities in this segment are material drives, inventory controls, manufacturing and quality control;

- **Downstream:** includes the distribution and delivery of the products towards final customers. This segment activity includes packaging, inventories and deliveries.

At last, it is important to clarify that companies who have a better coordinate and structure the relationship with their partners – in a network committed to deliver superior value in the final market – will be better prepared to reach competitive advantages in the market they compete (Christopher, 2005).

3. INFORMATION TECHNOLOGIES IN LOGISTICS

Today's world economy is known by the pressure caused by strong competition, constant shifts and a high level of uncertainty and market unpredictability. Besides, the market's offered product variety keeps rising, by which it adds difficulties when administrating the information flow throughout the supply chain, forcing the introduction of new technologies to ease logistic operations towards manufacturers (Ngai *et al.*, 2007). This way, it can be claimed that all companies are exposed to technologies' developments, being its application obvious on every level of the supply chain, including on communications with suppliers, producers, in the relationship with the clients (Beig *et al.*, 2012), as well as on global logistics management, especially on world distribution coordination, product design, production, shopping and inventories (Huang *et al.*, 2001).

IT's can be defined as the technological side of an IS, which includes the hardware, data bases, software, networks and other devices (Turban *et al.*, 1999).

According to several researchers, IT's have been being the essential infrastructure in competitiveness and cooperation amongst companies, having positive effects on the supply chain's performance (Zhao and Xie, 2002; Yee, 2005), on the achievement of competitive advantage (Spalding, 1998), amongst other benefits:

- More efficient results (Mukhopadhyay *et al.*, 1995);
- Global error reduction (Mukhopadhyay *et al.*, 1997);
- Increasing quality of the business's execution process (Devaraj and Kohli, 2003);
- Satisfaction increasing and relationship engagement (Devaraj and Kohli, 2000);
- Learning and organizational memory increase (Alavi and Leidner, 2001);
- Strategic benefits that lead to the companies' competitive advantage (Ray *et al.*, 2004);
- Innovation in several products and services, enabling the appearance of some important capacities (information delivery online; electronic access to services; ability to request and obtain specific services; payments and electronic billing presentation) (Albertin, 2000);
- Easy access to some markets (Albertin, 2000);
- Entry barriers establishment (Albertin, 2000);
- Data storage from an external environment (database) (Newell, 2000).

After being recognized the IT's rising importance towards companies/supply chains, it is now important to analyse in detail the technologies that allow to support the companies' and their respective supply chain's competitive advantage. Part of the analysed technologies that will be analysed here are: i) Radio Frequency Identification (RFID); ii) Augmented Reality (A.R.).

i) Radio Frequency Identification (RFID)

RFID is a wireless identification technology that allows electronic information communication when associated to physical items (Modrak *et al.*, 2010). RFID's main

component is the smart tag fixated in the product. The electronic information is identified on the tag and after is collected through electromagnetic devices, which goes to a radio transmitter where a radiofrequency holder transmits to a possibly distant receptor, designated as reader, capable of interpreting and registering information (Floerkemeier and Sarma, 2009). Hassan and Chatterjee (2006) consider that the RFID system is basically made out of three elements: tags, electromagnetic data readers and a series of computational programmes.

When the tag passes through the external electronic reader, the data on the tag's memory are recovered and then transmitted. This memory consists in an integrated circuit or microchip and has the capacity to store a considerable amount of information, like in this case (Atkinson, 2004):

- Electronic code of a specific product;
- A product's reference code;
- Production data;
- Delivery dates;
- Expiration dates;
- Suppliers' information.

There exist numerous studies on possible companies' winnings in case they adopt RFID; in the same way, it is equally common to find out other studies that prove the fact that RFID has not yet presented results that reveal its implementation as a benefit. The reality is that the possible generated benefit will always be different between companies, even that they are in the same market segment. Like any other technology, its capacity to generate value is not exclusively relying on technical factors, but also on economical and organizational factors (Amitava *et al.*, 2007).

On the supply chain level, several activities have been being applied, from production, distribution, transportation and retail (Rutner *et al.*, 2004), being its improvements presented in the following table (Table 1).

Table no. 1 – Advantages associated to RFID usage

User	Advantage
Suppliers	**Inventory** • More information about the inventory (Smaros and Holmstrom, 2000); • More effective decisions on replenishment (Singh, 2003); • Decreasing inventory levels (Attaran, 2007). **Operational** • Increasing productivity (Attaran, 2007); • Upgrade on the material/product movement tracing, which leads to a efficiency raising on order accomplishment (Jilovec, 2004); • Higher quality and trust of the product (Attaran, 2007); • Higher profit margins as a result of cost reduction (Prado *et al.*, 2006); • Cost reduction on technical help (Prado *et al.*, 2006).
Distributers	**Inventory** • More information on the inventory (quantity and tracing) (Amitava *et al.*, 2007); • Loss reduction (Amitava *et al.*, 2007). **Information** • Less possibilities of inventory recount (A.T. Kearney, 2004); • Data gathering efficiency (possibility to read multiple tags simultaneously and without requiring to manoeuvre articles to reach the line of sight) (Soon and Gutiérrez, 2008).

User	Advantage
	Delivery • Better management of the storage and transportation channels (Attaran, 2007); • Higher delivery precision levels (Attaran, 2007).
Tenants	**Service Level** • Customer service improvement (Soon and Gutiérrez, 2008); • Better identification of the target audience (Jones *et al.*, 2004); • Easier identification of the clients' needs (Attaran, 2007); • Better product display on the shelves (Attaran, 2007). **Inventory** • Improvements on obtaining consume data (Singh, 2003). **Information** • Faster data recollecting (Singh, 2003). **Security** • Theft decrease (Kinsella, 2003); • Product veracity verification, which allows forgery discovery (Kinsella, 2003).

Even though RFID is starting to be seen as promising and versatile technology, there also exist some disadvantages/limitations on adopting it:

- High hardware and software costs (Kwang *et al.*, 2010);
- Costs by applying tags on products (Smith and Konsynski, 2003);
- System installing costs (Smith and Konsynski, 2003);
- Costs on training and reorganizing the team (Smith and Konsynski, 2003);
- Resistance towards cooperation amongst the supply chain's different levels (Kwang *et al.*, 2010);
- Interference that may difficult the transmission between the tag and the reader (Kwang *et al.*, 2010);
- Lack of RFID professionals (Viehland and Wong, 2007);
- Consumers' privacy violation (Schindler, 2003);
- Lack of tag patterns on a world level (Vijayaraman and Osyh, 2006);
- The collected data are not standardized, which demands the implementation of a specific software that takes care of formatting (Smith, 2005);
- Possibility of having twisted tags due to the products' characteristics where they are applied on (Sellitto *et al.*, 2007);
- The range of products that reach extreme temperatures may damage the tag (Sellitto *et al.*, 2007).

ii) Augmented Reality (AR)

Through technological breakthroughs, society ownership numbers on smartphones and tablets keeps rising, which allows a generalised usage of AR systems. This system creates an environment where computer generated information are overlying to the user's vision of the real world (Chin *et al.*, 2013), in order to raise the information of a certain space, leading to a wider perception of the world (Vallino, 2002). AR technology supplies a mist of realities through overlying virtual objects on real environments (Azuma, 1997), thus allowing real time interaction between real environments and virtual models/objects in 2D and 3D.

In order to be able to visualize those objects it is necessary to recur to symbols that are generally associated to entities or to real world information (Kalkofen *et al.*, 2009).

In the following table (Table 2), there are several advantages presented, which are associated with each supply chain's level.

Table no. 2 – Advantages associated with AR usage

User	Advantage
Suppliers	**Inventory** • Mistake decrease, through the supply of more information on the inventory (Cirulis and Ginters, 2013). **Operational** • Higher interactive work and with less mistakes (Cirulis and Ginters, 2013); • Better productive process (this is, assembly/disassembly instructions through animations, images or videos) (Novak-Marcincin *et al.*, 2013); • Higher performance (user gets more focused) (Tang *et al.*, 2003); • Possibility of visualizing modifications in an already existing product (Lu *et al.*, 1999); • Cost reduction related with labour costs (Cirulis and Ginters, 2013).
Distributers	**Inventory** • Upgrade on inventory information (locations) (Cirulis and Ginters, 2013); • Quick identification on the packaged product (Ginters *et al.*, 2013). **Information** • Encourages human attention (through arrows, symbols, displaying objects and animations) (Tang *et al.*, 2003); • A more efficient decision making process (Ginters *et al.*, 2013); **Delivery** • Better distribution planning (Lu *et al.*, 1999).
Tenants	**Service level** • Better client-brand relationship (Owyang, 2010); • Better product promotion (Woods, 2009); • Higher client satisfaction, through provided experiences (Benjamin, 2009); • Arouses the consumer's interest (Benjamin, 2009); • Higher client loyalty rates (Fornell *et al.*, 1996); • Quicker purchasing decision (Williams, 2006); • Ability to test the product before its acquisition (Owyang, 2010); • Client's ability to see through the product's package (Bulearca and Tamarjan, 2010).

However, just like what happens with RFID, AR technology also presents some disadvantages/ limitations:

- Difficult social acceptance of technology – from ethical questions (glasses and gloves) to privacy issues (Krevelen and Poelman, 2010);
- The webcam has to see the marker clearly, wherefore a limited angle, excessive illumination and the camera's quality may cause several problems in the appearance of a 3D model (Ginters *et al.*, 2013).

4. METHODOLOGY

With the goal of relating the themes presented before with the entrepreneurial reality, it was recurred to a content analysis, which consists in a diversified set of methodological instruments, which are applicable to discourses, whose common factor is interference and deductive reason (Bardin, 1991). This methodology requires a research on the unsaid,

through an effort of interpretation between objectivity and subjectivity. With that being said, this sort of analysis was chosen due to the fact that it offers the possibility of researching the implicit assumptions (latent content) side by side with explicit declarations (manifested content) (Krippendorff, 2003). Besides, it is possible to analyse how investigators have approached and researched about certain areas (Peetz and Reams, 2011), as well as determine what in in vanguard, considered valuable or cherished by academics (Pedersen and Pitts, 2001).

However, there is a gap between theory and practice (Shapiro *et al.*, 2007), by which the adoption of study cases fills in such gaps. A study case is a qualitative method which is widely known by investigators (Yin, 1994) and it is particularly adequate to new research areas/fields or to certain areas where the existing theory appears to be insufficient (Benbasat *et al.*, 1987; Yin, 1994). The study case consists in a research strategy which results from the analysis of experimental cases that behold a certain profile in terms interest towards the investigation (Eisenhardt, 1989; Halinen and Törnroos, 2005), where questions focus on "how" or on "why" and the research strategy is quite comprehensive (Yin, 2005). The use of multiple study cases, rather than using a single case, allows a sample's maximum variation, being appropriated for analysis on market researches (Stokes and Perry 2005). Multiple study cases are always recommended when the study purpose is the description, the theory's construction, or to test the theory (Moon, 2008). As a matter of fact, multiple study cases allow general research results (Benbasat *et al.*, 1987), wherefore the present investigation focused in nine large corporations, highly representatives as far as this study is concerned, in order to provide information towards a deep analysis. With the purpose to build a theory about the competitiveness advantage upgrade through IT usage, it was recurred to a secondary data analysis obtained through media.

Bearing in mind that, actually, we live in a competitive environment and that companies need to gain competitiveness against their opponents, it was first attempted to analyse in which ways did the IT's constitute a tool capable of generating competitive advantage, whereas this section is organized as it follows: first, some cases were selected and study cases were analysed based in a wide variety of secondary sources; after that, it was tried to answer to the propositions formulated on Table 6 in order to obtain a deeper and wider knowledge on questions related with competitiveness and new technologies adoption.

Having said so, it was established the main investigation question:

Do IT's contribute towards a competitiveness upgrade on organizations/supply chains?

Through that investigation question, objectives and propositions were formulated and are find in the table below (Table 3).

Table no. 3 – Objectives and investigation propositions

Objectives	**Propositions**
Analyse if IT's adoption allows to obtain advantages in terms of cost	P1. With the RFID there is a cost reduction in labour;
	P2. With AR there is a cost reduction in the productive processes;
Analyse if IT's adoption allows to obtain advantages in terms of time	P4. With RFID there is an inventory management improvement;
	P5. With AR there is a productive processes' upgrade;
Analyse if IT's adoption allows to obtain advantages in terms of service quality	P7. With RFID there is an easy identification of the clients' necessities;
	P8. With AR there is a customer satisfaction upgrade.

4.1. Data Gathering towards Investigation

Since this investigation has as final purpose to understand in which way the adoption of new technologies does supports the achievement of competitive advantage against opponents, the companies' selection criteria were: i) position in the market; ii) used technological systems through the supply chain; iii) recognition for being success cases on what concerns the adoption of the abridged technologies. By bearing in mind such criteria, it is possible to understand in which way did technologies allowed improvements in several processes (e.g.: production, distribution and commercialization), that may be associated to success that the companies in question have in the world market. Besides, once there are not any restrictions on the dimension, country or activity field, it is possible to do a wider analysis and present conclusions on how technologies adapt in different realities. This way, the goal is not to offer a deeper vision of single companies' experiences, but to bring them together in order to obtain a wider vision and learn with study cases fusions (Seuring, 2009).

In order to reach the proposed goals, the data gathering for the study cases was made through secondary data analysis and based on a wide variety of sources, like journals, news, industrial reports, conference articles, white papers, press releases and specialized magazines (e.g.: *RFID Journal*, *Electronic Engineering Journal*).

5. CASE STUDIES

In order to answer the investigation question, motifs, advantages and the adopted technology's characteristics were analysed in nine companies located in different countries and continents, which allows a better understanding of technologies implementation all over the world. The difference among activity fields allows the achievement of a wider vision on the usage of each one of the various technologies, making this study more appealing and rich. Besides, every studied company has over 10.000 employees and have adopted an internationalization strategy with stores, factories and storages in several countries. In the following table (Table 4) it is presented the succinct profile of the nine multinational companies in study:

Table no. 4 – Companies' profiling

Company Name	Characterization	Employees Total	Source
Tesco	Hiper and supermarket and convenience stores network	+500.000	Tesco (2014)
Inditex	Clothing sector stores network	+125.000	Inditex (2013)
Air Liquide	Cylinder gas producer and distributer	50.000	Air Liquide (2013)
Lego	Game pieces manufacturer	+10.000	The Lego Group (2013)
Mitsubishi Electric	Air systems manufacturer	+124.000	Mitsubishi Electric Corporation (2014)
DHL Solutions	Stock transporter / Logistic services	+475.000	Deutsche Post DHL (2012)

5.1. Radio Frequency Identification (RFID) Application

During the last decades, the business environment has suffered major changes, forcing the companies to increasingly recur to the use of new technologies as a way to obtain competitive advantage. Challenges are getting higher and higher for companies, as it is on stores and the necessity to efficiently replace their stock on shelves, customer service or even the management of the entire levels of the supply chain. In this context, RFID technology reveals to be a strong ally on making these processes more effective (Wamba and Boeck, 2008), allowing improvements on labour costs, inventory management and supply chain efficiency (Jones *et al.*, 2004). Bearing that in mind, it will be displayed the RFID supported contexts and operations (cost reductions, inventory and transportation management and customer service) in three companies: Tesco, Inditex and Air Liquide.

5.1.1. Tesco's case

Hiper and supermarket stores network, founded in 1919 on the United Kingdom, counting over 6.000 stores in the world (like China, USA and France) (Tesco, 2014). Tesco already counts with a team over 500.000 employees. Their areas of action go through food service, books, clothing, electronic devices, furniture, fuel, financial services, telecommunications, internet services, DVD rental and music downloads (Tesco, 2014).

Despite the good presented results, Tesco was forced to implement the RFID system in their stores in order to raise their sales and offer customer satisfaction service (IDTECHEX, 2013). After RFID's adoption, the obtained results were quite positive, thus allowing cost reductions, process simplifications, inventory loss decrease, among several other advantages specified in the following table (Table 5), which helped to maintain their leadership position in the UK (Thomas, 2004).

Table no. 5 – RFID application in Tesco

Adoption drivers	• Customer satisfaction service (IDTECHEX, 2013); • Sales growth (IDTECHEX, 2013).
Advantages	• Inventory reports submission to the employees, their location and movement, either in store or in the warehouse (Roberti, 2005); • Sales maximization (IDTECHEX, 2013); • Processes simplicity, resulting in labour cost reduction (IDTECHEX, 2013); • Customer service upgrade –products' availability growth on 50% (Roberti, 2005); • Less inventory losses (losses and thefts) (IDTECHEX, 2013).
System characterization	• Network technology that allows to control hundreds of antennas, contrasting with the conventional majority that may control from 4 to 8 antennas (IDTECHEX, 2013).

5.1.2. Inditex's case

Inditex is one of the companies acting on the dressing business and it is world-wide known company. Inditex is composed by almost one hundred companies responsible by designing, production and distribution. This company was founded in Spain, in 1985, and actually has over 6.000 stores all over the world (Inditex, 2013). Its sale volume rounds 16.725 billion euros through brads like Zara, Zara Home, Pull&Bear, Massimo Dutti,

Bershka, Stradivarius, Oysho and Uterqüe (Inditex, 2013). Inditex is another example of a multinational who decided to adopt the RFID technology in order to improve their precision throughout the supply chain and to improve customer service. In fact, as it can be seen through Table 6, this group reached a series of advantages on several levels, mainly on customer service improvements and cost reductions.

Table no. 6 – RFID application in Inditex

Adoption drivers	• Necessity of precision on every chain supply's levels (Inditex, 2014); • Customer service improvement (Inditex, 2014).
Advantages	• Better work flow on distribution platforms, revealing a future cost reduction on labour (Inditex, 2014); • Warnings issues towards employees on necessary clothing pieces for store replenishment, thus raising their availability (Inditex, 2014); • During the merchandise unloading, the system immediately identifies the designs and sizes that need to be unloaded (Inditex, 2014 • Effective control of the entire inventory, both on stores and warehouses (inventory loss decrease) (Inditex, 2014); • Simultaneous reading of several tags, which means a cost reduction on labour (Inditex, 2014); • Customer service improvement – by soliciting a certain piece, the system verifies its availability either on the store or warehouse; in case the piece is not available in the warehouse, it's automatically located on the store's website or in any other store, being then sent to the store or to the customer's address (Inditex, 2014); • Knowledge on the target audience and on their necessities through the definition of prevention plans (Inditex, 2014).
System characteristics	• RFID tags are put individually in each piece (Inditex, 2014); The piece's ID is stored in each piece inside the safety alarm (Inditex, 2014); • When the stock reaches the stores, the employee passes the reader that automatically updates the inventory (Inditex, 2014); • RFID tags are 100% reusable and recyclable (Inditex, 2014).

5.1.3. Air Liquide's case

Founded in France, in 1902, Air Liquide is actually the world leader in health gases and technologies (Air Liquide, 2013). Their services go through gas production and distribution to the final consumer. Air Liquide is now in eighty countries and employs over 50.000 people, having a sale volume rounding 29.000.000 euros (Air Liquide, 2013). After 9/11, this company felt the need to increase control of what is done on stock transportation, since the substances they work with are dangerous and may cause negative impacts in case of a security breach (Wasserman, 2005). With such a set, they chose to bet on the RFID implementation, which allowed them to make an effective trace of transportations and their inventories, as well as other advantages presented on the following table (Table 7).

Table no. 7 – RFID application in Air Liquide

Adoption reasons	• Need to increase the safety issues on stock transportation: guarantee that dangerous substances are not accidentally or intentionally used, lost nor stolen (Wasserman, 2005); • Cost reductions (IDTECHEX, 2013).
Advantages	• Transportation tracing: possibility to check the routes, times and stock delivery locations (Air Liquide, 2014); • Inventories' control processes automation (location and quantity) (Air Liquide, 2014); • Stock transportation control and safety, which translates in an inventory loss reduction (IDTECHEX, 2013); • Easy information achievement (IDTECHEX, 2013); • Labour cost reductions (IDTECHEX, 2013); • Customer services – gas consume controls and automatic request of cylinder refills (IDTECHEX, 2013).
System characteristics	• The tag is put in each gas cylinder, by which they are read is made through readers (IDTECHEX, 2013).

5.1.4. Cross-companies analysis of RFID application

The analysis of the three presented study cases allowed the RFID's impact evaluation on the companies' and their supply chains' competitiveness improvements, having as research propositions:

P1. With RFID there is a labour cost reduction

This technology allowed a cost reduction on what concerns labour related costs, once that it allows tag reading without the need to analyse the product itself, like in traditional code bars (Lee and Özalp, 2007). By allowing the reading of several tags simultaneously, RFID generates a works reduction, either by distributers and tenants (Lee and Özalp, 2007). According to Pisello (2004), on what concerns about distribution, labour cost reductions can be as significant as 30%, since for the tenants is inferior, placing itself around 17%. Consequently, A.T. Kearney (2004) corroborates these results demonstration that labour savings towards manufacturers place around 9% and around 7,5% for distributers and tenants.

According to the obtained information through a detailed analysis on Table 8, it is possible to verify that all the studied companies suffered labour cost reductions. This cost reductions occurred on the automation and simplification of several processes throughout the supply chain. With these results, it was obviously identified labour cost reductions, by which it can be claimed that the first proposition (P1) is not rejected.

P4. With RFID there is an inventory management improvement

Nowadays, companies have a large scale of inventory on shelves, which means that its management always needs to be done efficiently on order not to cause result contradictions. The non-accurate inventory phenomenon is defined by Kok and Shang (2005) as the mistakes that originated shifts on the physical inventory done in the end of each period. Atali and Lee (2006) consider that the problem on incorrect inventory registration occurs due to two fluxes: losses and transaction errors. RFID emerges as a powerful technology that solves inventory discrepancies mistakes (Heese, 2007), since it provides an inventory

transparency through localization and inventory quantities data sharing (McFarlane and Sheffi, 2003). By implementing this technology in distribution centres, received stock is compared to its purchase order, avoiding discrepancies and time losses since the inventory is automatically updated (Angeles, 2006).

Inventory management is strengthened with tags and readers, allowing to be programmed in a way that, in case of an inventory rupture, the information is automatically sent and places a replenishment order (Owunwanne and Goel, 2010). With RFID's adoption, it is possible to obtain a more precise prevision of stock necessity, thus forcing the administrative board to act more effectively and opportunely (Owunwanne and Goel, 2010

This inventory control reduces loss and fraud possibilities, which leads to an inventory direct reduction (Lee and Özalp, 2007).

Booth-Thomas (2003) claims that inventory reduction through RFID usage is placed between 10 to 13% throughout the supply chain. Also, A.T. Kearney (2004) estimates that tenants feel between an 8 to 12% reduction.

By analysing Table 8, it can be verified that all the abridged companies suffered an inventory management improvement, especially on issues related to inventory loss decrease and easy access to localization and quantity information on the inventory. With that being said, it can be claimed that the fourth proposition (P4) is not rejected.

P7. With RFID there is an easy identification of the clients' necessities

Through RFID, tenants are able to adapt to the needs of demand and improve the precision of future sales predictions (Curtin *et al.*, 2007; Kumar *et al.*, 2009). Market orientation suggests that companies should focus on customers and on competitive environment through the provided information and this way answering to market's necessities (Kohli and Jaworski, 1990). RFID is used by companies in order to understand the customer's behaviours and buying decisions (Owunwanne and Goel, 2010). With this technology, it is possible to narrow down the customers' focus and improve globally service quality: functional quality (how the product/service is delivered), technical quality (the delivered product's/service's quality) and the quality of the service's environment (the environment where the product/service is delivered) (Brady and Cronin, 2001).

Among the abridges companies, Inditex and Air Liquide where the ones that, after adopting the RFID technology, obtained positive results on identifying clients' needs and consumption information attainment (Table 8). Through these results, it may be claimed that the seventh proposition (P7) isn't rejected.

Table no. 8 – Summary on the obtained advantages about RFID usage

	Tesco	Inditex	Air Liquide
More information on the inventory (location and quantity)	•	•	•
More effective replenishment decisions		•	
Inventory loss decrease (losses and robberies)	•	•	•
Better product tracing (warehouse and stores)	•		
Sales rising	•		
Labour costs reduction	•	•	•
More information on transported stock		•	•
More efficient data gathering	•	•	•
Stock/vehicles tracking			•
Higher levels on delivery's precision		•	•

	Tesco	Inditex	Air Liquide
Customer support improvement		•	•
Improvement on target-audience identification		•	
Higher product availability	•	•	•
Easy identification of the customer's needs		•	•
Consume information data improvement		•	•

5.2. Augmented Reality application

The way companies and society use technologies is on constant changing, being supported by the generalized adoption of new technologies, like the case of AR, that allows innovative and unique experiences to its users. With that being said, it is opened a path towards the development of solutions that allow to offer advantages to the entrepreneurial world, like it is with cost reductions, users' new experiences and productive processes improvements (Novak-Marcincin *et al.*, 2013). So, it will be analysed three different companies: Lego, Mitsubishi Electric and DHL Solutions, which already have this technology along their supply chain.

5.2.1. Lego's case

Being the third largest game manufacturer in the world, founded in 1932, in Denmark, it counts with 117 stores on 130 countries and over 10.000 employees (The Lego Group, 2013). Lego felt the necessity to provide the customers new experiences, so it adopted AR in order to demonstrate its product fully assembled (Metaio, 2013). Lego's bet went by two AR systems: the first was a mobile application, and the second was an interactive terminal. Through those systems, it was possible to increase its sales volume, positively increase buying decisions and among other advantages presented in Table 9.

Table no. 9 – Lego's AR application

Adoption drivers	• Necessity to show the fully assembled product to the clients (Metaio, 2013).
Advantages	• Sales increase around 17% (on 2011) (Metaio, 2013); • Positive influences on buying decisions (Metaio, 2013); • Vision of the fully assembled product and with animations of the product inside the package, which increases the consumer's knowledge about the products and diminishing buying uncertainty (Venturebeat, 2010); • Marking and unique experiences which involves consumers (Metaio, 2013).
System characteristics	Two systems usage: • *Lego Connect* – Mobile application that every consumer, by looking through the catalogue, point their mobile devices to the printed page and obtain game related content, including information on the product, example model in 3D direct access to its online sale page (Vuforia, 2012); • *Lego Digital Box* – Interactive terminal composed by a camera and a screen, where the consumer points his package to the camera and that reveals its content fully assembled in 3D (Venturebeat, 2010).

5.2.2. Mitsubishi Electric's case

One of the main acclimatising and refrigerating systems manufacturer is Mitsubishi Electric, founded in 1921, in Japan. This company is composed by 110 branches in 39 countries and counting on over 124.000 employees (Mitsubishi Electric Corporation 2014). Mitsubishi Electric is another fine example of a multinational company who decided to adopt AR in order to reduce costs through catalogue printing or even by easily distributing them (Metaio, 2013; Lord, 2013). Through the analysis of Table 10, it can be seen that needs were rectified and still achieved other advantages, like productivity increase and error reduction on equipment repairs.

Table no. 10 – Mitsubishi Electric's AR application

Adoption drivers	• Necessary cost reduction on marketing practices (Metaio, 2013); • Difficulties on catalogues distribution to all salesman in order to guarantee recent and updated information (Lord, 2013); • Sales volume maximization (Metaio, 2013); • Need to show how the fully assembled product to the client (Lord, 2013).
Advantages	• Reduction on catalogues' printing costs (Metaio, 2013); • Visual appeal and clients' experience increase (Lord, 2013); • Cost reductions due to larger user performance (Metaio, 2013); • Sales increase around dos 50 million euros (Metaio, 2013); • Equipment maintenance/reparation support, which translates in an error reduction (Lord, 2013); • Product visibility in 3D (Lord, 2013); • Product promotion (Lord, 2013).
System characteristics	• Mobile application through which the technician points his own mobile device, doing an automatic recognition of the unit type he's using; the application then provides a potential maintenance scenarios list, detailing instructions with 3D animations which assist the technician repairing the device. Through this same application, the salesman is able to show how the equipment will be assembled on the desired place through 3D images (Lord, 2013).

5.2.3. DHL Solutions' case

Leader on European land transportation, founded in 1969, in Germany, counting over 6.500 offices in over 220 countries, it counts with over 475.000 employees (Deutsche Post DHL, 2012). DHL Solutions offers numerous solutions for their customers, like in cargo transportation, storage and distribution and other solutions over its supply chain (Deutsche Post DHL, 2012). AR adoption was due mainly to the company's necessity to homogenate and improve their data system used all over the world, since there were several fails and divergences reported on what concerned data recollection (DHL, 2014). By adopting this system, DHL Solutions reached a vast quantity of information, which allowed advantages on cost reductions and operational efficiency increase, among others that are specified in Table 11.

Table no. 11 – DHL Solutions' AR application

Adoption drivers	• Need to reduce time wastes (DHL, 2014); • Need to detect errors (DHL, 2014); • Necessity to ease and homogenate commercial documentation (DHL, 2014); • Necessity to improve orders' transportation, thus creating adequate management (DHL, 2014); • Necessity to raise quality control and reduce learning associated costs (DHL, 2014).
Advantages	• Orders' separation errors decrease (DHL, 2014); • Reduction of time wasted on searching for orders (DHL, 2014); • Virtual visualization of storage processes (DHL, 2014); • Visualization of virtually overlapped modifications for measurement adjustments (DHL, 2014); • Storage costs reduction (DHL, 2014); • Cost reductions on planning processes (DHL, 2014); • Automatic registration and confirmation when the delivery service is completed (DHL, 2014); • Foreign packages' tags immediate translation or of commercial terms (DHL, 2014); • Extra information (content, destination and weight) and handling instructions attainment on every single palette (DHL, 2014); • Assembling or repairing instructions visualization in 3D, meaning an error reduction (DHL, 2014); • Customer support on determining the packaging type, which meant a better relationship with the customers (DHL, 2014).
System characteristics	Assembly and repair: • Hands-free devices (glasses) use, which show 3D virtual pictures that support specific tasks (DHL, 2014); Orders' separation: • AR readers that, by pointing to a certain object/code, present detailed information on the order (DHL, 2014). Customer service: • AR application for mobile devices, that helps consumers determining the package type that best fits to the goods for ship (DHL, 2014).

5.2.4. Cross-companies analysis on Augmented Reality application

Through information gathering and consequent analysis on companies who recur to AR, it was intended to check the veracity of the following four propositions:

P2. With AR there is a cost reduction in the productive processes

The results visualization possibility has been being a widely discussed topic over all activity sectors, since it allows errors reduction, translating into costs reduction (Cirulis and Ginters, 2013). By generating results, there is any kind of psychological distress, which could cause additional errors (Ginters and Martin-Gutierrez, 2013).

Through the analysis of information on Table 12, it is verified that Mitsubishi Electric and DHL Solutions obtained costs reduction through productive processes improvements. This costs reduction was mainly due to essential information sharing that assures perfect

development of every processes. With that being said, it can be claimed that the second proposition (P2) is not rejected.

P5. With AR there is a productive processes' upgrade

Each time is more important to develop manual skills in order to allow tools manipulation and getting to know component positioning (Gilchrist and Gruber, 1984). Sharing these manual skills is particularly important to support businesses related in production, development and/or product maintenance (Fox *et al.*, 2011).

Nowadays, manual skills are inherited through interaction between people: one that disposes those skills (this is, the instructor) and the other that needs to learn those skills (this is, the learner/tutor) (Fox *et al.*, 2011).. However, sometimes it is hard to find available people that possess such skills (Katz, 2008) and that are available to share their knowledge in the pretended place (Fox *et al.*, 2011). In order to minimize knowledge sharing difficulties, which means a productive processes improvement, AR appears as an innovative way to communicate visual information, like charts, texts or work demonstrations (Fox *et al.*, 2011)., being the best solution to share manual skills , which allows time saving (Boud *et al.*, 1999). For example, AR allows learners to see their own movements at the same time they see a 3D movement model that should be executed (Fox *et al.*, 2011)., without requiring the presence of an instructor (Sielhorst *et al.*, 2005).

After analysing Table 12, it can be seen that both Mitsubishi Electric and DHL Solutions experienced improvements on productive processes (this is, error reduction, extra information sharing and better users' performance), by which it can be claimed that the fifth proposition (P5) is not rejected.

P8. With AR there is a customer satisfaction upgrade

Benefits associated to AR usage have been generating some controversy due to the fact that initially this technology was seen as products/services promotion tool (Woods, 2009) and, now, it is being considered as a way to contribute towards a positive relation between brand and clients (Owyang, 2010) and customer satisfaction through the creation of experiences of value (Chou, 2009; Yuan and Wu, 2008). Like it is defined by Yuan and Wu (2008) and Schmitt (1999), AR usage can be seen as a way to create experiences that are not exclusively focused on the product's/service's commercialization, but also on experiences created for customers.

Experiences' marketing importance goes through the capacity to create value towards the final consumer (Pine and Gilmore, 1998), forcing companies to become externally competitive (Prahalad and Ramaswamy, 2000), as it can also motivate clients having quicker and positive buying decisions (Williams, 2006). Towards a better understanding of this thematic, numerous quantitative studies were studied, namely by Chou (2009), Yuan and Wu (2008), who ended up demonstrating that experimental value can be translated into customers' satisfaction. Customers' satisfaction can be seen from two different perspectives: specific transaction aspects and cumulative aspects (Johnson *et al.*, 2002). Specific transaction aspects refer to the value that customers give after a determined transaction, while cumulative aspects include the customers' full experience with products/services of a determined company and on the entire phases of the purchase process (Patterson and Spreng, 1997; Fornell, 1992). By occurring on all phases of the purchase process and due to the fact that AR mainly works on a pre-buying phase – since in this phase the customer evaluates the choices before he makes a buying decision (Fill, 2009) –, this technology

allows to put the product on the users' hands (Woods, 2009), offering them the opportunity to test the product as if they already have it, attracting them to buy the product in question (Owyang, 2010).

On what concerns the clients' satisfaction improvements, the obtained results were positive to all three companies, since the all offered the possibility to the clients to visualize/test the product, thus improving their relationship with the customer (Table 12). With that being said, it can be claimed that the eighth proposition (P8) is not rejected.

Table no. 12 – Advantages reached through AR application

	Lego	Mitsubishi Electric	DHL
Error decrease		•	•
Extra information share (instructions)		•	•
Visualization of virtual modifications on a real object			•
Users' highest performance		•	
Cost reductions on productive processes		•	•
Cost reductions on advertisement		•	
Possibility to get more information			•
Error decrease			•
Possibility to visualize/test the packaged product	•	•	•
Quicker buying decisions	•		
Allows customers' experiences	•	•	
Sales rising	•	•	

6. CONCLUSIONS

With globalisation's emergence, companies are increasingly under great challenges, forcing them to operate effective and efficiently in order to guarantee survival on competitive environment. Companies nowadays are branded by consumption general increase and the appearance of new products with shorter lifecycles, as well as they're affected by consumers' profile changes, finding them more and more demanding.

Facing such reality, all companies desire to differentiate from their competition in order to emphasize the position in the market. Logistics comes up as a nuclear tool to help companies to acquire that so much ambitioned and desired position of power in comparison to their opponents. The concept of logistics evolved through time and assumes every time more a nuclear role on companies due to their great capacity to answer to the markets' constant fluctuation. Supply chain is a concept that is initially related with logistics. Due to the globalisation phenomena, the complexity level of supply chains has been rising, what means a greater difficulty for companies to efficiently manage a complex entities network that may be geographically distant, which makes trades and flow management being something difficult financially, informatively and physically. It is through the supply chain that companies are able to manage and structure easily the relationships with their partners, reaching competitive advantage.

So, competitive advantage is obtained through strengthening every activities' being inside the company's value chain, from production to commercialization, making possible to position the company and create a base of values that distinguishes it from its opponents.

Within this need of competitive advantage winnings/maintenance, IT's revealed as a tool to attain a competitive differential between companies, being considered as a vehicle

that allows improvements on inventory management, customers' relationship and satisfaction and even costs reduction. This way, IT's should be present supply chain's levels, since they are considered resources capable of providing a superior value to the company, facing a dynamic market.

With that being said, this study has searched to identify conceptually the influence that several IT's, like RFID and AR, had on companies'/supply chains' competitiveness improvement. For that, several investigation propositions were raised through study cases' and secondary sources analysis, in order to analyse the felted impacts.

The main results show that through IT's adoption it is possible to reach improvements on costs reduction, time and service quality improvements. In that sense, the analysed companies on RFID usage achieved: i) cost reductions through processes improvement, as in automation; ii) time reductions on inventory management improvements, inventory loss decrease and stock location easiness; iii) service quality improvements through customers' satisfaction raise, thanks to a better identification on the clients' needs.

As far as AR technology is concerned, the companies reached: i) costs and time reductions on productive processes as a result of error decrease with extra information sharing throughout employees; ii) customers' satisfaction improvement, originated by a better relationship brand-customer, product promotion improvement and consumers' new experiences potentiation.

Since the adopted methodology in this study focuses on secondary sources' data use (e.g.: specialized journals, magazines and scientific articles) makes the results being influenced by the available information, it can mean a limitation. So, the results presented in this study are limited in the way that specific variables of organizational contingency are not controlled.

For future lines of investigation/research, it would be interesting to complete this study with an analysis to other fashionable technologies, either for companies, either for society in general, as it is on *Near Field Communication* (NFC) and *Natural User Interfaces* (NUI). This way, it would be possible to provide more information to companies about technologies that may supply some of their flaws and help them compete in an increasingly competitive environment. From another point of view, towards a better understanding of IT's impacts on different entrepreneurial realities would be beneficial to develop studies on companies that reveal a minor dimension when opposed to these studied ones, as well as on national companies.

Since this study only focused on a perspective of how IT's grant competitive advantage winnings against opponents, it would make sense to be developed a research on performances which includes productive cycle's time and costs reductions and quality improvement as indicators.

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