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ICT supply chain management in Bogotá

TIC en gestión de la cadena de suministro Bogotana

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ABSTRACT

This article seeks to identify the use of Information, Communications and Technology (ICT) in the supply chain and its application level in the industry of Bogota through a conceptual basis and analysis to different companies located in the city. The study begins with an overview of the ICT, throwing a comparison between the existing technologies of their characteristics, advantages and disadvantages to use. The second segment of the research has a practical part based on the development of surveys located companies in the city of Bogota (Colombia), which allows you to view different obstacles in implementing these technologies, their advantages and opportunities to use. The study finds that overall the use of ICT is currently higher in Bogotá and indicates that using these tools the organization achieves profits, generating significant added value.

Palabras clave:
Tecnologías de la Información y Comunicaciones
Cadena de suministro
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RESUMEN

El presente artículo busca identificar la utilización de las Tecnologías de la Información y Comunicaciones (TIC's) en la cadena de suministro, y su nivel de aplicación en la industria Bogotana a través de una base conceptual y un análisis a diferentes empresas situadas en la ciudad. Este estudio comienza por una revisión general de las TICs arrojando una comparación entre las tecnologías existentes con respecto a las características, ventajas y desventajas al usarlas. El segundo segmento de la investigación posee una parte práctica basada en el desarrollo de encuestas a compañías ubicadas en la ciudad de Bogotá (Colombia), las cuales permiten visualizar los diferentes obstáculos al implementar dichas tecnologías, sus ventajas y las oportunidades de uso que estas poseen. El estudio encuentra que -en conjunto- el uso de las TICs actualmente es mayor en Bogotá e indica que al utilizar estas herramientas la organización consigue beneficios, generando un valor agregado significativo.

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1. Introduction

The technological convergence favored by the so-called Digital Revolution, constitutes a group of advances whose applications open up a broad spectrum of possibilities. Technology sets up a new economic, productive and social model that involves the arrival of industries, professional profiles and economical models so far unknown by many.

Professor Javier Zamora, from IESE, in his paper *El ascenso de la(s) persona(s): Más allá de la consumerización* [1], claims that technological change of which people have a larger knowledge on the usage and the benefits of the ICT's tools and services, is creating social change. This social change has a direct impact on how companies are organized and how they relate to their clients.

This article attempts to expose the main characteristics of the implementation of the ICTs in companies from Bogotá, and presents a vision on how these tools will contribute in the industry's future.

2. Background

The supply chain is defined as a group formed by all of the efficiently coordinated process that have been directly or indirectly involved in the process of satisfying the costumer's need, structured throughout different levels that add value to the product or service. [2–4].

Due to its feature of being such a main and determinant element in a company's operations, the supply chain demands systematic and structured process that can be managed effectively. And is precisely here where the notion of Supply Chain Management (SCM) comes up, defined as the process of planning, executing and controlling of the supply network's operation, with the purpose of satisfying the client's needs with as much effectiveness as possible. [5–8].

Likewise, the systematic and strategic coordination of the traditional business' role and the used tactics, works within a company and among the different processes of a supply chain. [9, 10]. In essence, the supply chain's management assimilates the demand and the supply administration inside and outside of the companies.

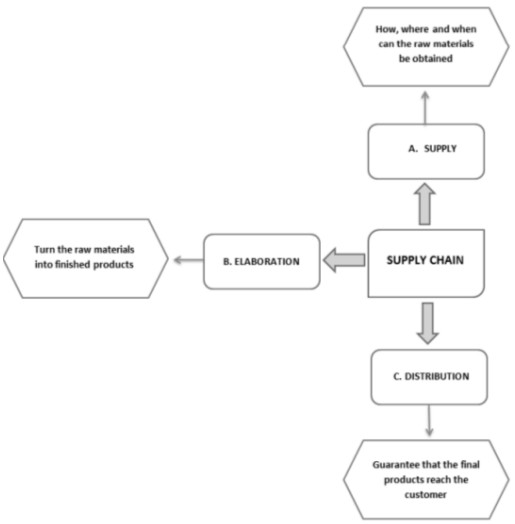
The supply chain's management attempts to form alliances and stable relationships among all of the flow elements, from the providers' providers to the clients' clients to develop efficiency on the used resources and effectiveness regarding the planned objectives. [11].

Distribution logistics are places between the last stages of the supply chain; nevertheless, this does not detract its decisive role on the organization's value chain. Efficient transportation and distribution allows the product to reach their destination in good conditions, diminishing the cost and improving the resource usage, which make the most important and valued criteria. [12].

For that reason, distribution logistics becomes more important. Interaction with other agents in urban areas, such as vehicle traffic (public and private transportation), or diverse supply sites in an established perimeter with an unknown urban classification make a high interest of study, given its three defining features: infrastructure influence, distribution strategy and the characteristics of the vehicle that is being used. [13, 14]

The supply chain can be interpreted as shown in Figure 1.

Figure 1: Supply chain.



Source: [15].

The structure of this article is divided into two main components, the first one is a conceptual review of the technologies used in the supply chain's management, and the second one is a practical review regarding companies from Bogotá. The second component is based on the first one. The conceptual review starts with the explanation of the different types of technologies that are used on the SCM. Even though some of them are not highly implemented, there is a high chance of doing so. Thereupon, those different technologies are compared on a grid. The second part structures a practical analysis in connection with the city of Bogotá, under the poll

methodology that collects information which will be analyzed and compared to the previous conceptual review and then specific guidelines are defined. The section ends with a brief examination on the usage of the technologies around the studied field. Below are described the definition and the main features of the SCM's technologies and then a grid is presented that compares the advantages, disadvantages and uses of these tools.

3. ICTs supply chain management

3.1. GPS (Global Positioning System)

A GPS is a satellite system that utilizes navigation to establish the position of an object with high precision. However, this positioning is generally not strong enough to always guarantee metric detail that allows identifying the lane location. [13].

Differential corrections allow reducing the error successfully in some situations. These corrections can come from different sources. One solution is based on local georeference ground bases, even though they have a limited transmission range. Besides, in their degradation, according to the receptor, it moves away from the fixed base. There are also some other solutions, such as the satellite corrections, which solve the reach problem, but they introduce new difficulties like poor quality signal in complex environments, e.g. urban areas with tall buildings around. [15].

Although the above solutions allow to reach notable precision levels, even for self-driving applications (autonomous vehicles, mobile robots, etc.), some limitations restrict their usage to particular conditions, since the signal quality levels are not ensured under every circumstance. [16].

In this sense, there is a third technological solution based on the differential correction offered by official geographical institutions through the internet that can be accessed using infrastructure-vehicle on any wireless means. It can be done with the help of the *Networked Transport of RTCM* via Internet Protocol Standard (NTRIP). Its main novelty lies in the fact that it can generate virtual baselines close to the mobile receptor from the stationary base network of the country, with which the correction liability is increased. [17].

3.2. EPC: Electronic Product Code

The EPC is a sole number stored in a radiofrequency tag. It allows identifying each product in a unique way. Likewise, it throws valuable information, such as the possibility to identify the product's location at any time. [18].

The objective of the EPC system is to make the supply chain more efficient and to increase the visibility of the products/objects moving within. All this can be accomplished through the tags, the hardware, the software and the Electronic Product Code Information Services (EPCIS) [19].

The EPC use will represent a revolution for the value networks. Its massification will allow a better control over the logistic processes of each sector, which creates online information that enables the business partners to make appropriate choices. [20].

Many of the possible applications of the EPC are relevant in any link of the supply chain and they impact more than one of its product's send and receive operations. These applications include, for instance:

- Easiness in the pick-up processes of the defective products: through the awareness of the location of a specific product, where it was made and the specific time that it remained in the level and the other links of the supply chain.
- Piracy detection: identification with tags will allow new security, verification and authenticity levels. [12].

3.3. TMS (Transportation Management System)

The TMS is software based on planning, management and control for land transportation fleets, used for product distribution [21]. The application examines various transportation scenarios; it proposes routing solutions and selects the best way to do it, and the least expensive provider. The most common TMS routing software modules, include route planning and optimization of the cargo, execution, auditing and shipment costs, deposit management, delivery in advance, order visibility and carrier management.

3.4. WAZE

It is a traffic and navigation application based on the largest community in the world. It is a system that creates live maps and provides road information in real time [22].

It has several features for it has a passive system in which general information is described. This information is carried out by the application and it shows how

to guide the Wazers (users) through shorter ways, or about the travel speed in a specific route, and an active system in which the users participate by sending information (posts) about the road conditions, accidents and advice to other users. These users are articulated in an interactive map that reports places on the road that are stuck, blocked, in construction and everything else that can affect the trip [23, 24].

3.5. *WMS (Warehouse Management System)*

This software is used to control the operations within a store room including the shipping, receipt, real-time tracking of the products, optimization of space usage, programming, planning, forecast consumption and warehouse inventory management. The main objective of the storage system automation is to control the movement and storage of the products [25, 26]. A WMS uses a data base designed to support warehouse operations, describing a variety of standard storage elements.

The WMS can be independent systems or be integrated into other technologies. They can be as simple as a handwritten list that is updated whenever necessary, or they can be a sophisticated software specially designed for the company's structure [27].

3.6. *RS (Routing System)*

The Routing Systems are informatics tools that support and facilitate the decision making in the transportation logistic activity.

Its objective is to facilitate the route planning for the vehicles, and it has an arrangement for its products distribution. It works by selecting the amount of vehicles on each route, the delivery orders for them and the most efficient and effective route to do so [28].

3.7. *ERP (Enterprise Resource Planning)*

These systems are known to perform the management certain production, distribution and other aspects inside a company. This practice is related to the management of different resources, business as well as the production and distribution aspects of a company. [29].

To be considered as such, an ERP has to meet the following requirements: it must be comprehensive (it should cover every aspect of the company's needs), modular (it must divide tis elements according to the company's departments and divisions), and adaptable (it has to adapt to the standards of each institution) [30].

An ERP system usually takes care of managing the production, logistics, sales, distribution, inventory, delivery, billing and accounting, among other things. To accomplish that, different software can be used to ease the data organization, the communication with the parts, the operations log and the report elaboration [31].

3.8. *ICTs MATRIX LOGISTICS*

See Table 1.

Table 1: ICTs Comparison Matrix. Source: own.

ERP(Enterpris Resource Planning)	• Provides integration betweeen the supply chain, the production and the administrative process. • Creates shared data bases. • Allows to incorporate improved, redesigned and 'better' processes. • Increases global communication and cooperation among sites andbusiness units. • Contains a commercial code software database. • It can provide a strategic advantage over the competitors.	• Very expensive acquisition and eventual improvements. • Its use may require important changes in the company and itsprocesses. • It is so complex that a most companies won't adapt to it. • Its use involves an on going process that could just not end. • The ERP experience is limitedand to assign staff for its work represents a constant issue	• Helping companies management of any type. • Automate processes, which offers a better control of the work. •Controling stock and inventory that the company has or does (work flow). • Saving costs (efficiency and effectiveness).

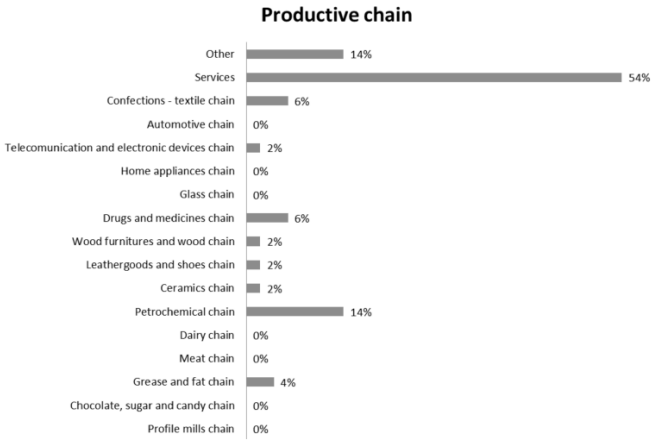
4. Structured poll results

After a bibliographic study about the technologies that can be implemented on the supply chain management, a poll is designed to analyze the usage of technologies on Bogotá's companies, observe the advantages and disadvantages relevant today around them, watch how those technologies are exploited, and contrast the theoretical part of the present article with what currently happens inside the companies. The information was taken from 50 different companies from various productive channels and sizes located in the city of Bogotá. The sample has a trust level of 75 % with a sampling error of 8 %, due to the difficulty of finding the proportion of the population that possesses the desired features. Given that, 50 % was chosen for P Y Q and the number of the population was taken according to the Chamber of Commerce, which has more than 400,000 registered companies.

Shown below is the summary of the answers in a Pareto chart and pie charts, followed by an analysis of the information.

1. Productive chain, Figure 2.

Figure 2: Productive chain. Informative poll 2016.



Source: own.

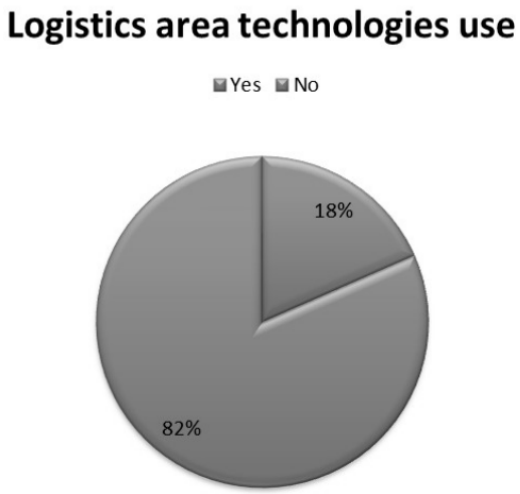
Most of the surveyed companies belong to the Service area (54 %), followed by the ones on the petrochemical chain and in another type of productive chains (14 % each).

Watching the previous results it is important to highlight that more than 50 % of the consulted companies belong to the services area, from which can be interpreted that this type of company are peaking in the present day and they no longer belong to the smallest group of the capital city. In a study carried out by the ODE (Economic Development Observatory) in 2014 it was concluded that the inhabitants of the District spend around 49 % of their annual expenses in services such as transportation, health, education, telecommunications, among others, which creates economic growth in the city, for it helps to increase the GDP and the job market. In consequence, it is necessary to study the sector operation and create more benefits for the city.

2. Is your company currently using some kind of technology in the logistics area? Figure **3**.

From the studied companies, 18.4 % do not possess any kind of technology in the logistics area, which exposes the fact that, even though the ICTs are currently more accessible to all of the companies, they still lack the type of advantage knowledge about the importance that the use of this tools bring to them for the efficiency of the company's competitive processes. This is why it is important to take in account alternatives oriented to train the company on the implementation of these technologies.

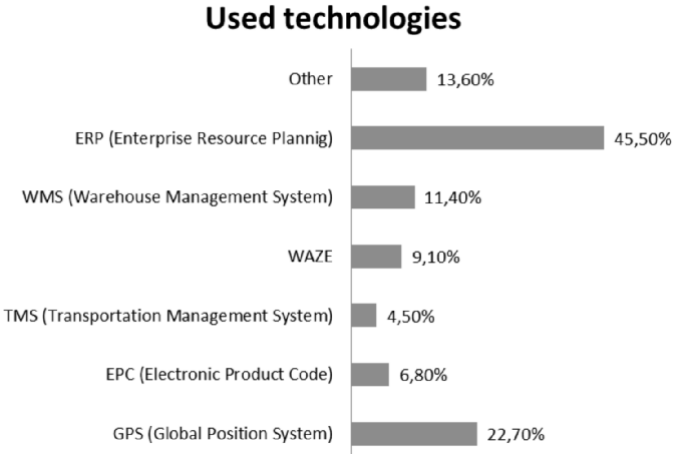
Figure 3: Use of the technologies in the logistics area. 2016 Informative poll.



Source: own.

3. Write down the name of the software or tool that the company uses. Around 45.5 % of the studied companies use the ERP tool, followed by the GPS software with 22.7 %.; figure **4**.

Figure 4: Names of the used technologies. Informative poll 2016.



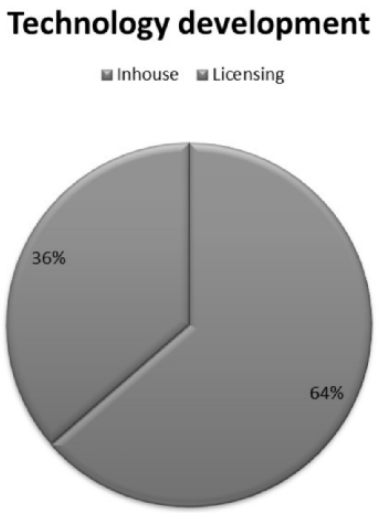
Source: own.

Although the ERP is not one of the modern tools, it represents the most use, given the multiple functions that it performs and the deep knowledge around it. In regard of the business competition in the country and specifically in Bogotá, the companies have the big disadvantage of joining the technological waves too late, because in many cases other external competitors have

already implemented solutions and gained productivity ground. But they have the great chance of growing in a more dynamic and easier way because of the fast-changing times and because of the world wide knowledge of the emerging technologies.

4. Its development was; figure 5

Figure 5: Technology development. Informative poll 2016.



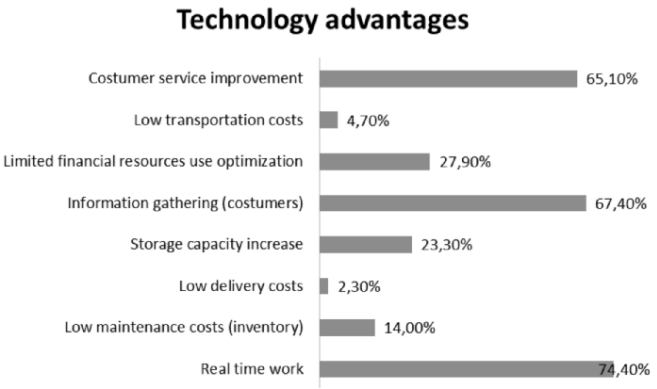
Source: own.

This question allows observing that 63.6 % of the companies developed their technology through a license, which points at a low perception of development from within the companies, a key element in companies from developed countries that are direct competitors. On the decisive time of using a technology in the organization, the advantages of doing it through a license can be seen clearer and simpler, but there are major obstacles such as the restrictions of each company generated by their uniqueness. This causes damage in the success of some of these technologies. It is not possible to conclude which kind of development is more useful for Bogotá's companies in this research, because there are more ways to be said about it. But it is possible, regardless, to conclude that there is a tendency to do this without a license process. This can bring benefits for the city's economy.

5. What kinds of advantages does the usage of these technologies represent? Figure 6.

The most relevant advantages to the studied companies when using those technologies are:

Figure 6: Technology Advantages. 2016 Informative Poll.

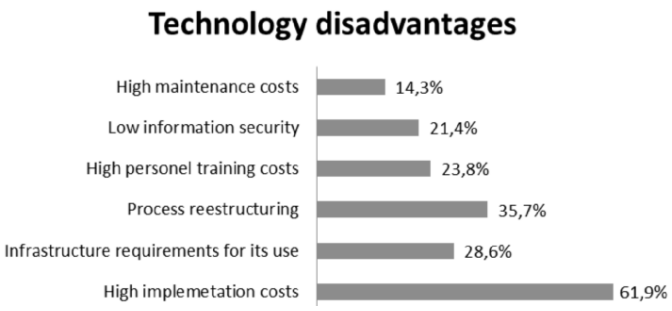


Source: own.

Work in real time (74.4 %), costumer data collection (67.4 %) and improvement of customer service (65.1 %). The cost topic was no longer relevant here. It can be concluded that the client is still the most important focus for any organization, but in this era the improvements are based in a deeper understanding of the client's needs, which produces a better service and an added value for the company, based on the gathered information. This is probably the most valuable resource that the organizations have to achieve competitive advantages and improvements in their processes.

6. What kinds of disadvantages does the usage of these technologies represent? Figure 7.

Figure 7: Technology disadvantages. Informative poll 2016.



Source: own.

At the moment of the analysis on the advantages on using technological tools, the studied companies show that high implementation costs is the biggest issue when conceiving a technology usage in the supply chain (61.9 %), followed by the difficulty of restructuring the

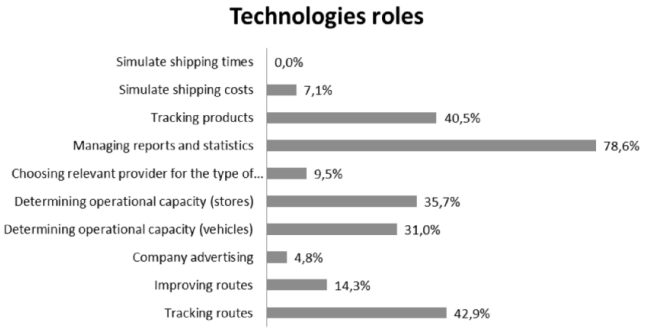
company's processes (35.7 %).

The disadvantages, on the other hand, evidence two separate interpretations: first comes the question on why is such a high cost generated when implementing these technologies, whether this high cost is related to the way of development or if it is inevitable to take in account no matter what. The second interpretation is about the company's processes, the restructuring creates a change within the organization that unavoidably brings higher costs to the company, which brings us to think if it is necessary to carry on with a deeper or wider study when establishing the most suitable, updated and flexible processes to keep the costs low when implementing new tools on them.

7. Which roles does this technology play?

The activities in which the technologies have more participation among the supply chain management in the studied companies are the reports and statistics management (78.6 %), the rout outlining (42.9 %) and the product tracking (40.5 %); Figure 8.

Figure 8: Technologies roles. Informative poll 2016.



Source: own.

5. Conclusions

- Given the growing human developments around cultural, social and economic topics, it is important to point out that from a business perspective these developments can be brought up when taking about software uses. These tools account for increasingly important features that allow growing the competitiveness in the sector. It is expected to have the access to the use of global and ubiquitous technologies, which means that they can be accessed through any device and carry more information that allows better decisions from the companies.
- The present work was able to glimpse on the importance that information has acquired regarding the companies, which shows the relevance and significance that this management should have for them. In order to do so, the use of technologies should have as its main tool Big Data operations, and incorporate data and social analytic tools, which will allow a more efficient power use of these tools compared to the ones used normally.
- The ERP has a big future regarding the main pillars (cloud, mobility, social networks and Big Data) and with a special treatment on business analysis and intelligence.
- From the bibliographical review, this work identified a group of ICTs that can be applied to the supply chain management. They can vary according to the features and needs of each stage of the chain. Additionally, it was observed that most of them contribute to a reduction in costs, the improvement of the information flow and process synchronization. By analyzing the theory and the results obtained in the structured poll, the main disadvantages are high costs of implementation, organizational culture and an inadequate process restructuration.

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