



## USE OF INFORMATION AND COMMUNICATION TECHNOLOGY IN LOGISTICS OPERATIONS OF STORAGE: A CASE STUDY OF APPLICATION IN INDUSTRY OF TOYS

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### **ABSTRACT**

Currently supply chains are increasingly competitive, making companies seek constantly a differential in its products, process or services information and communication technology, when well used, it becomes a differential for the pursuit of excellence in organizations the present study aims to present the use of information and communication technology in logistics operations, specifically, in storage with the use of an ERP system integrated with mobile technology methodology this is an exploratory research, and takes the form of a case study in a toy manufacturing company. The research demonstrated that the ERP system integrated with mobile technology allowed the reduction of costs in the storage process, as well as the agility in the storage operations, with the optimization of the flow of activities, simplification and speed in the process of supplying materials, one of the recommendations of the research, it is suggested, the assessment of use of RFID in the logistics operations along with the ERP system and mobile technology.

**Keywords:** Storage; ERP; Integration; Information Technology; Technology



## 1. INTRODUCTION

The advancement of information and communication technology (ICT) in recent years allowing organizations to perform operations that before were not imaginable today, there are several examples of companies that use you to obtain cost reductions to improve of competitive advantage (NAZÁRIO, 2017).

Information and communication systems focused on the area of logistics function as connections linking the logistics activities in an integrated process, combining hardware and software with the goal to measure, track and manage logistical operations, which can occur within a specific company, as well as along the entire supply chain (NAZÁRIO, 2017).

In this context, this research evaluates the use of information and Communication Technology, seeking to answer the following question: An Enterprise Resource Planning system (ERP) combined with mobile technology can raise the level of service of storage operations within an Organization?

To answer the problem of research, part of the following hypotheses:

- The use of ERP system integrated with mobile technology can improve process flow and reduce costs in the storage process
- Changes in processes with this integration will bring greater speed in the process of materials supply the Assembly lines.

Having as main objective to introduce the use of ICT in logistics operations, specifically in the process of storage with the use of an ERP system integrated with mobile technology, showing how knowledge form a case study.

The company studied that had a major expansion of its activities in the past 5 years with the use of Enterprise Resource Planning system (ERP) based on its processes. With this expansion, storage processes of materials in processes became critical, and storage and supply of materials greatly increased, so the information and communication technology used could be increased with the use of integrated systems that could allow greater management especially in the process of storage.

The article is organized into the following sections: Section 2, which features a review of the literature on storage materials and information and communication



technologies, applied in logistics operations. In section 3, it is outlined the research method used in development of a case study and in section 4 the case studied is presented and analyzed in section 5, contributing to elucidate the use of ERP integrated mobile technology, finally, conclusions and recommendations for future work are presented in section 6.

## **2. LITERATURE REVIEW**

### **2.1. Materials Storage**

To Ballou (2008), the storage activity is an administration room to keep stocks, namely, storage is any process that includes stocks in literature there are some kinds of storage, such as Distribution Center (DC), logistic operators, cross-docking, transit point, among others. For Carrilo (2017), the primary storage process is between the receiving and the separation of applications, for the movement of materials such as need for the process of the entire organization to function successfully.

This is necessary so that the stock administration is favorable to the company, because the thought that stocks is money still goes through organizations stopped but in fact is an indispensable process for it delivered products with more agility for customers, or even that the raw material is placed in the production process faster (CARRILO, 2017).

### **2.2. Concepts**

Soriano (2013) States that the storage has been through many transformations in recent years, and these factors are from the adoption of new information systems, automatic handling systems and separation of applications, new equipment and structures of storage.

According to Soriano (2013), the main purpose is to manage the storage space and time, this refers to the available space in the warehouse must be used in an organized manner and rational, as the time available for practice activities warehouse operating. In addition to the management of space and time, Ballou (2006) says that the storage of the products and the handling of materials, are also storage management functions.

### **2.3. Classification**

For Ballou (1993), not just the location, but determining the size you need the building is of paramount importance if used space rented in combination with space, you need to use the space rented only to meet the needs of peak storage according to the same author, there are four options for storage, and they are:

- Have the deposit.
- Rent physical space.
- Rent deposit (deposit) and store in each alternative transit.
- offers different levels of cost, risk and economic involvement.

For Bowersox and Closs (2001), there is a second aspect that involves quantitative analysis is the study carried out on the products to be distributed by deposits. Both the project as the operation of deposits will have to be directly associated with the characteristics of the products.

The products must be analyzed individually in relation to annual sales, demand stability, weight, volume and packing. Must be analyzed in this review the size, volume and weight of the average request to be processed in the warehouse.

#### **2.4. Storage Management Activities**

Ballou (2006) explains that the two relevant functions of storage are storage and movement of products and are divided follows:

- Materials storage.
- Consolidation to load training.
- Transshipment volume fractionation Maintaining.
- Handling loading and unloading to stocking.
- Separation of applications.

For Soriano (2013) there is no unanimity in relation to descriptions of the activities related to storage management.

## **2.5. Information and Communication Technology**

According to Jamil and Silva (2014), ICT's are part of a new concept of organizational context, which the authors define as "the set of procedures, methods, systems and relationships (of order management and/or technological) that guide the organizational actions both in regulatory aspects, and in the productive coexistence of its components" (JAMIL; SILVA, 2014, p 23).

In this new context, ICT's are analyzed in two dimensions: infrastructure and content. The content is related to management of information/knowledge that will be combined with the managers for effective decision-making. To Pinho, Nogueira and Franco (2014), as organizations need to be agile in your decision-making to adapt more quickly to changes of market, technology is essential to achieve this goal, allowing greater interactivity and flexibility the adoption of systems of information and communication technologies (ICTs) makes it possible to transform the existing business model.

According to Pinho, Nogueira and Franco (2014), ICT's are considered the main impetus of growth in the knowledge economy, however, it is important to note that communications technologies, especially, have been growing and causing the initial concept of ICT is revised. With the growing importance of information that takes organizations, whether public or private, to focus on modernization and technological sophistication.

## **2.6. Software Used**

### **2.6.1. Warehouse Management System (WMS)**

Warehouse Management System (WMS) is basically a management system that streamlines the operations of a warehouse through the efficient processing of information with high accuracy of inventory and information activities occur in receiving, in the storage, in the separation, on the production line and in the expedition, using this information to manage more efficiently the processes (BANZATO, 1998).

For Barros (2017), the benefits generated by the WMS are numerous due the main points, as for example, optimizing storage space, reducing waiting time, optimizing the routing of the separation of applications, online availability of real quantity in stock, among other benefits. All these benefits bring significant



improvements to the organizations, such as cost reduction, improving customer service, reducing overtime, additional manpower and decrease errors, because the system streamlines the information flow optimizing logistics processes (BANZATO, 1998).

### **2.6.2. Mobile Technology**

known as TIMS (Mobile Information technologies and wireless) this technology points to a big improvement in the processes, reflecting on gains in efficiency, speed of information, better planning and with the reduction of errors (SACCOL, MANICA; CALDERWOOD, 2011).

Some studies cite four fundamental entities for mobile technology; The environment, which involves the motivation of employees in the Organization; The user, which is labor who will operate the system; the device, which consists of the hardware, which can be anything from a computer to a touch screen for the manipulation of data, and; The software, which is the programming of data processing, including an internet service provider (CORTEZIA; COLUMBO, 2014).

Mobility here refers to a mobile device, without cabling that processes information with agility. Usually smartphones and tablets because they are more popular in the everyday life of the people and the ease of creating applications on these operating systems (CORTEZIA; COLUMBO, 2014)

In accordance with the current technological trend mobile devices like smartphones and tablets have been considered in the context of companies, these devices enable the development of applications that integrate with ERP and thus function as a mobile interface that can be used in the improvement of processes (SZYMCZAK, 2013).

### **2.6.3. Enterprise Resource Planning (ERP)**

For Rosini and Palmisano (2012), at first, an ERP system (Enterprise Resource Planning) is the evolution of MRP (Materials Resource Planning), an integrated system of production, the goal of ERP is to achieve the integration of all systems of the Organization, employing what is known for best practices, i.e. the best management practices of existing businesses.

According to Monteiro (2016), in the 90 arises the term Enterprise Resource Planning (ERP) by consultant Gartner Group. In order to integrate various areas of business of an enterprise, increasing information-sharing throughout the enterprise, centering only in a database.

With technological developments adding various types of technology, the reduction of complexity, or the ease of dealing with data is the main reason for the ERP implementation in an organization beyond the enterprise ERP improvements therefore brings a better customer support and management of the relationship with suppliers (HASSABELNABY; HWANG; VONDEREMBSE, 2012).

Currently we meet in the ERP/generation III where increasingly the ERP has become an open system that offers Web-Based Tools, integration with social networks and mobile devices such as smartphones and tablets (ROMERO; VERNADAT, 2015)

#### **2.6.4. Radio Frequency Identification (RFID)**

According Zhu, Mukhopadhyay, and Kurata (2012), RFID (Radio Frequency Identification) is supported by a tag and an RFID reader, interconnected by a software for reading and processing the data label has a small microchip that stores and transmits information in real time through antennae that emit and receive the data via radio ondar.

To Duroc and Kaddour (2012), this technology is a wireless network that uses radio frequency waves to communicate with the tags that have microchips containing the required information for each product in this way the RFID can have two types of use, and tracking of objects, requiring only the tags, antennae and a software (SUN, 2012).

### **3. METHODOLOGY**

The present study this is an exploratory research which has been prepared in the form of a case study, qualitative analysis of data collected in the company according to Gil (2002) exploratory research aims to create greater familiarity with the problem exposed, making more explicit or constitute hypotheses represented by a case study.



Defined by Yin (2001) as a search strategy that comprises a method that covers everything in specific approaches to data analysis and opted for conducting the study on the company in question, due to ease of access to data and information for research.

The study was conducted in a manner following an order of methodological study, first with the bibliographic survey about the topic to research in books, Capes, and Scielo site on the subject of information and communication technology used in logistics operations of storage in a company.

The next step focuses on collecting data needed to analyze what was operation prior to deployment of mobile technology and highlight what improvements the storage and supply activities of assembly lines would suffer after integration of systems and the results achieved by the company.

In this stage were carried out interviews with managers and employees involved in the deployment of mobile technology, where they spent all the steps performed and we were shown, as was the operation before this new model. We can verify that there were noticeable and relevant improvements in processes, the company provided documents with data proving this improvement obtained.

## **4. CASE STUDY**

### **4.1. Company Characterization**

The company researched develops and produces toys, children's products use bikes for education, sport, leisure, playground and childcare, since 1952, located in São Paulo, the company is large and today occupies the position of leading toy makers from South America.

Because your expansion and acquisition of new equipment, the stock in the warehouse of materials in processes also grew up getting overwhelmed when it comes to storage of these materials. From then on the length of time in storage and supply of materials has increased considerably, and so many materials began to be lost in stock, because there was no effective controls at the warehouse.

### **4.2. Data Collect**

At the warehouse of material components in the process are stored all the semi-finished products (components of toys) from materials of metallurgical





processes, painted, injected, blown, among others. That supply the Assembly lines, approximately 2 500 different items are stored in this warehouse that has an area of 30.097.50 M3 in the image below you can see the placement of the warehouse about other areas.

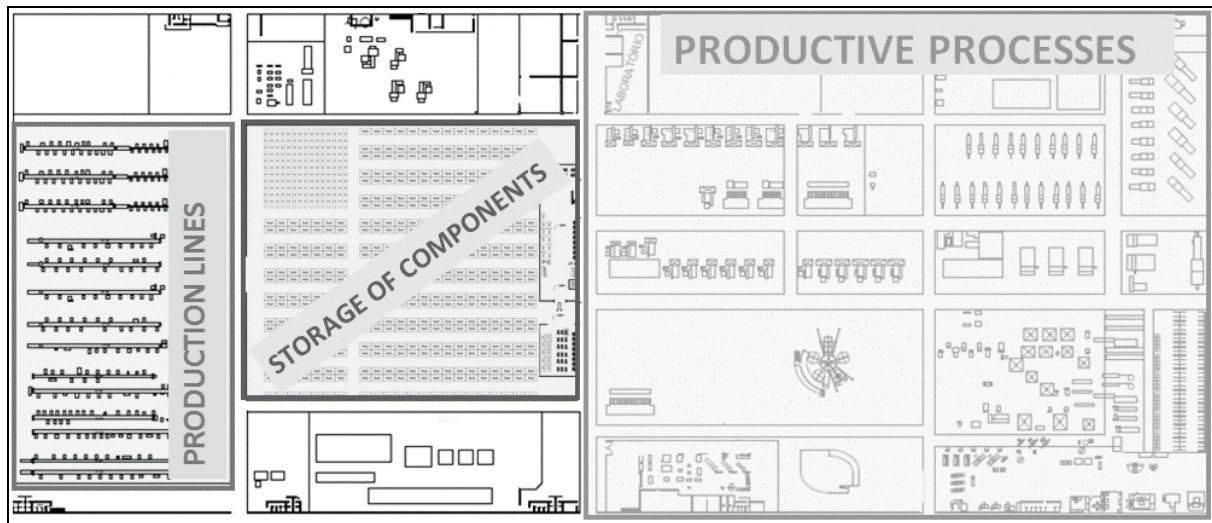


Figure 1: location of Components warehouse:  
 Source: Company object of study (2017)

The supply process of the assembly lines was executed according to the flow of activities below and even using the ERP system the process was time-consuming and took on average 4 hours at 3 hours and 30 minutes.

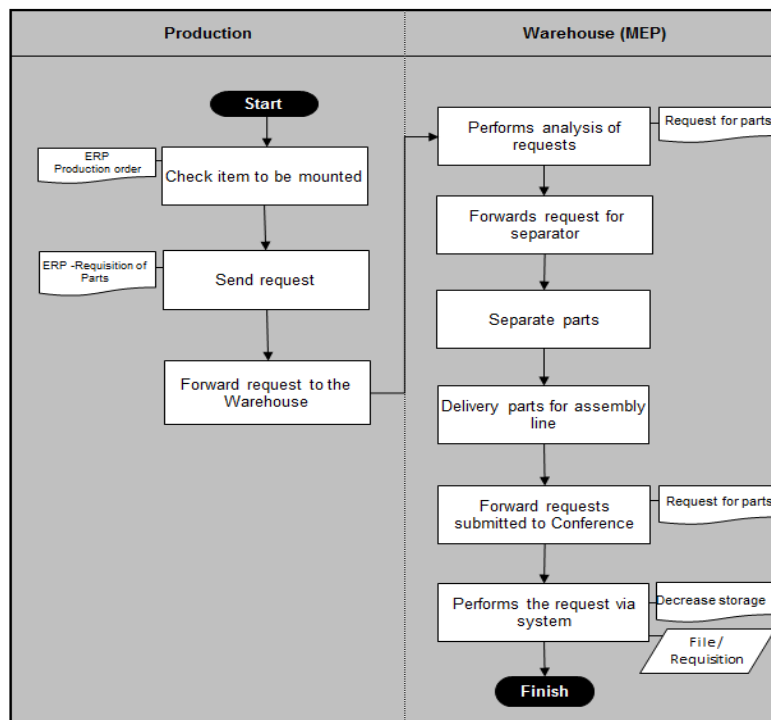


Figure 2: flow of supply activities  
 Source: Company object of study (2017)

In addition to a complex process, it was necessary a large team involved in 3 shifts, totaling 28 employees in the various activity performed by the warehouse according to the table below.

Table 1: sizing of manpower in the warehouse of components.

	SIZE LABOUR				TOTAL
	INPUT (Receipt)	OUTPUT (Supply)	Conferences	ADM	
Quantity	9	12	3	4	28

Source: Company object of study (2017)

According to the Supervisor of the logistics, this process presented not only a as also great occurrence of mistakes. Many times, employees did not know where the material was stored or even couldn't find the components in stock, since the materials were stored at random, all this takes lead a series of impacts on integrated processes to the warehouse, and the main one was the line stop caused by the storage of components, shown in chart for the year 2015.

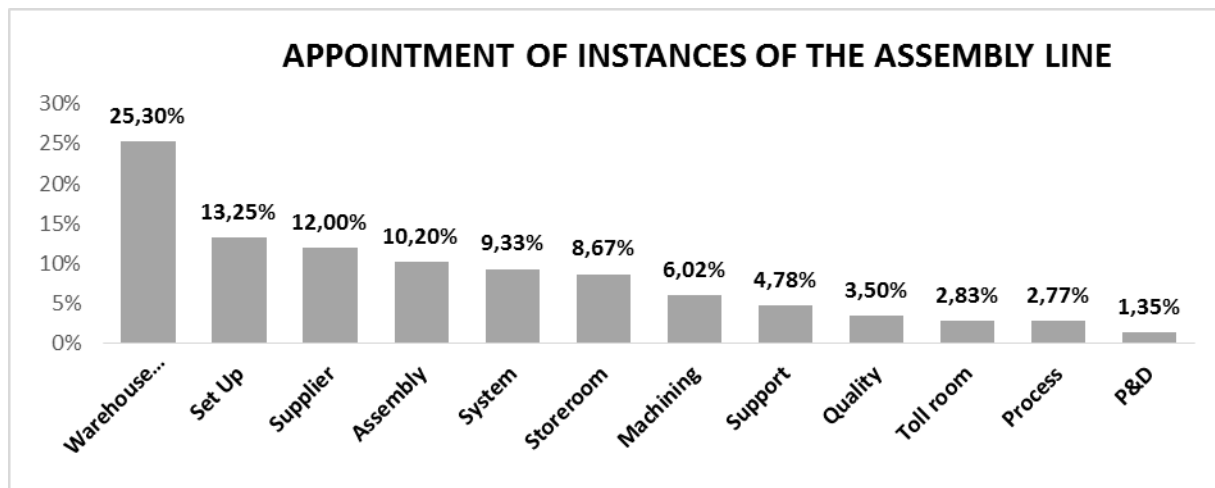


Chart 1: appointment of instances of the Assembly line

Source: Company object of study (2017)

In the table below, you can see how much downtime caused by the warehouse of components represented about loss of products assembled or is the amount of product that no longer fitted due to line stop

Table 2: appointment of occurrences of charts the Assembly line

YEAR	LOSSES	Warehouse (MEP)	Set Up	Supplier	Assembly	System	Storeroom	Machining	Support	Quality	Toll room	Process	P&D	TOTAL
		2015	Loss in Parts	68.749	36.005	32.608	27.717	25.353	23.560	16.359	12.989	9.511	7.690	7.540
	%	25,30%	13,25%	12,00%	10,20%	9,33%	8,67%	6,02%	4,78%	3,50%	2,83%	2,77%	1,35%	100,00%

Source: Company object of study (2017)

### 4.3. Analysis Of The Use Of Mobile Technology

To improve the storage and supply activities of the Assembly lines was proposed the use of information and communication technology; however, as the company already had an ERP system implemented and structured idea was using a technology that was easily integrated to the ERP system.

In a basic comparison between literature and the application in the Organization the solution presented greater relationship with the concepts of integration with ERP and low cost of implementation, was the use of mobile device.

For Monteiro and Costa (2016), mobile technology has easy integration with the ERP system of the Organization, increased mobility, low cost of implementation, the devices used are already part of everyday life of employees and streamlines and simplifies the process. In this context the was mobile technology, with the creation of a mobile application developed internally and especially to the activities of the warehouse.

### 4.4. Stock For Addressing

That implemented the mobile technology integrated with the ERP system were required some adjustments as the addressing of the stock that was not used. This adequacy did not require large financial investments, the warehouse was divided into streets and blocks, being identified with metal plates inscribed with the letter for the address and the blocks of each position were painted on the ground, as shown in Figure 02 After created, these addresses were registered in the ERP system.

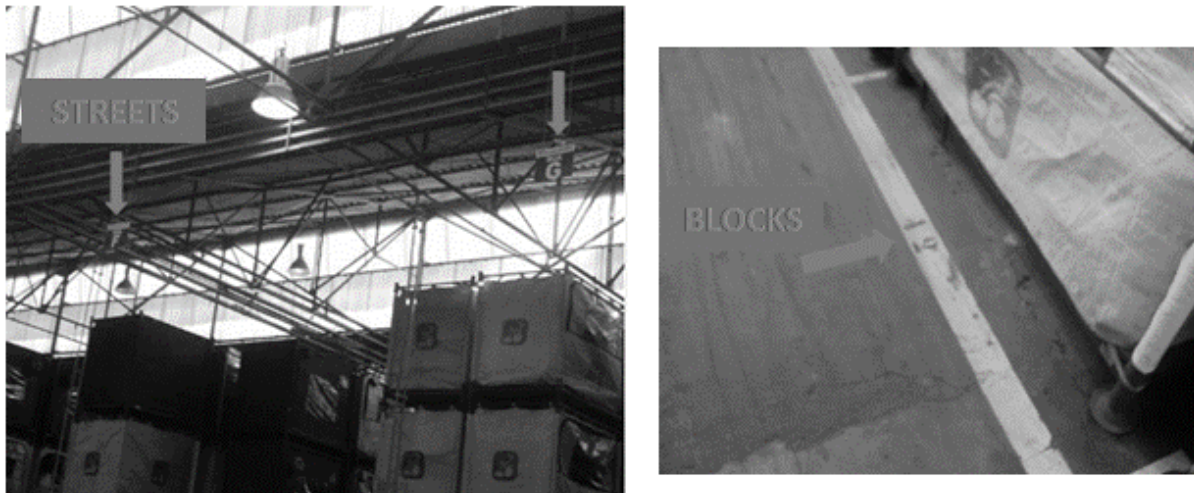


Figure 3: warehouse Address  
Source: Company object of study (2017)

#### 4.5. Identification of materials

For mobile technology was used to facilitate the storage and supply activities of the Assembly lines was necessary the adequacy of identification labels, i.e. the tags until then used were replaced by new labels that bring with them the barcode thus enabling reading and interaction with mobile technology.

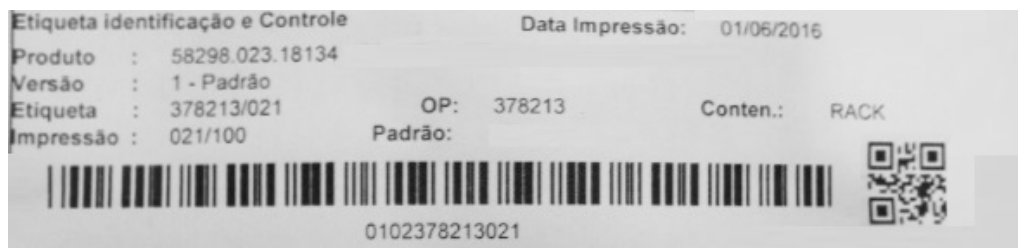


Figure 4: Material Identification  
Source: Company object of study (2017)

#### 4.6. Infrastructure

The largest investment for the system developed to work properly was on infrastructure, because it required the acquisition of mobile devices "phones" with Android system and rear camera. So that the readings of the labels could be carried out, as well as the installation of Wi-Fi antennas at strategic points of the warehouse, where the devices could connect and access the same database.

Table 3: Investments

INVESTMENTS			
QUANTITY PURCHASED	ITEM	UNITARY VALUE	TOTAL VALUE
15	Paints for demarcation of the areas and processes	R\$ 80,00	R\$ 1.200,00
13.200	Adequacy of barcode label	R\$ 0,05	R\$ 660,00
33	Identification cards the street nameplates	R\$ 17,50	R\$ 577,50
28	Identification cards the corridors	R\$ 17,50	R\$ 490,00
1	Software development	R\$ 7.200,00	R\$ 7.200,00
3	Adequacy of infrastructure Network points "Wifi"	R\$ 3.000,00	R\$ 9.000,00
12	Mobile devices "Phones"	R\$ 800,00	R\$ 9.600,00
* Average hours Survey used by the Developer.			<b>R\$ 28.727,50</b>

Source: Company object of study (2017)

## 5. RESULTS AND DISCUSSIONS

With the use of mobile technology integrated with the ERP system there have been significant changes in the process of storage materials the first was that the storage of materials before made at random, from the deployment of technology Mobile began to be stored and addressed soon after leaving manufacturing machines.

When the truck pulls out the components of the production processes, storage is done using the mobile device through the reading of the ID tag where the application automatically provides the information of available addresses. When choosing the addressing, the material is addressed can be consulted on the fly without the need to go to a computer terminal, as the image below.

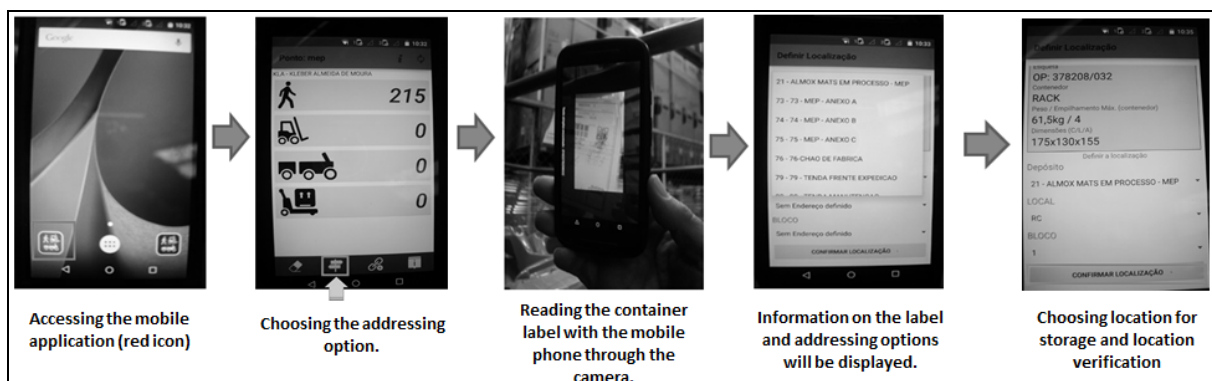


Figure 5: stages of use of the application to addressing  
 Source: Company object of study (2017)

The second change was in the process of supplying the Assembly lines where there was an extremely lengthy and bureaucratic process, and with the use of mobile



technology integrated with the ERP system. The process has been simplified and now requests are sent automatically by the ERP system to the mobile phones according to the need, in other words, all request generation process and Conference were eliminated.

As for the separation of materials, employees do not waste time to find the materials inside the warehouse since to choose the components to be delivered by mobile application the system will find all the locations that component within the warehouse always in order of the oldest, as the stream FIFO rule.

Below you can see the before and after of the supply process of assembly lines it took on average 4 to 3:30, with the mobile system integration with ERP system, was reduced to an average of 2 hours.

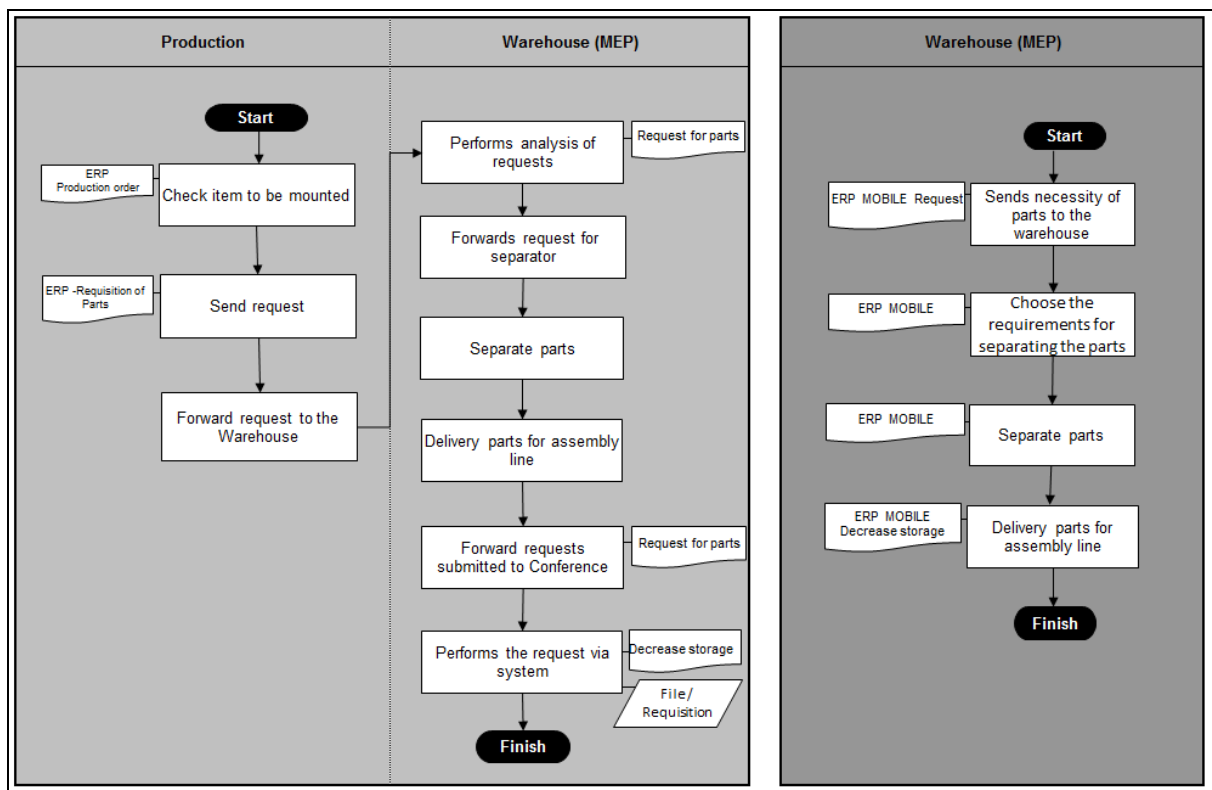


Figure 6: comparison between the streams of supply (Before and After)  
 Source: Company object of study (2017)

With the Elimination of certain activities within and outside the warehouse was possible 28,6% reduction in staff involved in this activity an R\$ 29.475,44 reduction/month, being allocated to other areas such as dispatch of finished products.

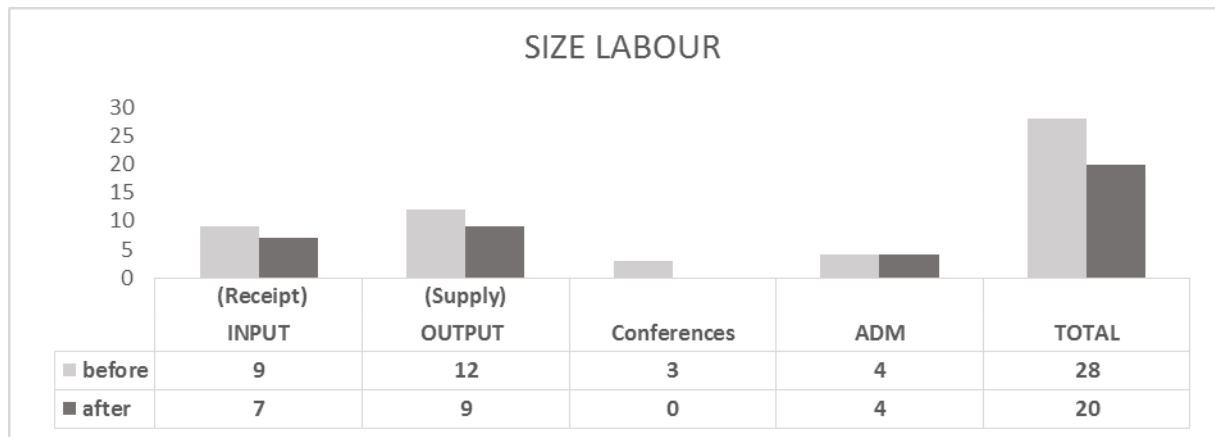


Chart 2: Sizing of labor  
 Source: Company object of study (2017)

With the optimization of the supply process activities of materials occurred 63% reduction of parts mounting losses and 62% in relation to the % line stop caused by components stores compared with the previous year, according to the table below.

Table 4: Comparative Notes of occurrences of stops the Assembly line

YEAR	LOSSES	Warehouse (MEP)	Set Up	Supplier	Assembly	System	Storeroom	Machining	Support	Quality	Toll room	Process	P&D	TOTAL
		2015	Loss in Parts 68.749	36.005	32.608	27.717	25.353	23.560	16.359	12.989	9.511	7.690	7.540	3.660
	%	25,30%	13,25%	12,00%	10,20%	9,33%	8,67%	6,02%	4,78%	3,50%	2,83%	2,77%	1,35%	100,00%
2016	Loss in Parts 24.931	76.931	37.344	28.764	12.518	46.524	7.693	8.893	9.127	3.964	2.947	1.147	260.782	
	%	9,56%	29,50%	14,32%	11,03%	4,80%	17,84%	2,95%	3,41%	3,50%	1,52%	1,13%	0,44%	100,00%

Source: Company object of study (2017)

## 6. FINAL CONSIDERATIONS

The results obtained with this survey attended the objective sought, it was possible to present the use of ICT in logistics operations, specifically in the process of storage with the use of an ERP system integrated with mobile technology.

The assumptions have been confirmed, with respect to hypothesis 1, it can be shown that the use of the mobile system integrated with ERP in company object of study, made possible cost reductions, as the 28,6% reduction in headcount and reducing the occurrences lines stops by failures of the storage area, in addition to the improvement in process flow.

Observed through the figure 6 and the survey data and interviews with employees. With respect to hypothesis 2 the same way it was possible to confirm



that the use of this system allowed the simplification and speed the process of supply of material for the Assembly line. Proven by the analysis of the data of the Assembly line that previously took an average of 4 to 3:30, and the mobile system integration with the ERP system, was reduced to an average of 2 hours.

Through the data it was possible to identify that really the integration with the ERP system was easy and along with that There was a low-cost implementation, which goes against the observed in the literature. The main perceived limitation in this survey refers to the impossibility of generalizing the findings, because in this case study was proven improvements in processes with the use of the mobile system integrated with ERP, however it is worth noting that despite the activities carried out have brought great benefit, other companies in the same or in other sectors may or may not benefit from the same strategy parsed.

As recommendations for continued research, it is suggested, the evaluation of the use of RFID in the logistics operations of company studied.

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