

**007-0183**

**How the Warehouse Management System (WMS) can contribute to the management of  
a Distribution Center (DC) in a furniture retail enterprise**

**Walter Antonio da Silva Costa (UNESP/FEB) walterasc@feb.unesp.br**

**Fábio Marques de Souza (UNESP/FEB) fabioms@feb.unesp.br**

**José Alcides Gobbo Júnior (UNESP/FEB) gobbo@feb.unesp.br**

**Sao Paulo State University – UNESP**

**Faculty of Engineering – Production Engineering Department**

**Av. Eng. Luiz Edmundo C. Coube, 14-01 – 17033-360 – Bauru – SP – Brazil –**

**Phone: +55(14)3103-6122**

**POMS 18th Annual Conference**

**Dallas, Texas, U.S.A.**

**May 4 to May 7, 2007**

## **Abstract**

*One of the critical phases of the physical distribution is the management and administration of products which are stored in Distribution Centers (DC), mainly in operations of order fulfillment. There are critical information related to products such as; quantity, time reliability and speed in the customer service. All these operations are complex and need computerized systems for better management. The Warehouse Management System (WMS) is a specialist system which manages the operations of DCs, attempting to meet the inherent needs of these operations. This specialist system, when working integrated with Enterprise Resource Planning (ERP), allows the obtainment of information from products, clients, branch offices, requests and route definition. The operations are able to keep more agility when the WMS system uses the Radio Frequency (RF) Technology; therefore information is available in real time. This way, many enterprises adopt these systems aiming at the improvement of the logistics operations and the management of DCs. There have been implementations of the WMS in several business segments in developing countries. One of the sectors with larger growth potential in these countries, is the furniture sector due to the huge potential of growth observed in these places. In the last years, the furniture sector is facing a tough competition in the market. One of the greatest differentials of the sector today is the quality of the supplied furniture. The constant searching for differentiation in the furniture sector, is the key for the survival of this market. For this reason new management models and advanced business strategies applied to the operational process and commercial relations of the enterprises are being introduced. Among the new technologies utilized, the automation of process with the use of technological tools such as; the bar code and electronic communication of data, is an important ally. In the furniture sector, the utilization of automation in the internal operations and in the relationship with the commercial partners*

*are even more fundamental for the increase in the efficiency of the operations and the reduction of costs.*

*The furniture sector possesses many particularities related to warehousing of goods, such as: geometries and different weights; high models turnaround; high segmentation of products in DC with the same sale code. The sector's particularities justify a deeper study. The main objective of this research is to identify how the WMS can contribute in DC management of a furniture retail enterprise in a developing country. For this purpose, it was carried out a qualitative and explanatory study. It was driven a study of a large-scale retail enterprise from the Brazilian furniture sector. The enterprise was one of the pioneers in WMS implementation in the furniture sector in Brazil. The enterprise adopted in their DC, a WMS to work together with the ERP of the organization. Considering the operational improvement potential, this study aims at providing the practitioners with a study which shows that, with the correct use of the WMS, significant profits can be obtained. In this context, the fulfillment operations of the enterprise were mapped. This mapping provided an analytical view on how the operations were conducted before and after the implementation of the WMS. The main objectives presented by the implementation of the WMS in the focused enterprise were: improvements in the accuracy of stock information; improvements in speed and quality of the operations of DC. The basic characteristics that the WMS presented in the integration with ERP were: facility of integration; possibility to administer several places in DC; use of data collectors by radiofrequency (RF Technology). One of the main results obtained with the WMS implementation was: the substantial reduction in customer's claims related to the logistic function of the enterprise; process agility and workforce reduction.*

*Keywords: Logistic. Distribution Center. WMS. ERP. RF. Brazilian Furniture Sector.*

## 1. Introduction

One of the critical stages of the physical distribution is the management and administration of products that are stored in Distribution Centers (DC), mainly with regard to order receiving, merchandise receiving, quality control, material handling, warehousing, picking and shipping. The information related to the products such as: quantity, delivery time and efficiency, in the order fulfillment, is also critical. All these operations are complex and need informatized systems for better management.

Currently, it is required that the enterprises provide a more efficacious logistics, which makes it extremely complex. This way, alternatives to minimize costs and improve customer services (BARROS; SCAVARDA, 2005) are attempted. However, the concept of logistics is very wide. According to CSCMP – Council of Supply Chain Management Professionals (2007):

Logistics Management is that part of Supply Chain Management that plans, implements and controls the efficient, effective forward and reverse flow and warehousing of goods, services and related information between the point of origin and the point of consumption in order to meet customers' requirements.

“Regarding depots, warehouses and distribution centers, the WMS seems to be as a good alternative to optimize warehousing, since it presents alternatives in order to optimize spaces and organize the product and distribution flow” (BARROS; SCAVARDA, 2005, p. 1). The WMS can usually contribute to the optimization of the business network in an organization, by reducing costs and improving customer services (BANZATO, 1998). According to Barros and Scavarda (2005, p.1):

The cost reduction is associated with the improvement of the efficiency in all the operating resources, such as: equipment and work force. On the other hand, the improvement in customer services can be due to the fact that picking and delivery errors and flaws are minimized, as well as the quickness in the entire customer service process, by combining improvements in material flow with improvements in information flow.

This paper aims at explaining the WMS, ERP and RF technologies, as well as the Brazilian furniture sector. The main objective of this study is to identify how the WMS can contribute to the management of a DC in a retail furniture enterprise in a developing country. For this reason, a qualitative and explanatory study was performed. According to Yin (2001), from a technical standpoint, this research must use a case study, in addition to bibliographical research.

## **2. Methodology**

This research – whose results are presented in this paper – can be classified according to Vergara (2000) and Gil (1991); with regard to the ends, as a mixture of exploratory and descriptive research; and with regard to the means as a bibliographical, participative and case study research. It is regarded as exploratory because it aims at providing a greater familiarity with the problem, making it clear. It involves bibliographical survey and interviews with people who had practical experiences with the studied problem. It is regarded as descriptive because it aims at describing the characteristics of a particular phenomenon. On the other hand, when the investigation procedures are analyzed, this research can be classified as a bibliographical one, due to the fact that it will use material which is accessible to the public in general (books, papers, theses, among other) for primary and secondary data analysis. It is regarded as participative research because one of the authors of this paper directly participated in the implementation process of the WMS at Alfa Enterprise, experiencing the use of WMS before and after the implementation. The practical part fits the definition by Yin (1994), for a case study, whose main purpose is to try to clarify a decision by mapping the reason for which such decision was made and what the results are.

### **3. Distribution Center – DC**

According to Gurgel (2001, p. 21), Distribution Center (DC) is a “warehouse with finished products and service items, originated from more than one factory and devoted to serve more than one market”. According to Ballou (1993), the warehousing costs in the DCs are justifiable, for they can be compensated by the transportation and production costs. A enterprise may reduce its productive costs, once its inventories absorb the production level float. In addition, its inventories in the DC may reduce transportation costs, for they allow for the use of larger and more economical quantities in the loading batches. According to Ballou (1993), the availability of the product in the market is an interesting aspect for marketing purposes. In this sense, the DC can be used to aggregate this type of value, that is, by storing the product the closest to the customer as possible, faster deliveries can be made, thus improving the service quality. The operations of a DC of the retail sector can be as follows: Receiving of products from suppliers or return of products by the customer; product warehousing in proper sites; picking and shipping (LACERDA, 2000).

### **4. Warehouse Management System – WMS**

The Brazilian DCs present an increasing number of warehousing automation projects, starting from the mere inclusion of bar code systems to control goods and their addresses, up to the whole operation complexity, without any human intervention (LACERDA, 2000). Lacerda (2000) affirms that the search for these systems is a reaction against the demands of a new business scenario, whose customer's demand is high. There is a strong competition among the enterprises, leading them often to implement radical changes in the warehousing and distribution structures. Ribeiro, Silva and Benvenuto (2005, p. 7), quote:

Due to the reduced inventory policy, the customers are requesting smaller and smaller orders more frequently, pushing the inventory backwards in the supply chain. The reduction

in the order size increases the demand for picking operations, in addition to making them more difficult when working with broken boxes' orders. In addition to this, the variations in the size of the packages with which the products are traded in the retail sector increase the number of items to be controlled, processed and handled in the warehouses, implying a productivity decrease, a greater need for space and higher administrative costs.

The WMS is a software-managed system that improves the DC operations, through the efficient management of information and task conclusions, at a high level of inventory control and accuracy (BANZATO, 2003; apud RIBEIRO; SILVA; BENVENUTO, 2005, p. 8). The information supplying a WMS comes from transporting enterprises, manufacturers, business information systems, customers and suppliers. All this information is the base for the WMS in the receiving, inspection, stocking, picking, packing (if needed) and shipping of products in a more efficient way (RIBEIRO; SILVA; BENVENUTO, 2005). According to Ribeiro, Silva and Benvenuto (2005, p. 8):

The efficiency is obtained by means of planning, routing and multiple tasks that take place in several warehouse processes. The WMSs optimize all the operating and administrative activities of the warehousing process, such as: receiving, inspection, addressing, stocking, picking, packing, loading, shipping, issue of documents and inventory, among other functions. Cost reduction and improvement in customer services are gains obtained from using these systems, for the operating productivity tends to increase.

According to Ribeiro, Silva and Benvenuto (2005, p. 8):

The system operates fully in real time among several warehouses, thus enabling the visualization of the merchandise status, either locally or at a distance, by means of remote terminals or Internet consultations, generating transfer receipts and allowing for a global and sectorial point of view on the merchandise. The WMS system also has warehousing optimization routines, which guide the merchandise relocation, trying to accelerate the stocking and removal, due to the merchandise turn.

The objectives of a WMS, according to Sucupira (2004), are:

- To increase the precision of the inventory information
- To increase the speed and quality of the operations in the distribution center
- To increase the productivity of the warehouse personnel and equipment

Yet, Sucupira (2004) lists the main functionalities of a WMS:

- Operation trackability
- Physical rotating and general inventories
- Capacity planning and control
- Definition of use characteristics for each warehousing site
- Item classification system
- Lot control, quarantine clearance dates and quality control situations
- Picking
- Customer – supplier interface
- Estimation of shipping packages and content lists
- Route control and loading of vehicles

The Warehousing Education and Research Council (WERC) has performed some research in 2003 in order to determine the potential and the experiences in using WMS among its associates. This research was sent to 941 enterprises, of which 131 had answered it (14%). It was on WMS' efficacy and the total performance. Two thirds responded that they had implemented the system in their enterprises, and the most quoted applications were (WERCwatch, 2004):

- stock picking;
- receiving/sorting;

- real-time tracking;
- material handling; and,
- labor management and planning.

It was verified that the WMS can be useful in many warehouse operations, however, the main benefit is the improvement in the order accuracy.

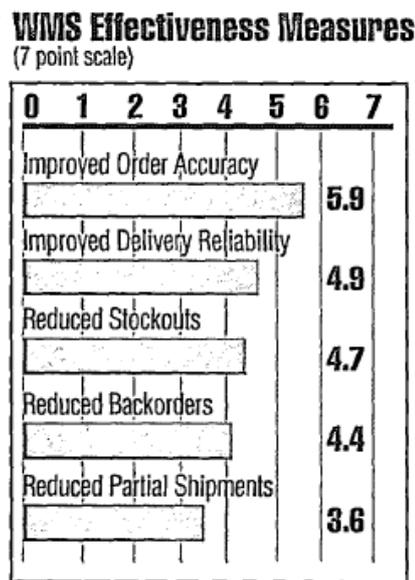


Table 1: WMS efficacy  
Source: WERCwatch, 2004

## 5. Enterprise Resource Planning - ERP

Enterprise Resource Planning (ERP) “is a term [...] that comprises a wide range of activities supported by modular software, also known as management software” (GOMES; RIBEIRO, 2004, P. 180).

According to Souza (2003):

ERP is a generic term for a set of activities performed by multimodular software, which aims at aiding the manufacturer or the manager of a enterprise in important stages of the business, including product development, purchasing of items, inventory maintenance,

interaction with suppliers, customer services and production order follow-up. ERP can also include application modules in financial aspects and even in the human resources management. An ERP system usually uses or is integrated with a relational database.

The ERP can be seen as management through software, so that its architecture can facilitate the information flow among all the enterprise's activities, such as manufacturing, logistics, finance and human resources. "It usually consists of a single database, operating in an ordinary platform that interacts with a set of applications" (SOUZA, 2003).

Souza (2003) also explains that:

The ERP employs the customer/server technology. It means that the system user (customer) runs an application (routine of a system module) that accesses the information from a single database (server). The database interacts with all the system's applications. This way, the information redundancy and the data retyping are eliminated, which assures the integrity of the obtained information. Below, it is presented a central database interacting with the several modules of an ERP architecture, within a logistic view of resource administration. In one end, there are the customers, and in the other, the suppliers.

According to Zancul and Rozenfeld (1999), "the modules shown in the figure above are present in most ERP's systems". In addition to them, some ERP systems have additional modules, such as: Quality Management, Project Management, [...], among other".

According to Souza (2003), "the typical ERP's modules" are: Finance, Accounting, Production Planning and Control, Human Resources, Costs, Sales, Marketing [...]" . Some of them even offer the Logistics module. However, many enterprises choose to acquire a WMS specialized software – due to complex logistic operations – instead of using the Logistics module from the generalist ERP module. Even though, one must be careful when choosing this setup: The databases must belong to the same platform; the interaction among systems must be perfect and preferably in real-time; both systems must present customization possibilities to fit the enterprise's operations, among other aspects.

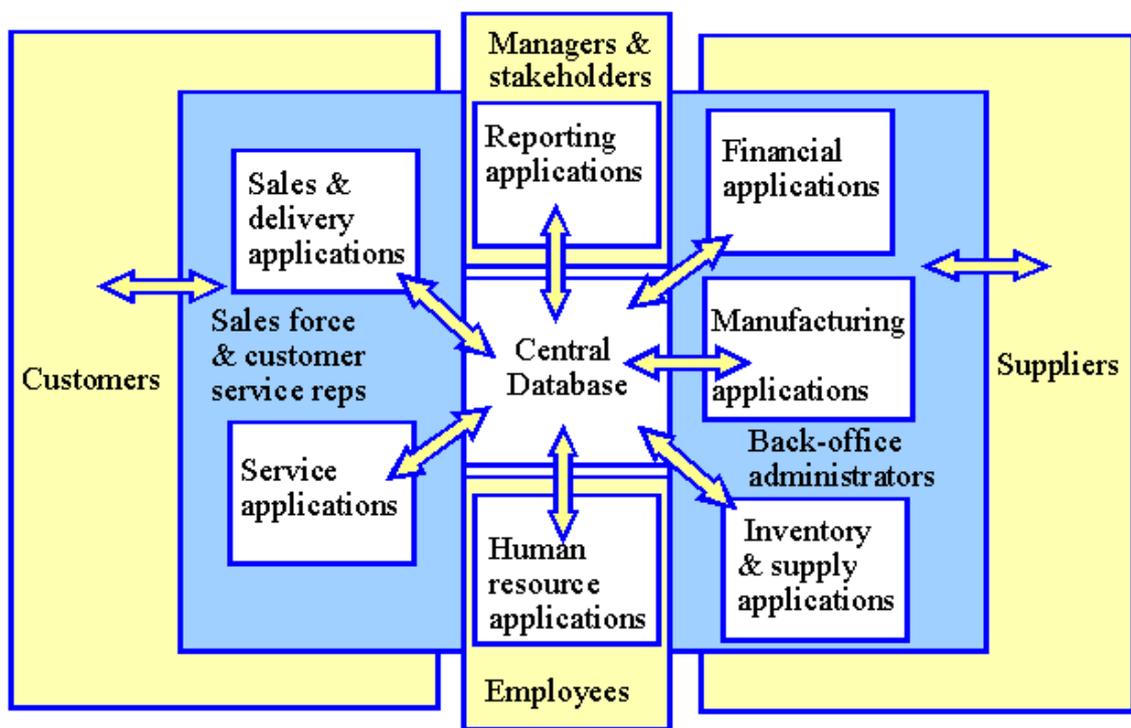


Illustration 1: The typical ERP's structure  
 Source: Adapted from Davenport, 1998 (apud ZANCUL; ROZENFELD, 1999)

## 6. Radiofrequency Data Collection – RFDC

The WMS can optimize the enterprise businesses by reducing costs and improving customer services (BANZATO, 1998). Banzato (2001a) explains the advantages of using WMS, mainly when linked to ERP. Yet, Banzato (2001b) affirms that, when the WMS operates in connection with a bar coding system, and the equipment reading is performed by Radiofrequency Data Collection (RFDC), the operations tend to be faster and more precise, for they operate in real time.

The automation of the product receiving processes guarantees the elimination of typing errors, verification and order consultation. By offering more quickness and efficiency in the collection and input processes. The benefits of the automation in this area are (PROXION, 2006):

- Quickness in the information flow;
- Increase in efficiency and productivity;
- Cost and time reduction;
- Reduction in typing errors.

In the warehousing, the automation using RFDC provides quickness and safety in the stocking operation. There are many benefits involved in the warehousing process (PROXION, 2006):

- More accuracy of the inventories;
- Reduction in the inventory levels;
- Better follow-up in the productivity of the warehouse staff;
- Reduction in the execution time of the receiving, warehousing, picking and order loading operations;
- Greater quickness in customer services;
- Competitive edge in the market;
- Reduction in damage;
- Improvement in work environment, mainly with regard to safety;
- Cost reduction directly connected to the management of the enterprise's logistic processes.

In the picking process, the use of RFDC guarantees the elimination of typing errors, order and table verification and consultations, making the process quicker and more efficient. The benefits are (PROXION, 2006):

- Decrease in bottlenecks;
- Reduction in the difficulties and deficiencies in picking;
- Reduction or invalidation of intermediate stocks;
- Improvement in the picking of items or materials in manufacturing activities.

The shipping can be benefited by using automation and RFDC, resulting in the elimination of typing errors, verification and consultation to orders and tables. The benefits in the shipping processes are (PROXION, 2006):

- More accuracy in the information;
- Better follow-up in the productivity of the staff;
- Greater quickness in customer services;
- Competitive edge in the market;
- Improvement in work environment, mainly with regard to safety;
- Cost reduction directly connected to the management of the enterprise's logistic processes.

## **7. Brazilian Furniture Sector**

Brazil has 26 states in addition to the Federal District. There are more than 16,000 furniture enterprises in Brazil, with more than 206,000 employees. The state of São Paulo alone concentrates around 3,754 enterprises (more than 23%) with almost 48,5 employees (around 23.3%) (ABIMÓVEL, 2006, p. 6).

## Concentration of furniture Manufacturers in Brazil

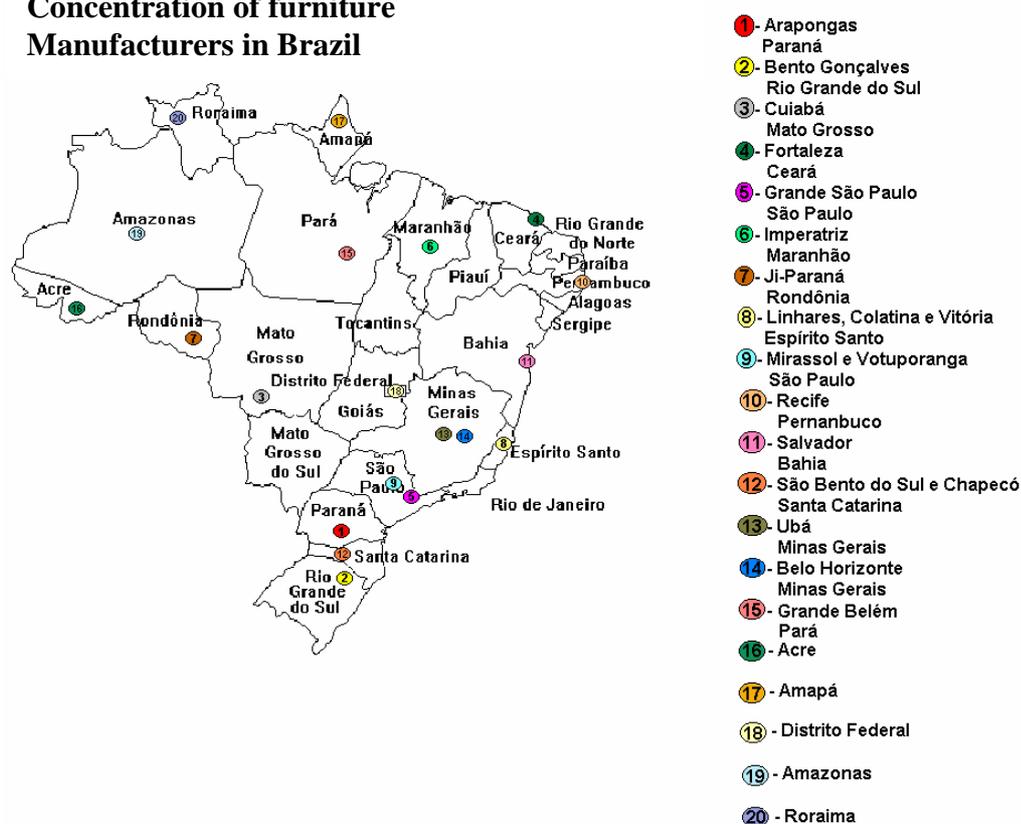


Illustration 2: Concentration of furniture manufacturers in Brazil  
Source: Abimóvel, 2006

The Brazilian furniture sector presents the following turnover:

Year	2000	2001	2002	2003	2004	2005
Sales (Million R\$)	7,599	8,631	10,095	10,756	12,543	12,051*
Domestic Sales (Million R\$)	6,918	7,738	8,767	8,934	10,060	9,901*
Exports (Million Us\$)	485	479	533	662	941	991
Imports (Million Us\$)	113	99	78	70	92	108
Trade Balance (Million Us\$)	372	380	455	592	849	883
Exports/Production (%)	10.1	11.6	15.4	17.2	22.0	18.3*
Imports/Domestic Sales	2.5	2.6	2.6	2.3	2.6	2.3*

Table 2: Brazilian furniture sector - turnover (\* Estimations)  
Source: Abimóvel, 2006

With regard to the origin of the imports, the Brazilian furniture sector presents the following distribution:

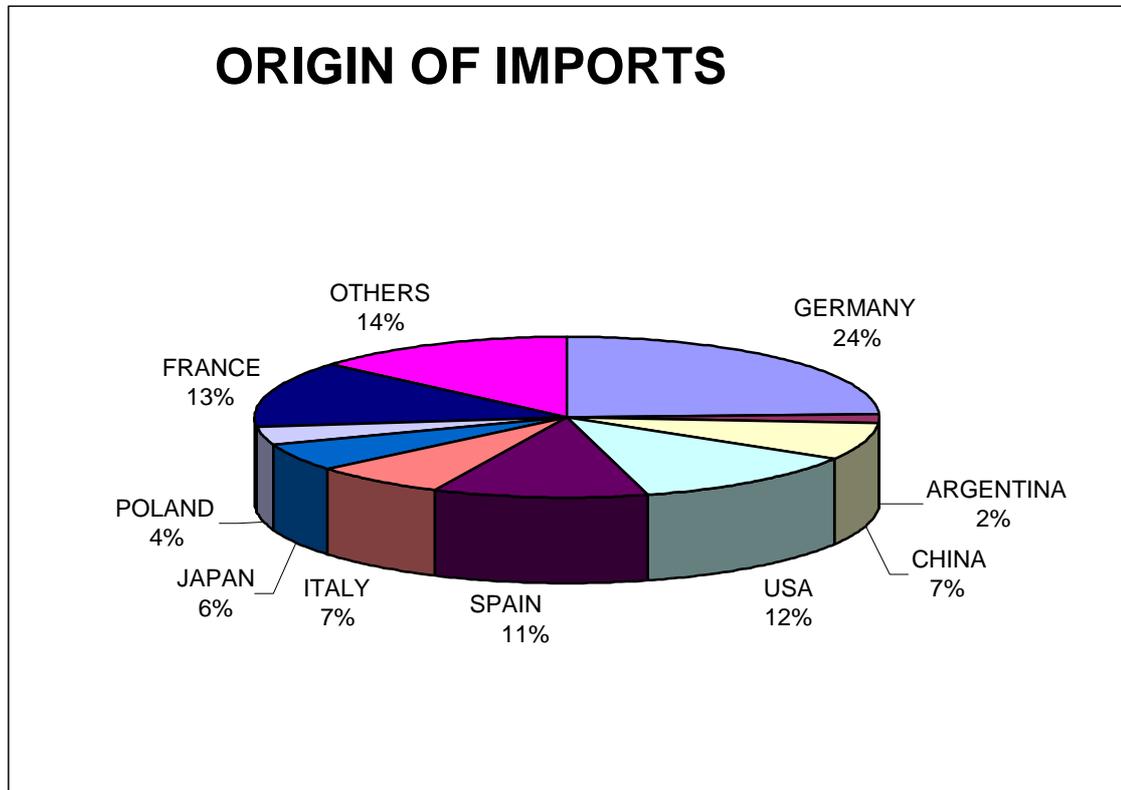


Illustration 3: Origin of the furniture imports (Jan./ Aug. 2006)  
Source: Abimóvel, 2006

With regard to the destination of the exports, the Brazilian furniture sector presents the following distribution:

## DESTINATION OF EXPORTS

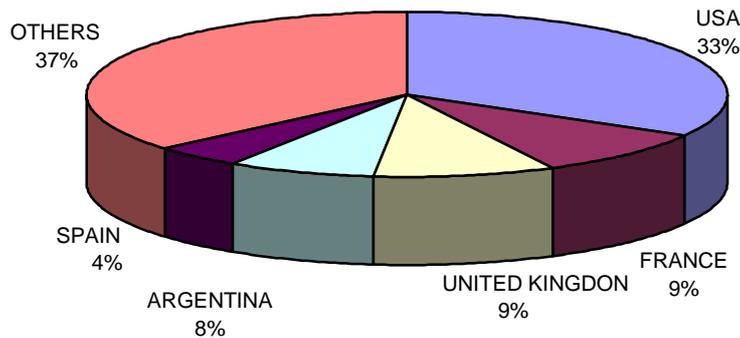


Illustration 4: Destination of the Brazilian furniture exports (Jan./Aug. 2006)  
Source: Abimóvel, 2006

In the last years, the Brazilian furniture sector has been facing a strong internal competition. A major competitive edge to the furniture enterprises is the quality of the furniture provided, which meets the market tendencies, once the customers have become more and more demanding. The constant search for innovation is the way to survive in this market. It is observed the introduction of new management models and advanced business strategies, applied to operating processes and commercial relations of the enterprises (GS1 BRASIL, 2006). With regard to the furniture sector, the use of automation in the internal operations and in the relationships with commercial partners, is more and more essential to increase the efficiency in the operations as well as cost reductions.

The retail sector has become specialized along the years (NOVAES, 2004). Many enterprises negotiate previously supply contracts and, afterwards, transfer the control to informatized systems among enterprises. The retail sector has also specialized and modernized the DC so

that the inventory could be better managed and the customers better served. According to GS1 Brasil (2006):

The major difficulty in identifying furniture to the industry is the control of multiple packages from the same commercial item, and it is also hard to the retail sector to guarantee that the customer receive all parts/components of the same product without errors, avoiding product return.

This sector presents many particularities with regard to the merchandise warehousing logistics, such as:

- Considerable differences in size, geometry and weight (for example, size: end table and double bed mattress; geometry: wooden door and concave glass door; weight: crib mattress and wardrobe).
- High product turnover (for example, quick assortment switch, impacting on the organization and depot operation).
- Multiple packaging for the same commercial item (for example, the “x” wardrobe can present even five different volumes in size, geometry and weight, but it is a single item with a single code).

## **8. Codification of GS1 standard commercial items**

“GS1 is a leading global organisation dedicated to the design and implementation of global standards and solutions to improve the efficiency and visibility of supply and demand chains globally and across sectors” (GS1 INTERNATIONAL, 2007).

The use of GS1 standard bar coding provides a common language between the commercial partners, allowing for the recognition of products by enterprises from all over the world, providing many business opportunities, widening the range of suppliers and favoring the enterprise enlargement towards a worldwide scale (GS1 BRASIL, 2006).

This way, GS1 Brasil, in partnership with the main sector enterprises, has listed the required information to identify products from the furniture sector. The solutions developed are used to identify an individual Commercial Item of a single volume, to identify the Logistic Units and to identify the products having several components (parts) separately packed. The GS1-128 code must be applied with, at least, the following AIs (GS1 Brasil, 2006):

- Global Trade Item Number - GTIN: this numbering must be represented in the GS1-128 code by AI 01 or 02, or by the GTIN-13 code.
- Lot number: this information must be represented in the GS1-128 code by the AI 10.
- Component or Volume Identification – For example: 1/3, 2/3 and 3/3: only applicable to products traded in several volumes. This information must be represented in the GS1-128 code by the AI 8006.



Illustration 5: Example of the GS1 label – 1/3 Volume  
Source: GS1 Brasil, 2006

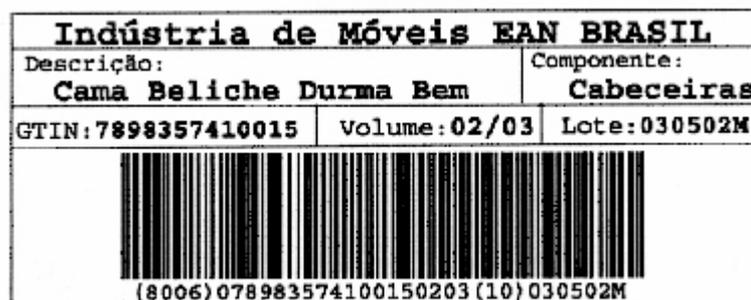


Illustration 6: Example of the GS1 label – 2/3 Volume  
Source: GS1 Brasil, 2006

<b>Indústria de Móveis EAN BRASIL</b>		
Descrição:	Componente:	
<b>Cama Beliche Durma Bem</b>	<b>Laterais</b>	
GTIN: 7898357410015	Volume: 03/03	Lote: 030502M
		
(8006) 078983574100150303 (10) 030502M		

Illustration 7: Example of the GS1 label – 3/3 Volume  
Source: GS1 Brasil, 2006

## 9. Case study – Retail enterprise from the Brazilian furniture sector

### 9.1 Introduction

A study on a major Brazilian retail furniture enterprise was conducted. This enterprise, from now on regarded as Alfa, was one of the first enterprises to implement WMS in the furniture sector. This enterprise has adopted in its DC a WMS in order to operate together with the managerial system (ERP) of the organization.

Alfa is retail enterprise whose main activity is to sell household furniture to end users, by means of its 75 resellers spread out in São Paulo City, Parnaíba and Ribeira Valleys and Campinas City, Brazil. It has a single DC located in the far east of São Paulo City. From this Center, the products sold in the stores are delivered directly to the customers' homes.

### 9.2 Mapping of the operations before using WMS

#### 9.2.1 Organization chart before using WMS

It is observed that, in this organization chart before using WMS, practically every department reported to the Main Operating Office, as the Quality Operating Office.

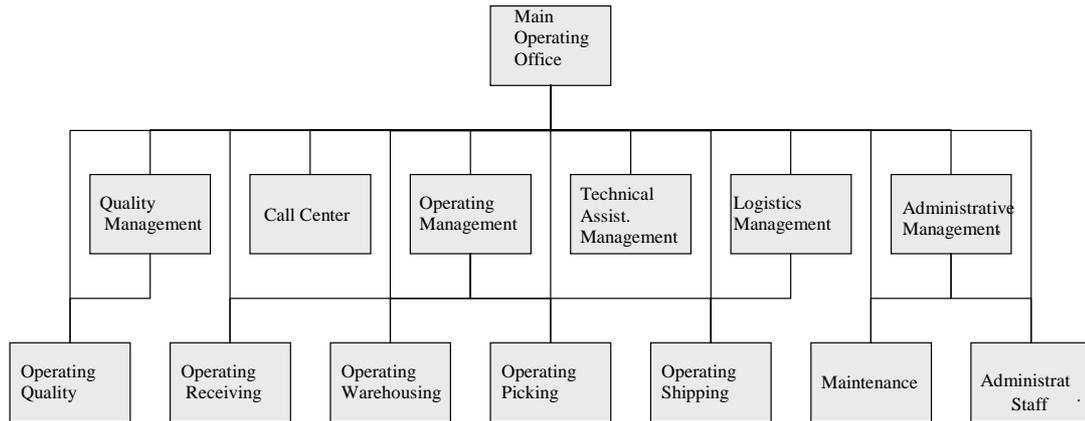


Illustration 8: Organization chart before using WMS  
Source: Alfa Enterprise, 2006.

### 9.2.2 Receiving of merchandise

The driver, when arriving in the DC, must park his vehicle in the parking space located outside the warehouse and follow to the front desk, carrying his personal as well as the merchandise documentation. Then, the receptionist must verify the documentation against the orders requested by the Purchasing Department, by means of specific ERP's screens. The document data are typed in specific ERP's screens, in order to perform the entry of merchandise, in case there is no divergence. The driver is then invited to enter the DC, by means of sound message, towards the factory yard. The documents related to the merchandise are kept at the front desk and then referred to the receiving room. When it comes to divergences, there are basically three that often occur. The other ones must be solved by the respective management.

- a) Divergence of values: It is when the values shown in the official merchandise invoice differ from the ones agreeded in the purchasing. The official invoice is then verified against the Purchase Order, which also contains the agreeded price. Once the error is confirmed, the supplier is requested to send a correction letter, depicting the correct

values. The official invoice entries the ERP system only after such letter is received – and it can be sent by fax – and then, the unloading is cleared.

- b) Divergence of quantity: In case the quantity described in the Purchase Order is higher than the one described in the official invoice, the write-off in the Purchase Order is only partial, and the lacking quantity must be delivered in the next loading. In case the quantity described in the official invoice is higher than the one described in the Purchase Order, the Order is completely written-off – as well as part of another order – with regard to the outnumbered part. In any of the cases, the supplier is informed so that the next shipping with the lacking merchandise of the Purchase Order can be scheduled, or a smaller amount can be sent in the subsequent Order, informing the Order number with which the supplier is operating.
- c) Divergence of the product description: In case the supplier sends the official invoice without its description, so that the merchandise cannot be identified (for example: some suppliers send the product colors discriminated, as codes), the supplier is requested the merchandise description, by fax. The recognition of the merchandise and its posterior unloading clearance is only possible after the receiving of this fax.

In the receiving room, the official invoices are referred to the receiving clerk, and then distributed to the checking clerks, as a direction to the receiving process. The empty pallets are transported by the fork-lift trucks, through verbal request of the checking clerks, who inform their type, and suggest the quantity of the needed pallet for the palletization of the received merchandise. The palletization is performed according to the leading lumber's perception, that is, the lumber identifies the best way to occupy the pallet and then assemble it. There is no palletization pattern. The merchandise with more than one volume can be palletized on the same or different pallets, however, without a pattern in shape, quantity and type of volume picking.

The quality control department is also accessed in order to accomplish the due controlling procedures and quality assurance of the received products. The Quality is responsible for controlling and verifying if the volume quantity of a certain product is in accordance with the information from the Logistics personnel. However, such procedure is not performed, for it is said that it delays all the receiving operation. Three finished products are randomly chosen, and they are taken to the Quality sector for surface, color, texture, perforation, ironware, assembling analyses – among other things – thus investigating the product quality. In case the merchandise is out of specification, the Control may refuse it, even returning it to the supplier, if justifiable. Approved or not, the merchandise is re-packed and returned to the receiving sector, so that there is no divergence of the quantity at the moment of checking. After the completion of the merchandise palletization, according to the list description, it is performed the checking through counting and comparison with the official invoice. In case there is no divergence, the checking clerk refers the official invoice back to the receiving room so that the merchandise is entered the ERP. In case the merchandise counting differs from the one in the official invoice, the checking clerk performs another counting. If there is still divergence, the checking clerk makes a note on the back of the official invoice and returns it to the receiving room, so that the quantities can be adjusted with the ERP. At the end of the unloading operation, it is verified if there is any return to the supplier. In case no merchandise is returned to the supplier, the signed stub of the official invoice is delivered in the dock, and then the driver is free to go. In case there is return to the supplier, the merchandise is separated and loaded in the supplier truck. The driver is invited to take the official return invoice and also the stub signed of the unloaded merchandise in the receiving room. After this procedure, the driver is free to go.

### 9.2.3 Material handling

After checking the products in the receiving room, the pallets are removed from the boxes and exposed next to the wall (which separates the receiving from the stocking room), still in the receiving area. There is no pallet and merchandise control in the transfer from the receiving to the warehousing sector.

### 9.2.4 Stocking

The control and follow-up are performed by the people in charge of the warehouse organization, without using informatized systems. The pallets are stocked according to their address availability, by means of a minimum location control. The warehouse is segmented by corridors and products:

- Corridors 01, 02, 03, 04 ..... Tables and Chairs
- Corridors 05, 06, 07, 08 ..... Wardrobes and similar products
- Corridors 09, 10, 11, 12 ..... Beds in general
- Corridors 13, 14 ..... Mattresses
- Corridors 15, 16 ..... Counters, Shelves and similar products
- Corridors 17, 18, 19, 20, 21, 22 ..... Kitchens in general
- Corridors 23 and 24 ..... Giveaways

According to this organization, a pallet of kitchen merchandise is stocked in the corridors 17, 18, 19, 20, 21 or 22, in compliance with address availability. Basically, the possible divergence takes place when a corridor of a specific merchandise is already full, then the pallet is stocked somewhere else. The pallet is stocked in the specific corridors belonging to

its product group, without the exact address being noted.

### **9.2.5 Picking**

The organization is interconnected by a Corporate System (ERP), which receives daily sales information, reserving the merchandise sold in the DC stock, so that the new sales can be oriented with regard to the quantities and delivery time offered to the customers. Every night the ERP consolidates the sales and makes available the product information, quantities, delivery routes – among other logistic information – for the delivery loading to be accomplished late at night.

The picking is accomplished by people through merchandise listings, bringing only the name and merchandise quantity to be picked, as well as its destination. The picker often does not find the merchandise in the specific corridors, causing delay in the picking or even shipping clearance lacking merchandise. However, if there is no problem, it is picked and sent to the corresponding shipping sector. It was observed that there was no pallet handling in the picking, only merchandise handling.

### **9.2.6 Shipping**

The picked loads are checked through listings by Alfa Enterprise employees, and made available for the drivers and their outsourced helpers. In case of divergences, they will be addressed punctually and with temporary solutions.

### 9.3 Mapping of the operations after implementing WMS

#### 9.3.1 Current organization chart

The current organization chart operated in a more verticalized way.

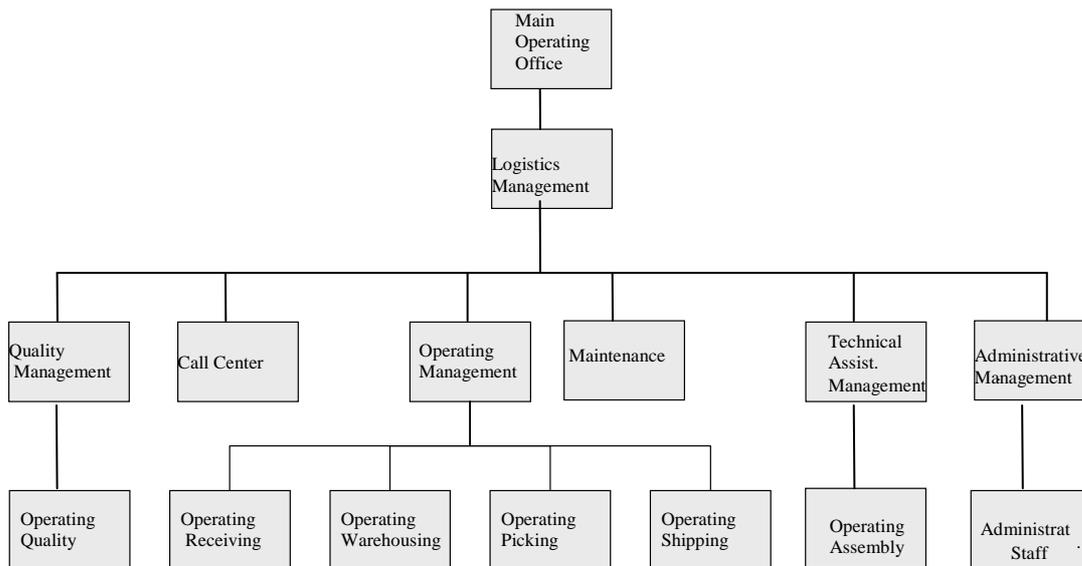


Illustration 9: Current DC organization chart  
Source: Alfa Enterprise, 2006.

The Main Operating Office deals with global subjects involving the DC, searching for information directly in the Logistics Management, which is responsible for all the other managements and sectors, such as Call Center and Maintenance.

#### 9.3.2 Receiving of merchandise

The driver, when arriving in the DC, must park his vehicle in the parking space located outside the warehouse and follow to the front desk, carrying his personal as well as the merchandise documentation. Then, the receptionist must verify the documentation against the orders requested by the Purchasing Department, by means of specific ERP's screens. The document data are typed in specific ERP's screens, in order to perform the entry of

merchandise, in case there is no divergence. The driver is then invited to enter the DC, by means of sound message, towards the factory yard, and to wait for clearing from the dock to proceed the unloading. The documents related to the merchandise are kept at the front desk and then referred to the receiving room, in order to supply the WMS. When it comes to divergences, there are basically three that often occur. The other ones must be solved by the respective management.

- a) Divergence of values: It is when the values shown in the official merchandise invoice differ from the ones agreeded in the purchasing. The official invoice is then verified against the Purchase Order, which also contains the agreeded price. Once the error is confirmed, the supplier is requested to send a correction letter, depicting the correct values. The official invoice entries the ERP system only after such letter is received – and it can be sent by fax – and then, the unloading is cleared.
- b) Divergence of quantity: In case the quantity described in the Purchase Order is higher than the one described in the official invoice, the write-off in the Purchase Order is only partial, and the lacking quantity must be delivered in the next loading. In case the quantity described in the official invoice is higher than the one described in the Purchase Order, the Order is completely written-off – as well as part of another order – with regard to the outnumbered part. In any of the cases, the supplier is informed so that the next shipping with the lacking merchandise of the Purchase Order can be scheduled, or a smaller amount can be sent in the subsequent Order, informing the Order number with which the supplier is operating.
- c) Divergence in the product description: In case the supplier sends the official invoice without its description, so that the merchandise cannot be identified (for example: some suppliers send the product colors discriminated, as codes), the supplier is requested the

merchandise description, by fax. The recognition of the merchandise and its posterior unloading clearance is only possible after the receiving of this fax.

In the receiving room, the product information is transferred to the WMS, in order to generate the palletization lists and make available tasks to the data collector of the fork-lift trucks and checking clerks. The lists are given to the person in charge of the receiving, who distributes them to the checking clerks and requests the fork-lift operators to transport the pallet empty, according to RFDC information. The checking clerk gathers a lumber team in order to perform the unloading and the palletization, and tells the driver to park the truck in the corresponding dock. Now, the palletization is standardized. Each commercial item (product) has the specification in the WMS for the pallet type, the maximum quantity and the type of picking among volumes, in case there is more than one.

The quality control department is also accessed in order to accomplish the due controlling procedures and quality assurance of the received products. The Quality is responsible for controlling and verifying if the volume quantity of a certain product is in accordance with the information from the Logistics personnel. In case the merchandise is out of specification, the Control may refuse it, even returning it to the supplier, if justifiable. Three finished products are randomly chosen, and they are taken to the Quality sector for surface, color, texture, perforation, ironware, assembling analyses – among other things – thus investigating the product quality. In case the merchandise is out of specification, the Control may refuse it, even returning it to the supplier, if justifiable. Approved or not, the merchandise is re-packed and returned to the receiving sector, so that there is no divergence of the quantity at the moment of checking. After the completion of the merchandise palletization, according to the list description, it is performed the checking through RFDC. The WMS now informs if there is divergence or not in the checking. When there is no divergence in the checking and in the palletization, all door clearance and pallet addressing operations are accomplished through the

checking clerks by the RF data collector. However, if there is divergence, the checking clerk can decide to recount the merchandise, making sure the quantities were properly typed, or request help from the WMS operator, who will do it through the desktop in the receiving room, being necessary to inform the number of the door in which the divergence took place, needing to be solved and the door cleared. By means of this operation, the door becomes available to a new unloading into the WMS system, and the corresponding pallets will be available for stocking. At the end of the unloading operation, it is verified if there is any return to the supplier. In case no merchandise is returned to the supplier, the signed stub of the official invoice is delivered in the dock, and then the driver is free to go. In case there is return to the supplier, the merchandise is separated and loaded in the supplier truck. The driver is invited to take the official return invoice and also the stub signed of the unloaded merchandise in the receiving room. After this procedure, the driver is free to go.

### **9.3.3 Material handling**

After checking the products in the receiving room, the pallets are removed from the boxes and exposed next to the wall (which separates the receiving from the stocking room), still in the receiving area. The lift trucks move towards the receiving room, where they take the pallet and weigh it, placing it on the floor scale in the receiving area. All the lift trucks have an RF collector fixed in the equipment structure. The lift truck operator must make available the pallet on the scale, so that the WMS can check its weight. This second checking is a guarantee, so that all the merchandise can be stocked in the correct quantity. In case the weighing does not diverge, the WMS requests the lift truck operator the warehousing of the pallet in the address that is displayed on the collector's screen. In case of weight divergence, the WMS requests information from the lift truck operator and its correction through a merchandise re-counting on the pallet.

### 9.3.4 Stocking

The stocking by WMS became more flexible. The stocking system now is random, that is, the palletized product can be stocked in any address, provided it meets the weight, height and width requirements of the metallic racking. In this setup, a product with more than one volume can have addresses far from each other. The warehouse is addressed according to sector, street, tower and stocking level. Assuming that the lift truck operator is stocking a pallet whose address is K.14.06.2, it must be interpreted as follows:

- Sector: ..... K
- Street: ..... 14
- Tower: ..... 06
- Level: ..... 2

When in the address, the pallet must be stocked, and for the conclusion of the operation, the pallet address must be read. In case of address error, the WMS informs that the pallet is stocked in a wrong address, and requests that it be stocked in the right address, by reading the new address. In case there is no stocking error, the system confirms the operation and goes back to the reading option of a new pallet. It is possible to follow and control the whole stocking process, performed by lift trucks, by the WMS in the desktops.

### 9.3.5 Receiving of orders

After preparing the loads in the ERP, they must be exported to the WMS so that the merchandise picking can be possible. In order to accomplish that, it is necessary to conciliate information. This conciliation of quantities involves the ERP and WMS systems, once the ERP has managerial information on the items, such as available quantity, ABC sales classification, among other. The WMS has detailed information on the logistic field, such as

receiving lots, addressing, weight, volume quantity, dimension, packaging, type of picking, among other. The conciliation may still present divergences of quantities. In case it occurs, the WMS system locks the operation of the subsequent stages, till the divergences are solved. Basically, the WMS does not release new tasks while there are divergences between the ERP and WMS systems, with regard to quantities. In case there is no divergence, the picking process starts.

### 9.3.6 Picking

A system of automatic conveyors was built, composed of conveyors, lifting work tables and scales. This system is managed by WMS. When picking, the picker must remove the pallet from the address that is displayed in the RFDC and take it to one of the system entries (ES1, ES2, ES3 or ES4, according to the figure).

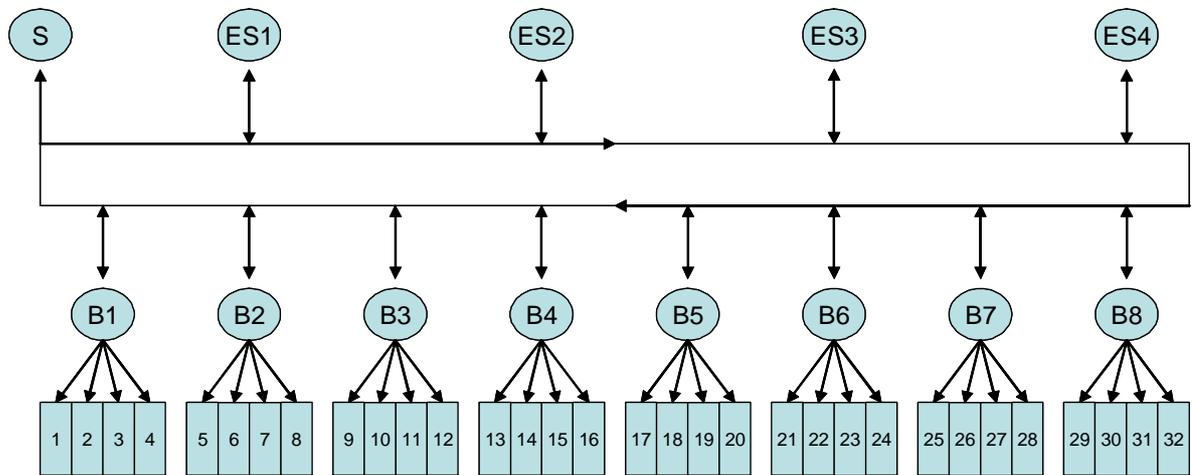


Illustration 10: Scheme for the automatic shipping conveyors  
Source: Alfa Enterprise, 2006.

The system has bar code scanners that identify the pallet and guide it to the B1, B2, B3, B4, B5, B6, B7 and B8 bays. There, other pickers scan the bar code of the pallet, in order to find out the quantity of merchandise to be removed from the pallet and the destination dock. When the picking is finished, the pallet can go to another bay or exit the system. If the pallet is

empty, it exits through the “S” conveyor (which is exclusive for empty pallets), otherwise, it exits through the ES1, ES2, ES3 or ES4 (wherever it is closer). The pallet exiting with merchandise is then identified by the picker and if it is used in the next picking wave<sup>1</sup>, it waits for the re-entry in the system. Otherwise, it is returned to the stocking.

Once all the pallets have already passed by the merchandise picking, they must return to the shelves, in case they still have merchandise. This way the operator, by means of the RF collector, scans the pallet’s bar code and obtains the information on the address that the pallet must be stocked again. The possible divergences at this stage are related to a human error, such as: the pallet was supposed to be empty, but there is still merchandise on it, among other things. In these cases, the solutions must originate from a detailed analysis of the occurrence and a proper solution to the case must be provided. Without divergence, the operator scans the pallet’s bar code in order to obtain a new warehousing address. It is transported to the requested corridor, and in case the address is located on the floor, the operator himself stocks it. Otherwise, the lift truck is requested.

### **9.3.7 Shipping**

With the completion of the picking, the Alfa Enterprise employee, with the RFDC, checks all the merchandise and make it available to the drivers and their outsourced helpers. In case there are divergences, these are solved by means of WMS, which controls and manages all the DC activities.

## **10. Conclusion**

With the WMS implementation, the previous organization chart was replaced with a more hierarchized one. Prior to that, the main office did not know what was occurring in the DC,

therefore the need for various information sources. Afterwards, with the use of the WMS, the information started to be displayed on the computer screens.

The receiving process was benefited, for the human labor was quite pronounced, causing several errors. The WMS has created a system that eliminates many errors that used to be discovered only in the warehousing, in the shipping or into the customer's home. Other advantages, such as the unloading of trucks, were achieved. It usually took 6 hours to unload a wardrobe truck with 5 volumes per item. This same truck is currently unloaded in about 2.5 hours.

In the past, the person responsible for the stocking used to decide the handling to make the pallet available, for there was not addressing by unit, but by corridors, which contained certain product groupings. With the WMS, the stocking became fixed, thus it is possible to manage the inventory, control the FIFO, decrease obsolescence, increase the turn and reduce the merchandise's localization time.

The picking process was previously performed by expert pickers who knew the product. This way, an expert picker in kitchens did not necessarily know about dorms. The picking of a load had to be split, resulting in various mistakes and delays. The WMS together with the RFDC do not need expert pickers, for the system informs the pallet address and it is taken and placed into the system of the automatic conveyors. In this system, the pallets are referred to the shipping sector, and there the merchandise is picked. Each system bay serves 4 boxes.

The checking in the shipping by RFDC became faster and more trustable, in addition to maintaining the management and main office informed.

Nevertheless, the most expressive gain resides in the end customer. The WMS implementation provided a substantial reduction of the complaints connected to the customers, with regard to the enterprise's logistic operations. There was a 95% decrease in

end customers' complaints with regard to the enterprise's logistic operations.

## 11. References:

**ABIMÓVEL** – Associação Brasileira das Indústrias do Mobiliário. *Panorama do Setor Moveleiro no Brasil: Informações Gerais*, v.1.2 (10 fev. 2007). Disponível em: <<http://www.abimovel.org.br/download/Panorama%20Agosto%202006%20%20Reduzido.doc>>. Acesso em: 10 fev. 2007.

**BALLOU, R. H.** *Logística empresarial: transportes, administração de materiais e distribuição física*. Tradução: Hugo T. Y. Yoshizaki. São Paulo: Atlas, 1993.

**BANZATO, E.** *Warehouse Management System – WMS: Sistema de Gerenciamento de Armazéns*. São Paulo: IMAM, 1998.

\_\_\_\_\_. *ERP + WMS = Excelência*. São Paulo, mar. 2001a. Disponível em: <<http://www.guialog.com.br/ARTIGO180.htm>>. Acesso em: 29 nov. 2006.

\_\_\_\_\_. *WMS com Informação em Tempo Real*. São Paulo, jun. 2001b. Disponível em: <<http://www.guialog.com.br/ARTIGO195.htm>>. Acesso em: 29 nov. 2006.

**BARROS, M. C.; SCAVARDA, L. F.** Estudo da Implementação do Warehouse Management System (WMS) em um Centro de Distribuição. In: VIII SIMPOI, 8., 2005, São Paulo. *Anais do VIII Simpósio de Administração da Produção, Logística e Operações Internacionais – SIMPOI*. FGV-EAESP, 2005. Disponível em: <<http://www.simpoi.fgvsp.br/index.cfm?FuseAction=arquivo&Tipo=BCDET&Ano=2005&ID=373>>. Acesso em: 30 nov. 2006.

**CSCMP** – Council of Supply Chain Management Professionals. Supply Chain Management/Logistics Management Definitions. *CSCMP Definition of Logistics Management*. Disponível em: <<http://www.cscmp.org/Website/AboutCSCMP/Definitions/Definitions.asp>>. Acesso em 10 fev. 2007.

**DAVENPORT, T. H.** Putting the enterprise into the enterprise system. Harvard Business Review. Julho-Agosto, 1998, p.121-131. (t: 827). Apud **ZANCUL, E.; ROZENFELD, H.** *Sistemas ERP: conceitos básicos*. Disponível em: <[http://www.numa.org.br/conhecimentos/conhecimentos\\_port/pag\\_conhec/ERP\\_v2.html](http://www.numa.org.br/conhecimentos/conhecimentos_port/pag_conhec/ERP_v2.html)>. Acesso em: 10 fev. 2007.

**GIL, A. C.** *Como elaborar projetos de pesquisa*. São Paulo: Atlas, 1991.

**GOMES, C. F. S.; RIBEIRO, P. C. C.** *Gestão da Cadeia de Suprimentos Integrada à Tecnologia da Informação*. São Paulo: Pioneira Thomson, 2004.

**GS1 BRASIL** – Associação Brasileira de Automação. Atuação Setorial. *Móveis*. Disponível em: <<http://www.gs1.org.br/main.jsp?lumChannelId=7B881A71171911DB853DDB753E7F9C5C>>. Acesso em: 28 nov. 2006.

**GS1 INTERNATIONAL.** About GS1. *Overview*. Disponível em: <<http://www.gs1.org/about/overview.html>>. Acesso em: 12 fev. 2007.

**GURGEL, F. A.** *Glossário de Engenharia de Produção*. 7. ed. São Paulo: Fundação Vanzolini, mai. 2001. Disponível em:<<http://www.poliag.com.br/download/glossario.doc>>. Acesso em: 05 dez. 2006.

**LACERDA, L.** *Armazenagem Estratégica: Analisando novos conceitos*, 2000. Disponível em: <<http://www.centrodelogistica.com.br/new/fs-public.htm>>. Acesso em: 10 fev. 2007.

**NOVAES, A. G.** *Logística e Gerenciamento da Cadeia de Distribuição: Estratégia, Operação e Avaliação*. 2. ed. Rio de Janeiro: Elsevier Campus, 2004.

**PROXION.** Proxion Solutions. *Nossas soluções*. 2006. Disponível em: <<http://www.proxion.com.br/2006/solucoes.php>>. Acesso em: 10 fev. 2007.

**RIBEIRO, P. C. C.; SILVA, L. A. F.; BENVENUTO, S. R. S.** O uso de WMS em Operações de Armazenagem em um Prestador de Serviços Logísticos. In: VIII SIMPOI, 8., 2005, São Paulo. *Anais do VIII Simpósio de Administração da Produção, Logística e Operações Internacionais – SIMPOI*. FGV-EAESP, 2005. Disponível em: <<http://www.simpoi.fgvsp.br/index.cfm?FuseAction=arquivo&Tipo=BCDET&Ano=2005&ID=226>>. Acesso em: 30 nov. 2006.

**SOUZA, M.** *ERP (Enterprise Resource Planning)*. Business Intelligence (December, 2003). Disponível em: <[http://www.imasters.com.br/artigo/1636/bi/erp\\_enterprise\\_resource\\_planning/](http://www.imasters.com.br/artigo/1636/bi/erp_enterprise_resource_planning/)>. Acesso em: 10 fev. 2007.

**SUCUPIRA, C.** *Gestão de Depósitos e Centros de Distribuição Através dos Softwares WMS*. Rio de Janeiro, jun. 2002. Disponível em: <<http://www.cezarsucupira.com.br/artigos111.htm>>. Acesso em: 29 nov. 2006.

**VERGARA, S. C.** *Projetos e relatórios de Pesquisa em Administração*. 3. ed.. São Paulo: Atlas, 2000.

**WERCwatch.** What a WMS can do for you. Warehousing Education and Research Council – WERC (December, 2003). In: *Material Handling Management*, v.59, n.1 (January, 2004), p.52. Disponível em: <[http://vnweb.hwwilsonweb.com/hww/shared/shared\\_main.jhtml?\\_requestid=45441](http://vnweb.hwwilsonweb.com/hww/shared/shared_main.jhtml?_requestid=45441)>. Acesso em: 1. dez. 2006.

**YIN, R. K.** *Case Study Research: design and methods*. Thousand Oaks, Newbury Park: Sage Publications, 1994.

**ZANCUL, E.; ROZENFELD, H.** *Sistemas ERP: conceitos básicos*. Disponível em: <[http://www.numa.org.br/conhecimentos/conhecimentos\\_port/pag\\_conhec/ERP\\_v2.html](http://www.numa.org.br/conhecimentos/conhecimentos_port/pag_conhec/ERP_v2.html)>.

Acesso em: 10 fev. 2007.