Restructuring of the System of Storage and Dispatch of Portuguese Air Force (PAF) Material

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Abstract
Given the current economic conjuncture, organizations have the need to become more flexible and to follow more efficient practices, in order to adapt to this new environment and take advantage of their available resources. The Portuguese Air Force (PAF) is aware that the logistic component is crucial to improve effectiveness in its mission accomplishment. The objective of this work is to analyze the warehouse system, the reception and expedition of material, and to study solutions based on new technologies, in order to outline procedures based on new tools capable to adapt to the integrated system already implemented. In fact, the PAF has already some tools that allow for implementing a computerization of these tasks, namely the warehouse management system, which is currently being implemented at the *Depósito Geral de Material* of the PAF. This work proposes the adoption of a centralized acquisition system in order to restrict the number of procedures carried out, and the variety of items acquired. In addition, it also proposes the use of the tool SAPConsole in order to make possible the reception and expedition of materials using bar code scanners. With the proposed improvements, the current procedures of the warehouse system will be more efficient, leading to lower costs and a better use of the available resources.

Keywords: Logistics, Warehouse Management, Centralized Acquisitions, Bar Code, Portuguese Air Force

Introduction

The Portuguese Air Force (PAF) was created on July 1, 1952, constituting itself as an independent branch, together with the Army and the Navy and integrating the aviation incorporated in those branches. It is a constituting part of the national forces system and its mission is to cooperate, in an integrated way, in the military defense of the Republic, through air operations, and in the air defense of the national space. It is also responsible for the fulfillment of missions in the framework of international commitments, as well as for missions of public interest specifically assigned to it.

The Air Force Logistics Command is one of the bodies belonging to its structure, having the mission of managing the Air Force's material resources, information systems and infrastructures. It has under its jurisdiction the General Deposit of Material of the Air Force, which, in turn, has the mission of receiving, storing and distributing the material subject to centralized management.

The logistics component is decisive for increasing the efficiency in the fulfillment of the mission, contributing to the activities of maintenance and sustentation of aircrafts, to the effort made in the multiple logistical aspects that cover the conservation of goods, fuels, food, clothing, and the acquisition of diverse material for services operation.

The PAF is aware of the need to modernize its weapons and equipment systems and, in this sense, has been developing programs that require a rational management of its human and material resources. There are areas where this evolution has been faster, among them the logistics area, where there has been a significant evolution in the last decade, especially with the implementation of the Integrated Management System (IMS), which provided the PAF with a system of integrated provisioning, providing an increasingly dynamic response both in terms of time and in terms of rigor.

However, the implementation of the IMS alone did not make the tasks of the logistical process fully computerized, and there were still some gaps in this regard. The Organization is facing a problem that needs to be solved in order to adapt its logistics system to new management concepts, supported by new technologies, thus enabling a timely and safe response to the problems that have arisen.

Based on this scenario, it becomes increasingly urgent to adopt new management methods that allow greater optimization of existing resources. Recognizing that existing procedures, methods, and circuits, are out of step with the current reality, the Organization considered necessary, and appropriate, to study solutions based on new technologies that enable PAF's Supply to be effective and efficient, in order to contribute to the total fulfillment of its mission.

The objective of this work is to analyze the current PAF supply system and to study solutions based on new technologies, in terms of storage, in order to delineate procedures based on new tools that adapt to the integrated system already implemented.

Because it is impossible to study the whole Organization, it was decided to analyze a small part of the Supply System, namely Storage and Material Expedition, taking as a

reference the procedure adopted in the GDMPAF (General Deposit of Material of the Portuguese Air Force). However, the solution found for the GDMPAF could be adopted by the existing warehouses in the various units of the PAF, since the procedures are overall identical.

Literature review and research questions

Logistics

Long before the businessperson realized the size and centrality of logistics in the business world, the military strategist already used it to move armies (Carvalho, 2017).

The wars were long and distant, requiring constant displacement of resources. In order to transport troops, arms and war cars to combat sites, it was necessary to plan, organize and carry out logistical tasks, which involved the definition of a route, not always the shortest one, as it was necessary to have a source of nearby drinking water, transport, storage and distribution of equipment and materials (Dias, 2005).

At the corporate level, logistics became more pronounced at the end of the 19th century, having undergone several changes in its context up to the present day. Nowadays, it assumes a fundamental role in the business environment, as it allows companies to obtain competitive advantages and enables the increase of their productivity as well as their profitability (Carvalho, Vilas-Boas & Neill, 2014; Soares & Mendes, 2016).

Briefly, logistics is the process of managing the flow of products, services and information, between suppliers and customers or vice versa, bringing customers, wherever they are, to the products and services they need, under the best conditions (Ballou, 2004; Moura, 2006).

Location of Warehouses

The location of factories, points of sale, warehouses or other infrastructures can be calculated using very similar methods and, in all cases, an optimal location implies minimizing transport costs, and at the same time the cost of construction or rental of the infrastructure (Carvalho, 2017).

In order to obtain an optimal location, formulations that imply greater centrality to the sales outlets, or customers they serve, should be used, and should not be dependent on marketing principles. It is important to do a cost/service sensitivity analysis to decide the location of a storage facility.

Next, only two localization methodologies will be presented, one using a gravitational modeling (gravitational model), the other using a detailed analysis of weighted costs in relation to the location alternatives (scores model) (Carvalho, 2017).

Gravitational Model

Technique used to locate individual installations, such as storage. It considers only as starting data the locations of existing facilities and the volume of goods to be transported. The center of gravity is determined by calculating the 'x' and 'y' coordinates that minimize the associated transport costs (Carvalho, 2017).

$$C_x = \frac{\sum d_{ix} V_i}{\sum V_i} \qquad \text{and} \qquad C_y = \frac{\sum d_{iy} V_i}{\sum V_i}$$

Being:

C_x – Coordinate x of the center of gravity;

C_y – Coordinate y of the center of gravity;

d_{ix} – Coordinate x of the existing i-th installation;

d_{iy} - Coordinate y of the existing i-th installation;

V_i – volume of goods transported to or from the ith facility.

Scores Models

These models allow taking into account other costs, or other factors, that may be relevant to deciding what is the best option concerning the location of the warehouse. They can take two distinct forms, the additive model and the multiplicative model (Carvalho, 2017).

The additive model is calculated as follows:

$$S_j = \sum_{i=1}^{m} W_i F_{ij}$$

Being:

S_j – total score for location j;

W_i – total weight for factor i (in %);

F_{ij} – score for factor i at location j;

n – number of locations;

m– number of factors.

The multiplicative model is calculated as follows:

$$S_j = \prod_{i=1}^{m} F_{ij}^{w_i}$$

Where the variables have the same meaning as those of the additive model.

Warehouse Layout

A well-structured warehouse with a coherently defined layout can lead to significant reductions in operating costs and process agility. There are several important things to consider when organizing a warehouse layout, namely:

- the popularity of articles, where those with the highest number of inbound and outbound transactions must be stored in places such that the distances to be made are minimized;

- the similarity, which is justified by the fact that the products received and / or sent together should be stored together;

- their size, where products should be stored in appropriate spaces according to their dimensions.

According to Carvalho (2017), we can have two types of warehouses (Figures 1 and 2):

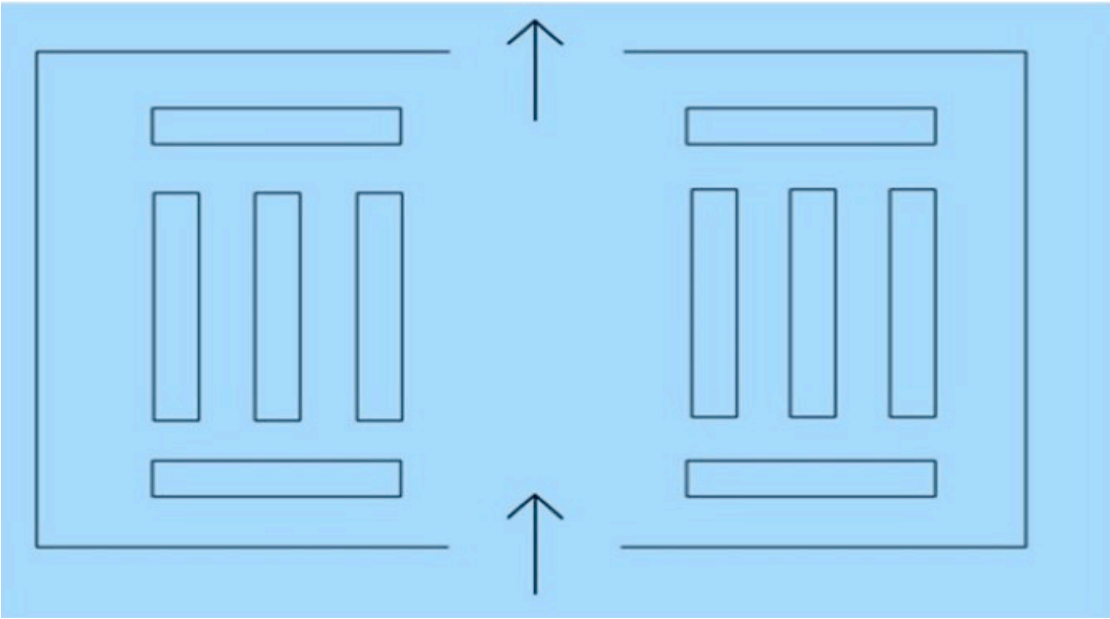

Figure 1 - Broken flow or U-shaped warehouse
Source: Carvalho (2017)

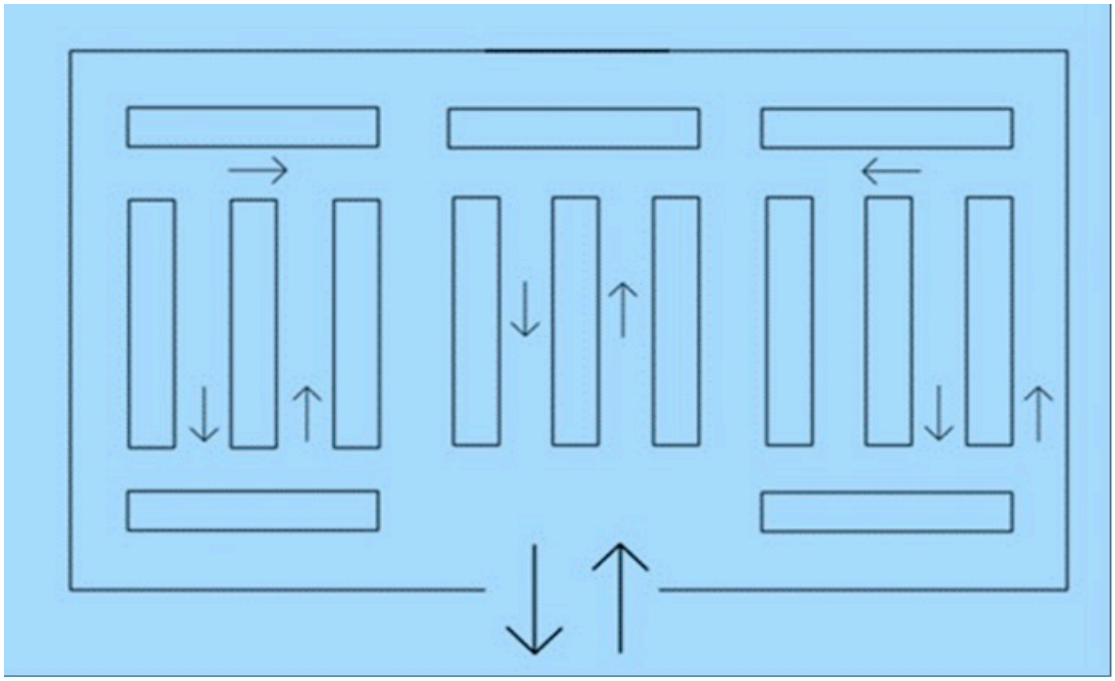

Figure 2 – Directed flow warehouse
Source: Carvalho (2017)

These two models provide different ways of accommodating the materials, and though shelves are the most used form, there are other forms, such as floor marking. The advantages and disadvantages of each criterion and its application depend on a case-by-case basis, always aiming to achieve greater cost reduction and greater efficiency. According to Carvalho (2017), an ideal warehouse is one in which the distances are reduced and where the access of vehicles to the proper areas for products / materials of greater use are facilitated.

Stock Management

Nowadays, for those in charge of companies, strict control of all logistics activity is essential. Stock management is included in this area and, if carried out in the best way, greatly contributes to the profitability of a company.

A stock is a forecast of products intended for consumption and must be able to respond to customer orders in an economic manner. However, there are costs associated with it, such as order processing costs, stock carrying costs and stockout expenses. In order to achieve a good stock management, it is necessary to minimize these three categories of expenditure (Zermati, 2000).

Despite its disadvantages, a stock is useful, but it has a very high associated cost, so it is advisable to manage it well, in order to use it as efficiently as possible (Bertaglia, 2016).

Today, storage requires much more than simple automated procedures; it needs information systems that allow quick and intelligent decisions (Banzato, 1998; Guarnieri, Chrusciack, Oliveira, Hatakeyama & Scandelari, 2006).

According to Chopra and Meindl (2016) information technology systems (IT) are very important at all stages of the logistics chain, because they allow companies to gather and analyze all the information they have.

ERP (Enterprise Resource Planning) systems have as antecedents the MRP and DRP systems, developed in the 60s and 70s of the last century, and provide information on the overall activities of organizations. ERP allows appropriate and timely decision making at different management levels, overcoming the limitations of traditional applications (financial management, human resources management and others), each with its own software and databases, which are sometimes incompatible (Moura, 2006).

The existence of a common database is one of the most important aspects of ERP systems, as it ensures the consistency and comparison of data regardless its origin, eliminating bureaucracy, repetition and redundancy of operations (Alves & Silva, 2001).

Transport

Ballou (2004) considers that, in terms of costs, physical distribution is, for most companies, the most important activity, accounting for about two thirds of logistics costs.

Transportation is the operational part of logistics that geographically moves the goods. Due to its fundamental importance and the associated cost, transportation has deserved considerable attention from companies' managers. Transportation needs can be essentially satisfied in three different ways:

- a company's own fleet;
- contracts establish with transportation companies;
- the contracting of several companies, which offer different transport services, which can serve the contracting company more efficiently when combined.

From the point of view of the logistics system, there are three fundamental factors for transportation performance: cost, speed and consistency (Bowersox, Closs & Cooper, 2010).

Research questions

Therefore, the objective of this work is to analyze the warehouse system, the reception and expedition of material, and to study solutions based on new technologies, in order to outline procedures based on new tools capable to adapt to the integrated system already implemented, and one can now present the two research questions of this study:

- To what extent is it possible to improve GDMPAF warehouse management, in particular the tasks of receiving and shipping material?

- How should the PAF reduce the number of articles acquired in order to make its cataloging feasible?

Methodology

In this work, the research method presented by Macedo, Zacarias and Tribolet (2005) was used, being composed of three stages: first, the purpose and orientation of the investigation is defined, then the method of collecting data and, lastly, the technique applied in the analysis and treatment of the data collected in the previous stage is defined.

These stages do not translate into a complete investigation process, but merely an interaction of a research process. In practice, an investigation process is characterized by being incremental, as shown in Figure 3.

Figure 3 – Stages of a Research Methodology
Source: Macedo et al., (2005)

Despite the existence of three interactions in the method just presented, in the current work only the first two were performed, as it was not carried out the validation of the obtained results, nor the change to the informational model.

1st Interaction - Definition of the question to be answered during the investigation process.

Step 1 - Definition of the general scope and methodology.

Assumptions defined at the beginning of this paper:

1. Area of study: Logistics Chain Management.

2. Element of study: General Deposit of Material of the Portuguese Air Force.

3. Initial focus: Receiving and shipping material in a warehouse.

Step 2 - Data collection.

1. Bibliographic research in the area of Logistics to make the theoretical framework of the study. Applied technique: Documentation analysis.

2. Collection of information about the Organization, including the mode of operation and the procedures used in the reception and dispatch tasks in the warehouse, in order to obtain more detailed information about the object under study. Applied technique: Analysis of documentation and observation.

3. Research of ERP tools, in order to determine which is best suited to achieve the proposed goal. Applied technique: Documentation analysis.

Step 3 - Analysis and Synthesis.

With the analysis of the information and documents collected in the Organization, the following problems and issues are analyzed:

1. The Organization under study has very bureaucratic procedures, which limits the implementation of new methods.

2. The procedures for receiving and shipping material are carried out manually.

3. The purchasing system is decentralized, which implies the need for a greater number of human and material resources.

4. Lack of articles' cataloging, which makes it impossible to manage them automatically.

5. How can the method of receiving and shipping material be improved?

2nd Interaction – Execution of operational objectives.

Step 1 - Definition of the operational objectives of the work.

Once the problems are presented and the questions asked, it is necessary to specify the objectives that allow us to answer the main question of the present work, which are the following:

1. Adoption by the Organization of a system of centralized purchasing, in order to restrict the number of procedures performed, as well as the variety of items purchased.

2. Use of the SAPConsole tool in order to receive and dispatch material using optical barcode readers.

Step 2 - Data collection for the execution of the main objectives.

Collection of data on the Organization, including more detailed information on the supply circuit, mainly on the procedures performed in the reception and dispatch of material. Obtaining this information was done in manuals issued by the organization, as well as with the persons responsible for the areas under study. Techniques used: Analysis of documentation and observation.

More detailed search of the SAP tools in the area of Logistics, namely at the level of warehouse management.

Step 3 - Analysis of the collected data and proposal of a possible solution to the problems under study allowed to identify the main gaps in the supply circuit in what concerns the reception and dispatch of materials. This work aims to propose new methods for current procedures, in order to streamline processes and obtain accurate information in real time.

Results analysis and discussion

Location of the central warehouse

The PAF already has its own infrastructure, located in Alverca, with the capacity and means to ensure the functions assigned to a central warehouse. However, with the application of one of the methods mentioned in the literature review, it was intended to verify if this is a viable solution to remain as a logistics platform, in order to minimize transport costs, or if it would be more advantageous to think of an alternative location.

At the time of data collection to perform the calculations, it was found that it would not be possible to carry out this study, since the PAF does not have records of the quantities of material that are transported by the GDMPAF to the different Units, or vice versa.

With this limitation, it was accepted in a simplified way that the central location of the GDMPAF, in relation to the other PAF Units, is a good option for the Organization as a logistical base, as can be seen in Figure 4.

Figure 4 – Location of GDMPAF
Source: Authors

Current layout of warehouses

Currently the GDMPAF has 11 warehouses with a storage capacity of 2,000m^2 each. The layout used in the PAF warehouses continues to be the one foreseen in RFA 415-1 (B) - RAMFA, whose last version dates from 1994 (RFA 415-1 (B), 1994), according to Figure 5.

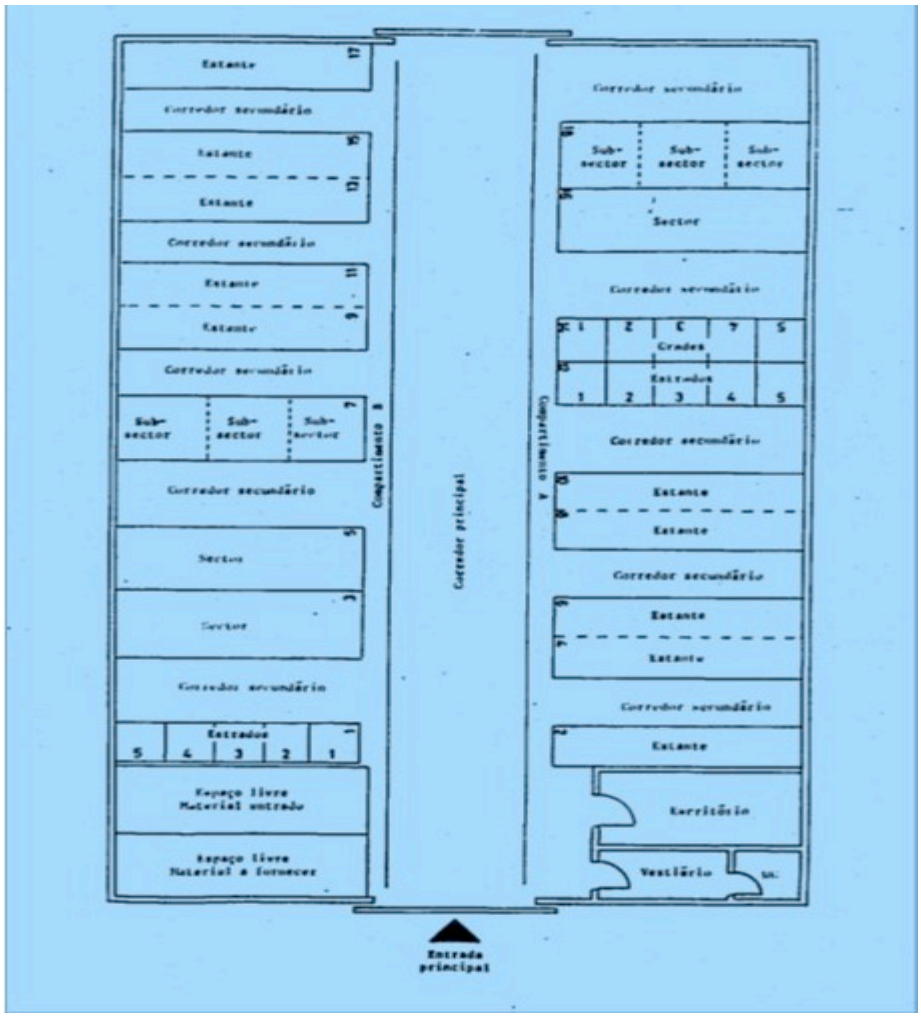

Figure 5 – Example of compartmentalization of a warehouse
Source: RFA 415-1 (B), (1994)

Solution to reorganize the current layout of warehouse

The layout currently used is provided in RAMFA dated March 1994, so it is easy to see that it is already outdated.

This layout has several shortcomings and is not in line with the efficiency requirements that are currently required. PAF has already realized these constraints and is currently testing alternatives to this layout, in order to make it more efficient in the handling of materials.

The most obvious change is the way the shelves are arranged in the warehouse. Instead of a main corridor and several secondary corridors in which the shelves are arranged perpendicular to the main corridor, the proposed solution is one with several corridors along the warehouse in which the shelves are placed parallel to these corridors, thereby facilitating the movement of people and materials (Figure 6).

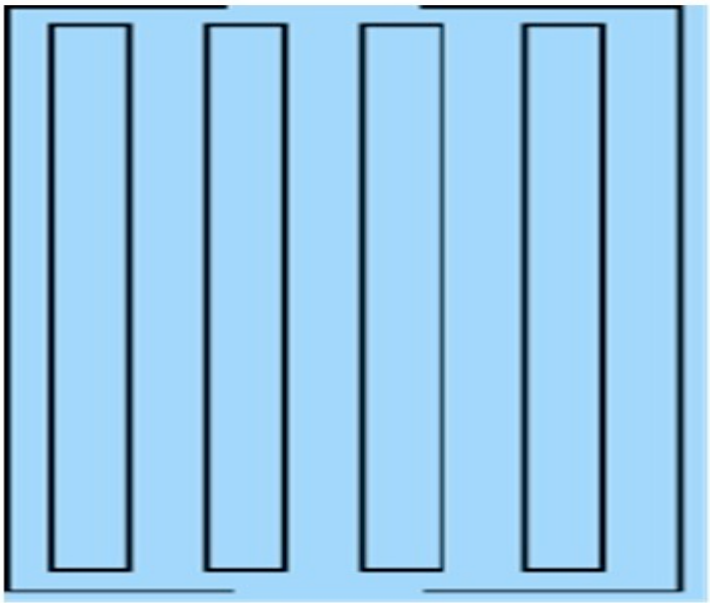

Figure 6 – Example of a new compartmentalization of a warehouse
Source: Authors

With this new organization of space, it becomes easier to access people and machines throughout the warehouse. It is also possible to gain storage capacity, as the area of the placed shelves is slightly higher than it previously was.

Warehouses and Stock Management Systems

The profitability of the space in a warehouse, the management of stocks, and the quality in the service provided, are factors that influence companies to invest more and more on technology and computer solutions.

A warehouse management system allows to optimize processes, to monetize available space and to perform a better inventory control, that is, it is an information system that plans, schedules and controls all the operations carried out in a warehouse.

The GDMPAF, through the Supply Group, is responsible for receiving, storing and distributing to all Units Air Force material subject to centralized management.

In GDMPAF, material shipment occurs when there is an order for material by a unit or service. Currently, the counting and insertion of data in the GIS is done manually, whereby a delivery note that accompanies the material to the destination Unit is automatically created.

By the end of 2010, the PAF had only the SAP R/3 system with the Sales and Distribution (SD) and Materials Management (MM) modules for purchasing and sales

control, as well as warehouse and stock management. In this way, the management of materials is carried out in a non-automatic way.

This situation presents several obstacles in stock management, namely in the entry, transfer and dispatch of material, which are carried out a posteriori and manually. Consequently, there is no real-time information, and there will be a greater probability of errors occurring when the operators enter the information.

The PAF started the implementation of the GIS project, which aims to operationalize a computer system in the SAP environment. This project uses a common technology platform (ERP), which allows for the standardization of financial, logistical and human resources processes, according to the best practices recognized for each area. This ensures reliable, timely, aggregated and comparable information for use at the various levels of responsibility of the Defense Bodies, and at the same time inducing a significant reduction in IT costs.

Initially it was defined that its implementation would be carried out for all areas simultaneously (financial area, logistics and human resources in all National Defense agencies, within a year). However, the adoption of unique and cross-organizational processes could not be carried out as planned because of the lack of objective conditions of both the agencies and the project itself.

The complexity of the project led to the adoption of a new phased implementation strategy, taking into account the different realities and degrees of preparation of the involved organisms. This situation has also occurred in all the countries whose Armed Forces have implemented ERP, since the strategy has always been implemented in stages, proceeding prudently to the next phase only when the previous phase is properly consolidated.

Conclusions and recommendations

The Portuguese Air Force is becoming increasingly aware of the need to minimize costs and to monetize the means at its disposal. Due to this fact, it is important to adopt tools that are capable of responding to the needs of the Organization in what concerns the reception and dispatch of material, in order to make this procedure more efficient and with a lower cost.

At the time of data collection, a number of procedures and tasks that could be improved were identified, and with which the Organization does not need to spend much more resources than it currently uses. In some cases, it may even reduce the operating costs, even if some initial investment is necessary, and the gain may be obtained in the short term.

The PAF has already a large part of the tools that will enable it to perform a computerization of the tasks of reception and dispatch, namely the Warehouse Management (WM) system, which allows it to perform a more efficient warehouse management.

As a response to the first research question, it is proposed the acquisition of the SAPConsole tool, thus making it possible to perform the tasks of receiving and

dispatch in a more efficient and cheaper way, allowing making resources profitable and facilitating the performance of the PAF mission.

However, in order for the PAF to take full advantage of this new tool, it would be necessary to implement the WM component with SAPConsole, thus enabling the automation of the entire logistic process as well as the optimization of the warehouses. The interaction between the WM modules and the SAPConsole makes it possible to perform all processes in real time and allows achieving improvements in various tasks and processes.

With this system, it is possible to receive material automatically, through the optical reading of the bar code issued by SAP, as well as the transfer between warehouses, shipping, and inventories, or even thrashing and returns.

The implementation of this system also makes it possible to assure greater autonomy of warehouse operators, using terminals that, through bar code readers, can exchange information with the central system in real time.

Concerning the second question, it is recommended that the PAF adopt a centralized purchasing service, considering all its advantages and limitations presented throughout this work.

With the centralization of purchases, the PAF is able to reduce the number of procedures performed, and it also manages to reduce the number of certificates and digital signatures required. It also reduces the diversity of the acquired goods, facilitating their processing and cataloging at the level of Supply, and enabling the implementation of an automatic warehouse management system.

The creation of a central department responsible for all PAF's acquisitions could have its advantages not only in reducing costs but also in the centralization and rationalization of competences by those responsible for purchases.

With the use of the GDMPAF as a central warehouse and the warehouses of the remaining PAF's units as peripheral warehouses, the introduction of an article identification system through the optical reading of the bar codes allows to obtain a solution that completely changes the logistics process implemented by the PAF.

This solution allows the simplification of tasks, minimizing the use of paper and, consequently, reducing bureaucratic processes, as well as the costs with personnel. With the computerized tasks and the automation of procedures there is also a reduction of errors in data entry, which contributes to increase the efficiency of the logistical process, allowing several tasks to be carried out in a more agile and centralized way.

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