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PRODUCT POSITIONING OPTIMIZATION IN INTELLIGENT WAREHOUSES

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Abstract. To obtain competitive advantages in the global market scenario, companies have aimed at reducing logistic costs as well as streamlining the order fulfillment. The use of tools to efficiently manage warehouses, ensuring a best allocation of the products has been growing. The method of the ABC Curve, based on the Principle of Pareto, qualifies the portfolio of a company so that products can be separated into classes. The items of Class A deserve special attention since they represent 80% of the financial transactions of a company. On the other hand, the AHP multi-criteria tool enables the analysis of several criteria (demand, financial transaction, seasonality, among others) to determine the best alternative to achieve the main goal. In this context, this paper presents a tool/technique to ensure the correct positioning of the products optimized by either the allocation based on the ABC classification or the allocation by prioritizing the products established by the AHP. The tool/technique was implemented in language C and 1,620 loading and unloading tasks were simulated for random allocation, ABC and AHP to assure the flow of inputs and outputs from the storage. The results show that the system proposed is viable and efficient, as it shortens the distances traveled and streamlines the order fulfillment time, reducing the logistic costs. The reductions achieved with the allocations based on the ABC method ensure 8.42% for the traveled distances and 8.43% for the time spent to unload the trunks. The multi-criteria tool allowed reductions of 12.81% and 13.47% in the distances traveled and time spent, respectively, to allocate the items in the storage. The research is of great relevance to the area of internal logistics, as it ensures an optimum flow of the storage, reducing the unnecessary movements.
Keywords: Optimization, products positioning, AHP, ABC Curve.

1. INTRODUCTION

According to the world stage of competitiveness and different degrees of globalized economy, enterprises search for alternatives to remain active. The management of warehouses, adopted as a factor of high importance in the business context, is considered a strategic element. An efficient management enables reductions in costs and movement time and agility in the services requested (Oliveira *et al.*, 2011).

The Council of Logistic Management - CLM (1996) had defined the concept of logistics as the "process of planning, implementing and controlling the efficiency flow and storage of goods, services and related information from the point of origin to the point of consumption to conform to costumers' requirements". Logistics is an important factor to obtain strategic advantages for the enterprise. Bowersox *et al.*, (2007) state that logistics represents a source of competitive advantage if managed in an integrated manner.

Logistic optimization is achieved by correctly positioning the items inside the warehouse in order to reduce the distances traveled during the process of movement. The availability of an adequate infrastructure enhances the efficiency of the productive system, as it increases the value and reduced the costs per unit of input. The effects of infrastructure on the general considerations of the economy efficiency are evident (CSCMP, 2010).

Papers on the best route collection to meet requests, regarding only the fixed position of the items in a warehouse (Klimm *et al.*, 2007; Olmi *et al.*, 2008; Ravizza 2009; Vivaldini 2010) and inferring the need for comprehensive and continuous research in this area can be found in the literature. Recent studies have showed that the optimization of operations in warehouses relative to resources represents great improvements in the logistic process of enterprises (Baker and Canessa, 2009; Gu *et al.*, 2007; Mountz, 2010; Tinelli *et al.*, 2011; Zhanga and Laib, 2010).
The automation of warehouses promotes a reduction in both logistic costs and stock levels, providing agility to customers´ services and creating competitivity and a better monitoring of the warehouse productivity.

A relevant number of researches has supported optimization as a competitive factor (Grossmann, 2005; Varma *et al.*, 2007; Sarker and Diponegoro, 2009; Sousa *et al.*, 2008; You and Grossmann, 2008).

The Mobile Robotics Laboratory - LabRoM Group of Mechatronics at the Engineering School of Sao Carlos - EESC / USP, engaged on the development of tools for intelligent warehouse management, has generated several papers in the area, and the present one reports on the continuation of studies on optimizing the positioning of finished products (Vilvadini *et al.*, 2009; 2010; Tinelli *et al.*, 2011; 2013). Two methods to assure a correct positioning of the stocked products, guaranteeing a great material handling based on the financial transactions are described.

The article is organized as follows: Section 1 introduces the subject; Section 2 shortly contextualizes storage management; Section 3 describes the product position optimization; Section 4 presents the methodology adopted;

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Section 5 shows the layout adopted; Section 6 describes the evaluation of criteria; Section 7 provides the results and simulations; Finally Section 8 concludes the paper.

2. STORAGE MANAGEMENT

Internal logistics is a relevant area in operations management, covering storage area, displacement of consumer goods, as well as management information. It ensures an optimum flow of materials in the environment and reduces logistic costs. Ballou (1993) states that the internal logistics planning fills a large gap existent in competitiveness among companies. Therefore, the storage and handling of materials become essential components to the set of logistic activities.

Storage management aims to control all the tasks regarding both flow of materials and information about the storage. According to Gu *et al.* (2005), the main activities developed during the storage process are delivery of the product and its storage, retrieval and dispatch.

An efficient management of storage stock can ensure greater competitive edge and profitability. The type of stock addressed in this paper is the storage of finished products. For an effective management of the storage, the application of Information Systems is crucial, since it will ensure agility and reliability during the information process.

Storage can occur in three forms (Ballou, 1995):

a) Based on the operator´s memory;

b) The products has a fixed position in storage;

c) Random positioning, i. e. the products can be allocated in any position in the warehouse, thus, requires integration of information systems to manage the location (Moura, 1997; Arnold, 1999; Dias, 1993).

A new way to manage the positioning of finished products in warehouses ensures agility and reliability, because it integrates tools to properly position the items in the warehouse and the WMS (Warehouse Management System), ensuring a good flow while handling the materials and reducing the distances and time service requested.

2.1 Materials handling

The materials handling to the internal logistics is managing the flow of input, storage and output of the products. The movement and handling of materials require time, manpower and money, therefore, it is necessary to minimize them to reduce the request time and not execute unnecessary movements and abrasion equipment. According to Moura (2005), the movement of materials represents 15% to 20% of the total cost of a finished product.

2.2 Reduction in the distances traveled

The definition of the location of the manufactured product in the warehouse will determine the distances traveled during the path to ensure it will be sent to the dispatch area.

Similarly, the positioning of the heavier or fragile products nearer the expedition reduces the effort of moving, as, premature abrasion of handling equipment. Therefore, the allocation products that have the flow of movement/demand into the warehouse in places near the areas of expedition, reduces the total movement (Oliveira *et al.*, 2010).

Gu *et al.*, (2007) defined the Storage Location Assignment Problem – SLAP as the designation of the physical place where each item should be stored, aiming at reducing the costs of materials handling and optimizing the use of space.

The objective of SLAP is to determine in which area/shelf of the warehouse the items will be stored, so that the total operational costs are minimized and the movement of materials is reduced. Carlo and Giraldo (2012) state the SLAP can be classified into three types, according to the information about the arrival and departure of the stored products in the warehouses and based on:

a) Information on the item (SLAP /II): information about both arrival and departure of the item, without considering its specific characteristics, as code, or type;

b) Information on the product (SLAP /PI): product data, as code, batch, unit value, among other items are known. Thus, was accomplished the attribution of classes for the product. The products will be stored according to areas pre-established for a given class;

c) No data (SLAP /NI): there is no relationship between storage and item/product, since no information about the classification above is considered. In this case, the storage occurs randomly obeying the closest position.

The information and necessary criteria for the application of SLAP to define physical arrangements are related to several factors, as floor plan of the warehouse, dimension/capacity of storage, number of available places in the shelves and place where the products should be stocked.

Onüt *et al.*, (2008) proposed a heuristic based on criteria to classify the items into classes and reduce the distances of movement in warehouses.

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The reduction in the distances is a factor that improves the movements flow. According to Freire (2008), studies on the layout and positioning of the production line and storage aim at reducing the distances of necessary movements to the flow of products.

Changes in technologies of internal movement for the reduction in the equipment movement with the use of gravity between line and stock and reduction in the total weight of non-products transported tend to reduce the passive logistical movement, improving the productivity of the activities. Investments in these technologies, which privilege the active movement, have proven highly advantageous in the medium-and long-terms. Besides reducing costs in repetitive operations, these technologies also ensure a positive environmental impact, reducing the use of energies, as fuels and electricity, and emissions of pollutants (Freire, 2008).

3. PRODUCT POSITIONING OPTIMIZATION

Defining the location of the product within a warehouse determines the distance for its recovery and directly impacts on storage costs. The model designation position aims to reduce the distances between the shelves and the expedition.

Slack *et al.*, (1999) state in all enterprises some products are more important than others. Thus, discriminating the different items stocked so that each one can be treated specifically according to its priority minimizes the complexity of the problem and facilitates the management of the stock.

A relatively simple, but powerful and widely used tool is the ABC classification, based on the Pareto Principle (Slack *et al.*, 1999), in which 20% of stocked items represent 80% of the total company financial transactions. The Pareto Principle ensures that all companies will occur in the proportion 80/20. The method consists in classifying the products stocked into three groups: A, B and C, which is the order of decreasing priority. The logistics manager may treat each group differently, focusing their efforts on class A, which represents the largest portion of the value of the stock at the expense of other classes, especially C, which is lower significance in business and does low attention. Tinelli *et al.*, (2011) presented and validated the use of the ABC classification.

The method of the ABC curve, used to qualify the items of higher financial movement (Jing-Wen and Tie-Jun, 2009; Lourenço and Castilho, 2006; Ramanathan, 2004; Tinelli *et al.*, 2010, 2011; Tuji, Jr. *et al.*, 2004 and Atamanczuk, 2009) proposes the application of the ABC Curve to qualify the products that show better participation in the flow of movement.

Tuji Jr. *et al.*, (2004) applied the ABC Curve to optimize the inventory management of a micro food industry and highlighted that the tool provided improvements in the operational activities.

A study that determined the localization of products in a warehouse from the established classes according to the index of movement of the products was proposed by Petersen *et al.*, (2004). The products that have higher rates of movement will be allocated next to the terminals of load and unload (expedition). The classification by demand inside the ABC perspective, for the supermarket sector, limits the adequate storage of the products.

According to Huiskonen *et al.*, (2003), other aspects can be used to improve the efficiency of the inventory management, i. e. approach qualitative aspects.

Martins and Alt (2001) claim that the ABC Curve can be used to efficiently manage the values applied to stock when their classification is defined by values and improves operational results in the monitoring of moviment activities. The tool is applied via a demand survey of the items and their planning of in decreasing. The items that possess greater movement belong to class A; those of regular movement form class B and the others constitute class C.

Gouvinhas *et al.*, (2005) defined two fundamental principles that should be followed: the first is related to the planning of the activities of the item directed to the shipping dock and the second is related to finding nearby activities to reduce the distances of movement between the operations. The authors developed a study in an enterprise of food storage that used the ABC technique to determine the best allocation of products in the plant of the warehouse privileging the optimized movement activity.

According to Van den Berg (1999), by applying the ABC Curve to an enterprise to the analysis can be reduce its operational costs without losing quality of the product provided of the stock.

Another tool used is the Analytic Hierarchy Process (AHP) multi-criteria analysis, which establishes the criteria (demand, fragility, weight, financial transactions, and seasonality) to be prioritized. The technique differs from the ABC curve, as it can perform a joint analysis of several criteria to establish their hierarchy. Several studies in the literature have applied different tools to prioritize items, ideas and decisions

Magalhães (2011) proposes the use of the AHP multi-criteria tool to prioritize the portfolio of enterprises that produce white line appliances and establish the items that deserve more attention in the implementation of reserve logistics.

Chiyoshi *et al.*, (2000) applied the integrated hypercube model to metaheuristics, as simulated annealing and search taboo, to solve problems of probabilistic localization of the products related to randomness the availability of servers.

Atamanczuk (2009) addresses the classification of stock to design the positioning of products in a physical arrangement of a warehouse in the supermarket sector. The conditions for the positioning follow the Standards of

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Sanitary Surveillance, separating the products into groups, such as: drinks, solid foods, and others. According to the family of the products, areas are determined in the physical arrangement of the warehouse to designate them.

In this context, Santos and Rodrigues (2006) relied on the classification of the products into families, respecting the similarities of the items.

Tools, like ABC and AHP are fundamental to classify and prioritize finished products. Based on this information and together with the applications of demand detection techniques, we can obtain data to optimally position the products in warehouses.

4. METHODOLOGY

This research aims to implement an optimization system in the heading of items taking into account the financial transactions of the products so that the distances to be traveled during the materials handling can be reduced. The system improves the agility of the operational process, enabling efficient operations of warehouse jobs by supplying correct of finished products. The items of higher spin/financial movement or density are placed next to the dispatch area reducing costs with unnecessary travel.

This paper presents the methods adopted in the research. First, will be shown the AHP multi criteria tool and its formulation to find which tool/method reach higher efficiency to optimize the positioning of finished products, after this, the methodology of application of the AHP to allocate finished products into the warehouse will be presented, based on the criteria listed as high-priority on application of the AHP tool. The paper proposes the application of the methods (ABC and AHP multi criteria tool) in Language C and reports on will make tests of simulation and run time of tasks in the warehouse.

The problem of Designation of Storage Location (SLAP) based on product information (PI) is also addressed in this paper aiming at a solution to optimally allocate finished goods in the warehouse and a reduction in the costs of unnecessary travel material handling equipment and maintenance. In this regard, we have observed that a tool is required to rank and prioritize the products.

This section describes the model of the warehouse adopted for both methods. After this research propose the applications of the AHP multi criteria tool, to obtain a theoretical result relative at which method/tool, respectively ABC/AHP, ensure further optimization for the positioning of finished products into the warehouse. Therefore, adopts the ABC Curve, based on the Pareto´s Principle to designate areas in the warehouse to store each class obtained. The AHP multi criteria tool, after applied, will give us which criteria should prioritize in relation to other, thus to propose a designated area for each hierarchy established in all the tests based on the AHP.

The methods were developed in Language C by integrating the Proposed System with the Supervisor System developed in LabRoM, validated by simulation tests.

4.1 AHP Multi-criteria tool to establish the criteria for allocation

The Analytic Hierarchy Process (AHP) is a decision-making technique developed by Thomas Saaty in 1977. It is a method of multi-criteria decision aid in complex environments where many variables or criteria are considered in the prioritization and selection of alternatives.

According to ODPM (2004), with the AHP, the analyst conducts trials simple pairwise comparison of product characteristics, which are then used to develop priorities ranking of the alternatives. The weights and scores are achieved primarily through pairwise comparisons among all criteria.

The AHP can be used to build the problem of decision making, being a simple hierarchy consisting of three levels: overall goal of the decision, criteria by which alternatives will be evaluated and available alternatives. Analysts can systematically evaluate alternatives, making pairwise comparisons for each criterion chosen. Concrete data from alternative or human trials can be used in the comparisons as a way to input underlying information (Vargas, 2010; Saaty, 2008).

4.2 AHP

Saaty (1987) defined the structure for the application of the AHP multi-criteria tool. Tinelli *et al.*, (2013) applied the tool to find the criteria (demand, financial transactions and seasonality) to prioritize areas for well designating the warehouse to allocate the product hierarchy, as follows:

a) High: includes few items, representing the largest share in the criteria established as a priority in the application of AHP multi-criteria tool, along with items that have higher density (representing approximately 80% of the criterion with respect to the sum of this criterion);

b) Average: Products that are significant for the average criterion established as a priority, but have low weight (this category comprises 15% stake in the criteria);

c) Low: items that have little involvement in the priority criterion of application of AHP multi-criteria tool (only 5% interest in the criteria established).

4.3 AHP for products allocation

The AHP Method differs from the ABC, as it considers only one criterion per analysis (for example: financial transactions or spin), the AHP Method can be based on several criteria. A proposal to designate items from the warehouse based on the AHP will be based on items that presents the largest financial transactions along with the variable of the items that present the largest mass, already the items heavy generate increase wear of equipment of handling, allocating the same near of the dispatch areas we were able to reduce this costs.

The designation of positions in warehouses for each level of hierarchy was based on similar to the layout with areas for each class ABC, as shown in Figure 2 (b).

a) High priority: 20 positions, representing approximately 20% of the positions available;

b) Medium priority: 67 positions - 40% of the total of positions in the warehouse;

c) Low priority: 81 positions, i. e., 48% of the 168 positions available for the storage of finished products.

4.4 ABC for products allocation

The ABC Method is usually employed to investment management in stock, but it can also be used for the management of operational activities. The proper adjustment of space for storage and analysis of financial transactions or seasonal demand of the portfolio ensure the optimization of the storage system.

In this context, to demarcate the areas that belong to each class, A, B and C, in the warehouse for allocation the items. The shelving closest to the shipping area will be designated as class A. The Pareto´s Principle proposes that his class behold 20% of the effectives positions into the warehouse, since this product belong 80% of the profitability of the enterprise. Continuing the determination of the number of shelving for each class B and C, behold 30% and 50% respectively.

In the warehouse adopted here, a total of 168 positions of allocation (Figure 2(a)):

A – 34 positions, representing 20% of the positions available in the warehouse;

B – 50 positions - 30% of the positions;

C – 84 positions, i. e., 50% of the positions of storage in the warehouse.

The ABC Curve is based on data related to the demand of finished products, their respective unit values and code. To classify the items, the demand was multiplied by the unit value of the products to find the products that represent the largest share of financial transactions of the enterprise. These products should be organized in a decreasing order.

The classes were determined by the accumulated percentage of each item relative to the total financial transactions. Establishing this script, based on the limitations of each class proposed by Martins and Laugeni (2002) the allocation was established.

Integrating the information of the classification of the products with the designated areas into the warehouse for each class, the algorithmic developed allocates the items of optimized way compared to random classification.

5. LAYOUT

To validate the application of the techniques adopted a layout is necessary to simulate the tasks of loading and unloading of the truck, i. e. the flow of input and output of finished products in the warehouse. Therefore, we can verify the costs, in other words, the distances traveled and the run time of each task, be it from the dock to the shelf (unloading) of from the shelf to the dock (loading).

The layout of the warehouse used (Figure 1) has nine aisles, three platforms of loading and unloading, designated docks and six depots, because the warehouse operates with six AGVs (Automated Guided Vehicle). The AGVs receive tasks to be executed, may be of loading or unloading, after conclude the task the system is informed about how long it took each task and the distances traveled.

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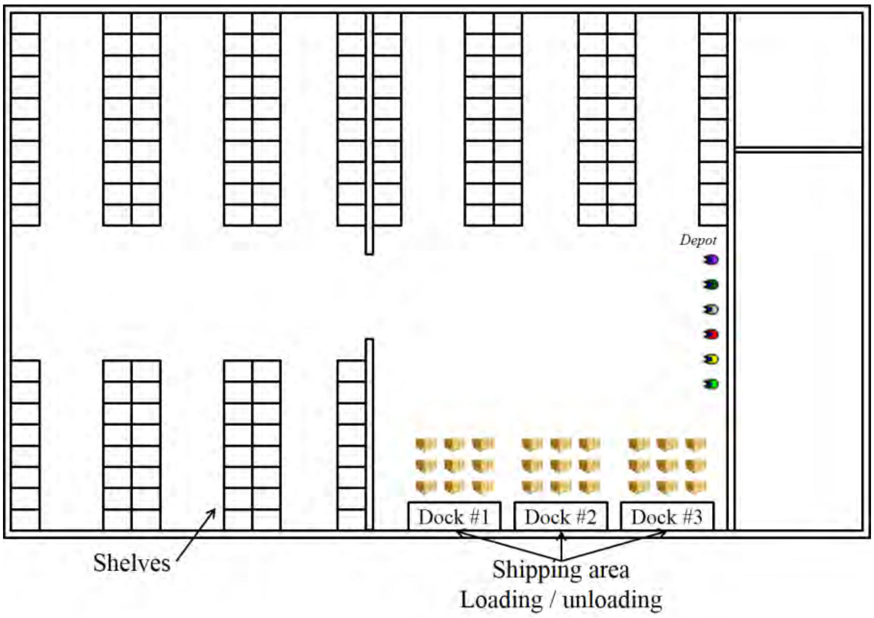
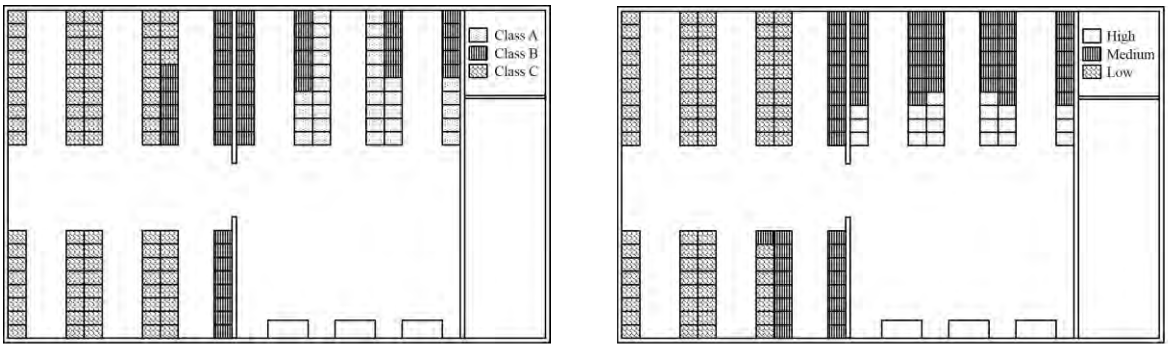


Figure 1. Layout adopted

The tasks are received by the WMS and each task has a source (*xi*, *yi*) and destiny (*xf*, *yf*). The set of tasks representing the treatment for each request, as loading or unloading. Adopted that each request contains a set of tasks of unloading from one truck, in other words, transport pallets from the dock to the shelf, and for each request a set of 27 tasks (27 pallets).

Based on these conditions the ABC Method was applied and the AHP multi criteria tools to allocate 27 pallets into the warehouse, it is noteworthy for this initial test the warehouse shows all the positions available (Figure 2).



(a) (b)

Figure 2. Areas designated in the warehouse for (a) ABC class and (b) level of hierarchy

6. EVALUATION OF CRITERIA

Following the steps proposed by Saaty and analyzing the multi criteria tool to determine the allocation technique that provides the best results, we can prioritize the items that submit the greater participation scale in the question financial transaction, together with the allocation based on AHP multi criteria tool, presented 69.8% relative to the allocation based on the Curve ABC that presented 30.2%.

The application of AHP have priority relative to the Method ABC, thus the AHP should present further optimization of positioning of finished products in warehouses during the simulations.

7. RESULTS AND SIMULATIONS

The result of the project was the implementation of a system for optimizing the positioning of finished goods stored in smart warehouses to reduce logistic costs and ensure optimal flow of materials, as well as streamline the service requested.

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To validate the Proposed System, simulations were performed with both techniques implemented (ABC and AHP) and random storage, comparing the running time and distance traveled in each category.

The simulations were based on loading and unloading tasks for a period of a day, comprising 20 to 1,620 tasks performed simulation tests for the random storage, based on the ABC method and AHP using the criterion.

The AHP allows evaluating variables in a decision-making process generating the result that this research objective. This tool was adopted because it enables the analysis of several criteria for classification. Regarding the number of items analyzed, the ABC showed a better performance, since it has no limit to generate the classification, in order to assign one hierarchy for lots of items with the AHP, we need to use families of products or classify the items according with the criteria established as high-priority by the AHP.

The programs were developed in C language to validate the progress of the tasks assigned the Proposed System Optimization System developed interacts with the Supervisor of assigning tasks to the AGVs developed in LabRoM (Mobile Robotics Lab - EESC / USP) by Kelen C. T. Vivaldini. The tests were performed by computer simulations using six AGVs in an intelligent warehouse.

The tools used were programmed in C language and integrated with the System Supervisor assigning tasks to the AGVs. The System Supervisor receives the tasks to be executed and sends-transfers them to the AGVs.

The request is received by the WMS and the proposed system re-designs the positions where the pallets will be loaded and unloaded. It sends the requests to the Supervisor, which checks the service time for the request and the quantity of AVGs necessary to execute the task and designates the tasks to the AVGs. After the execution of each loading and unloading task of one pallet, the AVG invite a message to the Supervisor and the Proposed System also (Figure 3) is updated, updating the data of the WMS about the order fulfillment. After the order fulfillment is finalized the Proposed System has the data relative to the costs (distances traveled) and service time.

The Player/Stage simulated environment (Gerkey, 2003) was used to fulfil the order by emulating the execution of the routes by the AGVs.

The Test was carried out 20 tests, and 540 for each type of task allocation random ABC and AHP, totaling 1,620 tasks. Each test run consisted in the execution of 27 tasks, 10 tests for loading, in other words remove the pallet from the shelf and take it to dock and 10 tests for truck unloading, or transporting pallets from the dock to the shelf.

Table 1 shows the activities of loading and unloading from the truck. Considerable reductions in both distances traveled and run time were obtained. AHP obtained further optimization related to the positioning based on the random allocation.

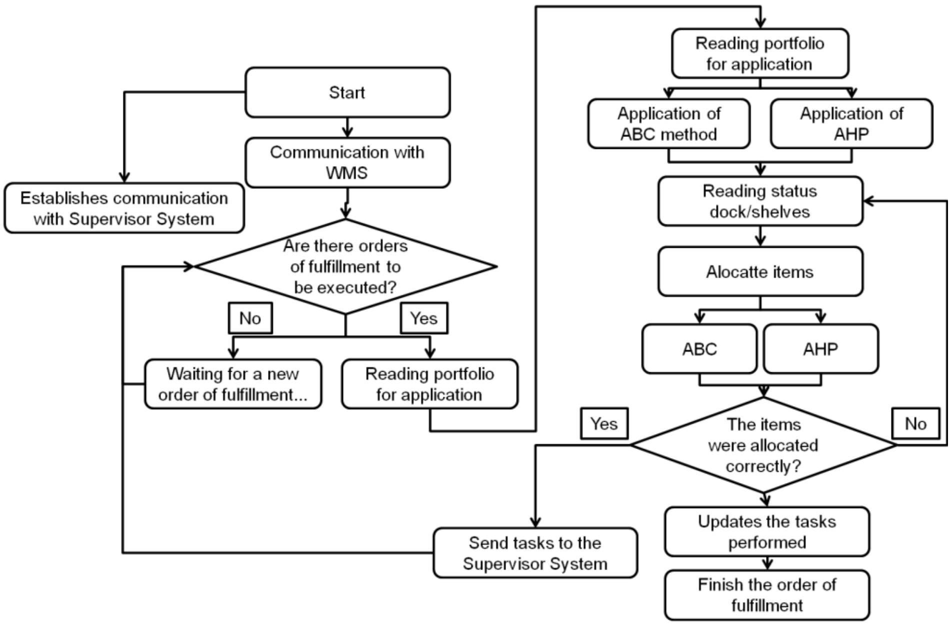

Figure 3. Proposed System

Table 1. Comparison among random, ABC and AHP allocations for cost (distance traveled) and time spent.

		Reduction (Random - ABC)	Reduction (Random - AHP)	Reduction (ABC - AHP)
Total distance traveled (m)	Unloading	8.42 %	12.81 %	4.39 %
	Loading	1.96 %	3.06 %	1.10 %
Total time of execution (ms)	Unloading	8.43 %	13.47 %	5.04 %
	Loading	0.18 %	4.42 %	4.24 %

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Figures 4-7 show the optimization and data of tests of loading and unloading tasks.

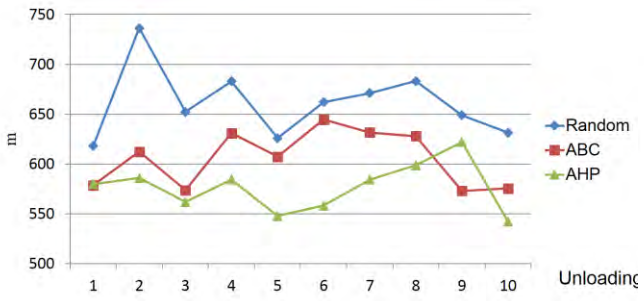

Figure 4. Comparison among random, ABC and AHP allocations for cost (distance traveled) and time spent.

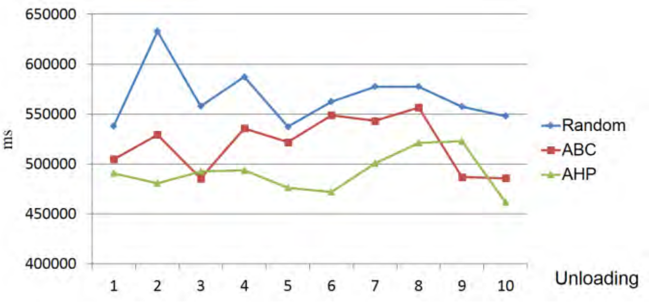

Figure 5. Comparison among random, ABC and AHP allocations for cost (distance traveled) and time spent.

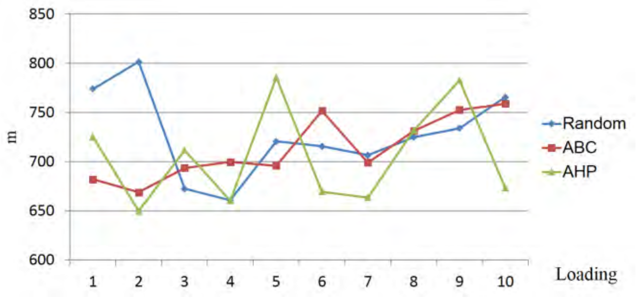

Figure 6. Comparison among random, ABC and AHP allocations for cost (distance traveled) and time spent.

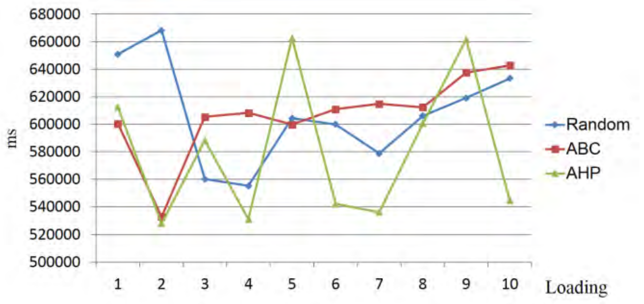

Figure 7. Comparison among random, ABC and AHP allocations for cost (distance traveled) and time spent.

As can be seen, the distances were reduced because the items were allocated according to their representation in the financial transactions of the company. The application of the Proposed System resulted in a better flow in the warehouse, ensuring no unnecessary movements of cargo and material handling equipment.

This section describes the tests performed by simulations in C language Both tests obtained optimization for placement of finished goods in warehouses intelligent, both for loading and for unloading, some tasks showed increased distance, but at the end of each test, and overall optimization was achieved.

The optimization of positioning was achieved, as through simulations yielded significant reductions in the execution time of the task and the distances traveled, so the costs of material handling equipment will be reduced, since through the System proposed activities will be performed with greater speed and efficiency. It is worth mentioning that the reduction in the execution time of tasks may result in less labor or fewer AGVs.

The proposal was feasible, applicable and secured an optimization of the positioning of finished goods in warehouses intelligent, since the proposed application of the ABC method and AHP reduced the distances and the service time of the application, but the application of AHP reached further optimization compared to ABC.

8. CONCLUSIONS

The contribution of this project to researches under development in LabRoM (Mobile Robotic Lab) involves theoretical basis to the application of optimization of positioning products in stock focusing on the minimization of costs operating in storage environment using AGVs.

Present as a relevant factor the high cost of manpower involved in the activities of handling, therefore the optimization of this activity of handling provide relevant reductions in the operational costs. To determinate this reduction one solution presented is related about the activities of movement of the finished products into warehouses. The reduction in both time and distances traveled enables enterprises to perform their activities with less need for human resources and more agility.

The topic is of great relevance to the improvement of storage conditions, since it is an approach with low development and national dissemination. This research has raised some theoretical aspects related to the management of storage, so as to propose a system to classify / categorize the company's portfolio. For this approach the Proposed System was based on techniques from the literature, is following analysis, we adopted the methods ABC and AHP.

We have provided the main calculations performed for the AHP during the analysis for a proper understanding of the technique. An algorithm integrated in the Proposed System was used for the mathematical calculations. The AHP was used in two ways, being first applied in pure form, or to categorize the portfolio by the characteristic (criterion) prioritized and the second application consists in proposing an arrangement of positions for each hierarchy at layout. The ABC curve was applied to establish the products in each class and then propose an arrangement of areas designated for each class.

The steps of the project were: classification of the finished products with greater representation in the financial transactions of the company according to the ABC method, prioritization of certain items in relation to the others, with the application of AHP multi-criteria tool to select which feature prioritize such as financial transactions, demand and seasonality.

Finally, we conducted a comparative analysis of classification of products, random allocation, based on ABC and AHP, where the Proposed System was tried and efficient computational tool has been validated. With analysis of the results is found to optimize the positioning of the products in the warehouse, since both the distances traveled, and the time to service request were reduced.

As future work we propose the application of the System to a company as well as the integration of the same techniques to determine improvements in the layout according to the needs of an intelligent warehouse.

9. ACKNOWLEDGEMENTS

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