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Use of the ABC Curve in Medicine Line Balancing: A Case Study at a Brazilian Pharmaceutical Distribution Center

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Abstract: Within the logistics, especially in distribution centers, there is still use of manual activities, with great possibility of gaining productivity. This work aims to improve efficiency in the supply and separation stages by balancing drug lines using the ABC classification. For this, a case study was carried out in a large Brazilian retail pharmaceutical network, in which products of higher output were relocated in more strategic areas. Ergonomic gains, reduction of required manpower, greater assertiveness, and savings of two hours of work (25%) were the main results achieved. The study also made it possible to disseminate an accessible, automated and effective tool for line balancing on large scale inventories.

Key words: ABC Curve, Line Balancing, Logistics.

1. Introduction

Even today, in the national logistics of large companies, the use of manpower is used to carry out innumerable activities. Because of this, it has the opportunity to influence the productivity, bringing numerous improvements. Special attention is given to the supply and separation process in a distribution center where, due to the lack of organization and because there are products with a high demand variation –as the example of flu remedies or sunscreens that are sold seasonally– they end up loosing considerable efficiency.

This work intends to carry out a classification of the products according to their outputs, in order to better organize them in the supply and separation lines at a distribution center of an eminent Brazilian pharmaceutical retailer network. For this, the methodology of the case study will be used, where the curves (A, B or C, according to the ABC curve concept) and locations of each product will be defined initially, and in a second moment, they will be rearranged. The obtained results were not only the gain of efficiency, but the improvement in work ergonomics, since more accessed products were positioned strategically for the operators' use.

The contribution of this study is due to the use of a simple, accessible and effective tool for line balancing in large scale warehouses with the premise of Pareto analysis or ABC curve. In addition, the work proved to be valuable when applied successfully in a highly complex sector such as medicines, with high diversification and quantity of existing products.

2. Theoretical foundation

In this section will be addressed the key business of the article, the logistics area. Where it will be limited and deepened to the distribution center field of study. Finally, will be seen the the Pareto analysis, the instrument used in the case study.

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2.1. Business logistics

According to the author Ballou (2013), logistics can be defined as the process of transit and storage of materials, so as to allow them to be drained from a starting point to their final destination. In addition, information flows that ensure satisfactory levels of service at relevant costs are included.

Regarding its objective, the author defines as the need to deliver objects or services in the physical, temporal and geographical condition desired by the client. The big challenge, however, is to balance its supply and demand in order to avoid logistical costs. These tend to vary around 19% to 22% of net sales, however, it can undergo strong variations in the market (Ballou, 2013).

These costs can be divided into operational and administrative costs, in which the first is directly linked to distribution and the second is not (Lancioni, 1991). Viana (2008) cites as improvement of the logistic efficiency the reduction of the paths traveled by the goods and a better use of its volumetric capacity.

2.2. Distribution center

To a large extent, the distribution center is divided into input, stock, and output processes. And for this, it needs to be managed administratively - bureaucratic and control steps - and operationally - physical stages (Moura, 1997). In Figure 1 the following summary is presented.

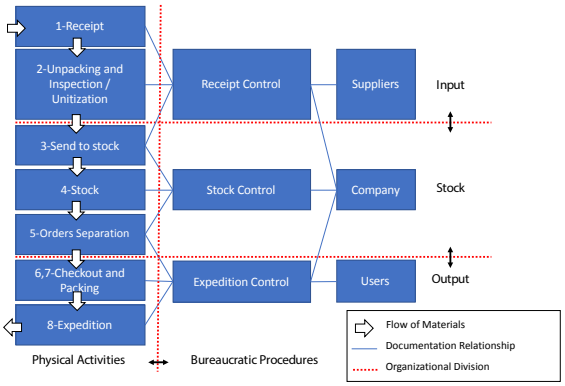

Figure 1. Distribution center (*source*: adapted from Moura (1997)).

After being previously identified, it can be described its three types of processes as follows:

a) Input processes: Viana (2008) describes how the step of receiving goods and other correlated activities such as unpacking, checking, returning or authorizing the storage of products, as can be seen in Figure 2. It connects directly with the purchase and payment stages of suppliers;

Figure 2. Input processes (*source*: author).

b) Stock processes: Viana (2008) calls storage or stock, the process of maintaining materials, adapting to their physical constitution and conditioning them to a stock management until its use is necessary. Ballou (2013) points out that raw material, semi-finished, finished materials, spares and administrative materials participate in this stage. Figure 3 shows the main stock processes.

Among their main functions, Gu et al. (2007) highlight the equilibrium in the transit of materials in the supply chain, reducing the risks of variability caused by demand (seasonality) and production. In addition, it enables the combination of products, making orders more flexible and reducing transportation costs. Ballou (2013) estimates that warehousing costs in the industry revolve in the range of 12 to 40% of logistics costs.

As a way to enhance efficiency in inventory management, the products are unitized on pallets or containers and stored at fixed or random addresses. In the first case, it is a bay or shelf for a particular product. Its negative point is the possibility of emptying due to the inexistence of products and the necessity of maximum inventory volume. For those of variable location, occupancy is gained because it uses average inventory and management is lost, since the same product can occupy different positions in the stock (Ibidem).

According to Ballou (2006), after being stored, the picking process or orders separation is guaranteed by an intensive labor use, with a high level of product mansonicity. That is why they are constantly aim of improvement, giving scope for considerable

Figure 3. Stock processes (*source*: author).

operational improvements and productivity gains. Among them, it can be cited the handling by:

- Orders: the way the incoming orders are handled has the opportunity to reduce costs, lead time and workforce. As an example, it can be generated a picking list based on the purchase order;
- Sequencing or sorting: is the arrangement of a set of products based on transpotations routes so they can be efficiently separated. This will also save time, avoiding going back after products to pick up goods. Altghout, sequencing items based on the selling process may require the cooperation of sales staff and customers so that it could be possible to relate items in the most likely order of occurrence. Alternatively, powerpul softwares can be used to sequence the items into efficient separation lists, saving time or setbacks in the line;
- Zones: process in which operators will be selected for a delimited area of the stock;
- Order splitting: derived from the zoning process, happens when the stock is in more than one location;
- Lots: combining the products of more than one order at a single time;
- Intercalation: separation and storage take place at the same time and
- Pattern setting: labor performance models used as benchmarks for productivity measurement.

c) Output processes: regardless of the type of separation used, the conference or checkout stage will check for errors and trigger its correction. Next, the product is packed, proceeding to the expedition, where the documentation is provided and the trucks are loaded (Pedreira, 2006).

The loading stage is influenced by customer orders, nature of the loaded material (solids, liquids, gases), conditioning (on pallets, in bulk), type of dock (high, low), type of loading (pallets, platforms) and transport vehicle (Mauro, 2009). Figure 4 shows the main exit processes.

2.3. ABC Curve

Due to the high complexity of the production system of managing hundreds or thousands of products (Vollman et al., 2005). And according to Van Kampen et al. (2012) and Aktunc et al. (2019), when it comes to inventory organization, the analysis of Pareto or ABC curve is one of the most prevalent and widely used prioritization methodology.

It takes into account that the lack of different products generates different levels of impact due to their degree of importance (Slack et al., 2015).

According to the authors, products with high output generate greater dissatisfaction due to their lack, as well as those with high added value concentrate

Figure 4. Output processes (*source*: author).

a great financial impact, besides generating high storage cost. Thus, a common practice is the use of the concept of "value movement", which corresponds to the product between the output quantity of the commodity and its unit value. In this way, large movements of value must generate doubled care.

The Italian economist Vilfredo Pareto, in his analysis, found that 20% of the products had the capacity to contain 80% of the total value stored, being this study also known as 80/20 rule (Corrêa and Corrêa, 2012). In Figure 5 it is possible to observe its representation.

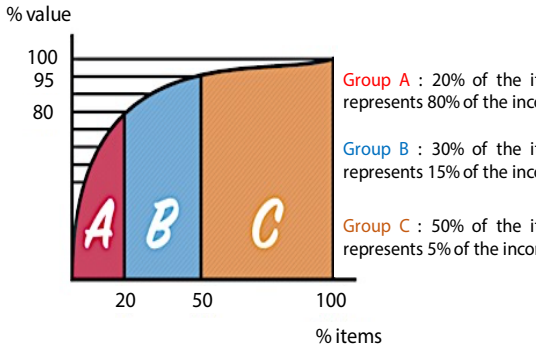

Figure 5. ABC Curve (*source*: author).

3. Case study

3.1. Contextualisation

Based on the logistic distribution center of one of the country's largest pharmaceutical retail chains, the present work focused on analyzing its inventory processes. More precisely, the stage of drug supply and separation, lacking a better balance of product lines, since the larger outputs should occupy more strategic positions in the structure where they are stored (flow racks).

For this, we used the Pareto analysis, or ABC curve, to define the order of priority to occupy better positions in the layout of the company distribution center.

3.2. A,B,C products definition

After receiving and checking the products in the distribution center, those classified as medicines are transported to their respective sector.

As shown in Figure 6, they are firstly stored on shelves –storage area in blue–, being fed and separated in flow racks –green area. Finally, they are transported by mats to the conference or checkout area –in yellow– followed by the packing and expedition.

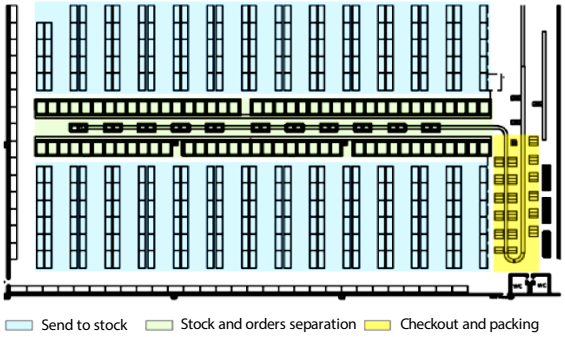

Figure 6. Medicine sector (*source*: author).

Once the area of study is defined as the green one in Figure 6, the region decomposes into 2 corridors (line 1 and 2) of flow racks and, through the middle, a mat is passed. Behind the flow racks, the products are supplied in bin boxes (Figure 7 on the left) and separated by pick by light (Figure 7 on the right).

Figure 7. Stock and orders separation (*source*: author).

Taking into account that the flow rack has 7 levels of height, it was defined that in the more extreme (first and seventh floor) would be placed products C curve, since they are ergonomically more difficult to be accessed. In the second and sixth floors, because of the median access, those of curve B would be placed. And finally, in floors 3, 4 and 5 (of easy access) would be placed products of high turn, curve A.

Counting all positions of A, B and C curves, a total of respectively 1609, 1076 and 2084 addresses or products were reached (each product occupies an address). Thus, the 1609 most accessed products (34% of the total) will be classified as curve A; the

following 1076 (23% of the total) as curve B and the remaining 2084 (44% of the total) as curve C.

Only the criterion of number of accesses per product was used and no use was made of its unit value, as it was explained in the section of theoretical foundation. This is due to the fact that high value-added products are addressed in another sector of the warehouse called "expensives". Therefore, the price of the commodity is not a relevant factor and will not be analyzed.

In this way, in order to stratify the information that will be relevant to the study, a report from the integrated logistics system (WMS) was used, in which it could be found informations such as: code and description of the products found at each flow rack address, the level or height at which they are found and the number of accesses during the last 3 months before the analysis. A fragment of the result is in Table 2.

4. Theme discussion and results

After analysis, it was possible to draw the study case ABC curve as can be seen in Figure 8.

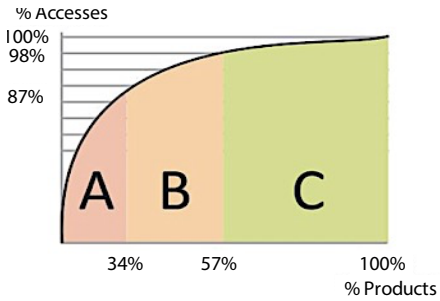

Figure 8. Study case ABC curve (*source*: author).

It was found that 1609 (34%) most accessed products, classified as curve A, concentrated 87% of the accesses. In addition, 1076 products which were denominated as curve B (57% accumulated) represented 98% of the accesses. And finally, 2084 products were titled as curve C (100% cumulative), consisting of 100% of the cases.

Knowing the ABC classification of the products and where they were addressed (Table 2), those data were inputed into Microsoft Excel®. Using its fuction "vlookup" and using the flow rack address (example: 001-001) as the primary key, it was possible to get all the information about the product curve. Figure 9 shows the representation of a flow

Table 2. WMS report of products accesses. (*source*: author).

Floors	Flow Rack	Product	Description	Accesses	%	% accumulated	Curve
4	012-024	2810	Buscopan	5482	0,21	0,21	A
1	029-101	319015	Deocil SL 10CP	5409	0,20	0,41	A
7	023-167	335479	Indapamida 30 CP	5369	0,20	0,62	A
4	012-104	220850	Ibuprof. 600 20CP	5080	0,19	0,81	A
...	...	...	...	...	...	...	...

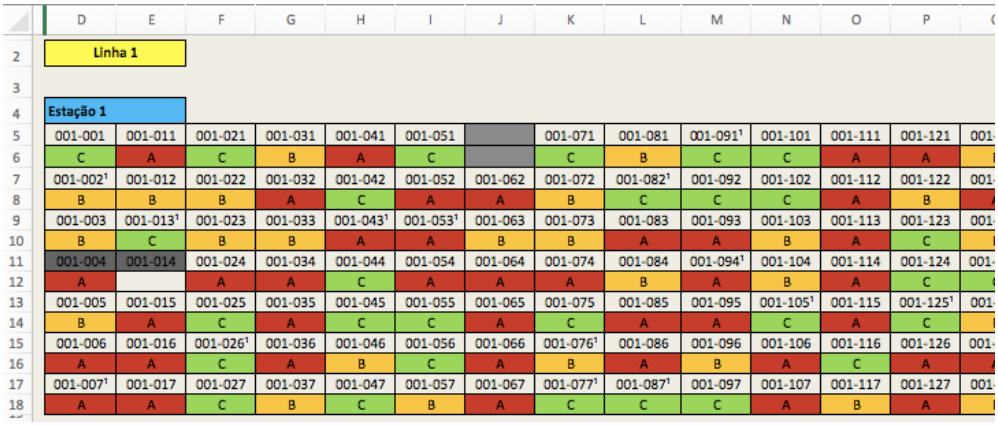

Figure 9. Mapping flow rack structures in Excel® (*source*: author).

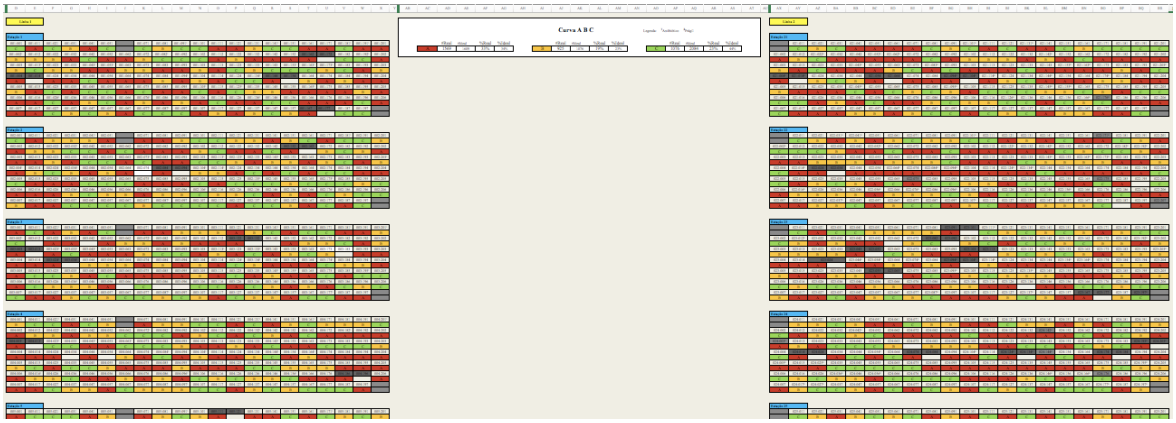

Figure 10. Flow rack structures mosaic in Excel® (*source*: author).

rack station, while Figure 10 shows a mosaic with the two medicine lines.

Lastly, the exchange of poositions between products was established to obey a correct line balancing (curve A at levels 3, 4 and 5, curve B at levels 2 and 6 and curve C at levels 1 and 7). This barter was treated as a project and held by stock operators on a sunday (the normal work operation is from monday to saturday). After rearrangement, the result of a flow rack station could be observed in Figure 11.

In the same it is observed that addresses in gray are those used to return empty boxes, from the separation to the supply. And those in dark gray are characteristic of double picking, that is, products of high output that, for that reason, occupy two addresses of flow rack.

It is also noted that the result has greatly influenced the ergonomics of suppliers and separators, making work less unhealthy, faster, more assertive and requiring a smaller amount of labor. Gains were accounted for as a two-hour reduction in the time needed to supply and separate needed products in an 8-hour work day (25% reduction). These data were obtained by reducing the average working time during 4 working weeks where there were no significant changes in the demand or seasonality of the analyzed products.

5. Final considerations

With the objective of improving the productivity in the supply and separation of a logistics distribution center, the present work was able to deliver to the scientific community and area professionals, a tool able to prioritize products by number of accesses, to classify them according to the ABC curve and perform a line balancing in large warehouses with a great quantity of products.

Estação 1														
001-001	001-011	001-021	001-031	001-041	001-051		001-071	001-081	001-091†	001-101	001-111	001-121	001-
C	C	C	C	C	C		C	C	C	C	C	C	
001-002†	001-012	001-022	001-032	001-042	001-052	001-062	001-072	001-082†	001-092	001-102	001-112	001-122	001-
B	B	B	B	B	B	B	B	B	B	B	B	B	
001-003	001-013†	001-023	001-033	001-043†	001-053†	001-063	001-073	001-083	001-093	001-103	001-113	001-123	001-
A	A	A	A	A	A	A	A	A	A	A	A	A	
001-004	001-014	001-024	001-034	001-044	001-054	001-064	001-074	001-084	001-094†	001-104	001-114	001-124	001-
A		A	A	A	A	A	A	A	A	A	A	A	
001-005	001-015	001-025	001-035	001-045	001-055	001-065	001-075	001-085	001-095	001-105†	001-115	001-125†	001-
A	A	A	A	A	A	A	A	A	A	A	A	A	
001-006	001-016	001-026†	001-036	001-046	001-056	001-066	001-076†	001-086	001-096	001-106	001-116	001-126	001-
B	B	B	B	B	B	B	B	B	B	B	B	B	
001-007†	001-017	001-027	001-037	001-047	001-057	001-067	001-077†	001-087†	001-097	001-107	001-117	001-127	001-
C	C	C	C	C	C	C	C	C	C	C	C	C	

Figure 11. Balanced station (*source*: author).

In addition, the technique proved to be simple to execute in a widely used software, Microsoft Excel®, with fast and expressive gains.

The study was limited to a specific sector and could be extended to other areas. In this way, it is possible, for example, to perform line balancing at the products storage area, where they are placed in shelves as soon as they are received and checked. The classification of the products with the greatest number of accesses and the correct storage in the most accessible places would probably provide benefits, such as the use independence of forklifts or platforms to reach them, reduction in supply time, reduction in the number of failures, among others.

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