Application of Kaizen Lean methodologies to the Improvement of Warehouse Operations of a Pharmaceutical Industry Company

Kaizen Institute

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Abstract

A company's adaptation to its clients' demands is a crucial factor for the creation of value. Waste reduction, in order to increase the operation's efficiency, leads to improvements that influence positively both the companies' behaviour and a reduction in their costs. These are the main goals that lead the companies to hire Kaizen Institute so that, through the help of the Kaizen Lean tools, they can identify and later remove/minimize their wastes.

In this context, Empresa X, a company in the pharmaceutical industry, is selling one of its two industrial units with a warehouse, and its third warehouse, in the end of 2015. The remaining warehouse is going to be renewed, being projected an increase of 43% of the production capacity and a decrease of 44% of the warehouse capacity, so it is necessary to redesign Empresa X's warehouse and its operations in order to mitigate the warehouse capacity reduction and guarantee the warehouse is ready to fulfil the production capacity increase.

Supported by a bibliographic review, this paper describes the application of Kaizen Lean methodologies for the planning and implementation of one, or a compilation of various solutions created for the improvement of the new Empresa X's warehouse on an organizational and managerial level.

The main results, associated with the implementation of the improvement solutions show a 25% decrease of the average operation time, a 12% decrease in total warehouse capacity, and a 22% decrease in the average distance for each warehouse operator.

Keywords: Lean, Pharmaceutical Industry, Warehouse Management, Kaizen

1. Introduction

Given the current economic climate and the reduction of the client's demand, the companies' problems and inefficiencies become more evident, originating a crescent worry on the reduction of waste and on the efficiency of the operation (Waring e Bishop, 2010).

Without capital for costly investments, it is essential to find solutions with affordable prices that lead to effective results on the reduction of costs and on the creation of value to the company (Waring & Bishop, 2010). To solve these problems, Kaizen Institute applies the Kaizen Lean tools in order to improve four

aspects: Quality, Cost, Service and Motivation (QCDM – Quality, Cost, Delivery, Motivation).

Kaizen means continuous improvement, and Lean is a long term strategy that aims the reduction and elimination of waste or of processes and assets that don't add value to the company, this is to say that, for the Lean objective, it is essential to have an associated kaizen thought (Ortiz 2010).

According to Taiichi Ohno there are seven types of *muda*: Overproduction, inventory, defects, motion, processing, waiting and transport (Verrier, et al., 2013).

Gemba is the shop floor, the place where value is added. The main principals of the kaizen methodology are: *muda* elimination, 5S methodology (housekeeping) and standardization. It is important to eliminate *muda*, maintain an organized and clean workplace, and standardize the procedures in order to achieve the best practices (Imai, 2012).

Empresa X (named like this for confidentiality purposes) is leader on the market of generic pharmaceuticals with its own brand and, simultaneously, produces and packs pharmaceuticals products for other brands on the same line of business.

The evolution of the pharmaceutical market and the reduction of the profit margins per medicine leads into a more urgent need for the companies, especially the companies that produce and sell generic medicines, to introduce Kaizen Lean's management system that will maximize the processes' efficiency and minimize the waste.

The next section presents the research methodology used. In the section 3 a brief literature review is done about Lean warehousing. In section 4 the case study is introduced, where the four main subjects studied are presented, as well as the main goals. In section 5, the planning phase, it is explained how the data was collected and analyzed. In this section a set of improvement proposals is also presented.

In section 6, the implementation phase is described. In section 7, the results obtained are discussed and analyzed. Finally, in section 8, the main conclusions are presented and the future work is proposed to further improve the results of the study.

2. Research Methodology

The research methodology used to elaborate the study on hand, is based in Melton's structure to apply Lean Thinking (Melton, 2005), which is presented in Figure 1.

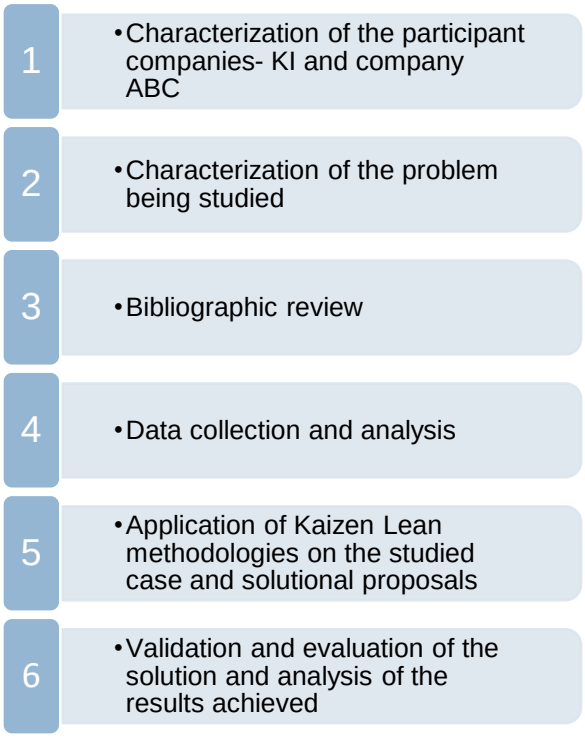

Figure 1 – Research Methodology

Initially both companies involved are characterized (1). Then there is discretion of the main goal of this study (2).

Thirdly, there is a literature review of the main concepts regarding Kaizen Lean and Warehouse Management (3). Then all the necessary data is collected and analysed (4). Following, there is the application of Kaizen Lean methodologies to the main problem (5).

Finally, there is a validation and analysis of the results (6).

3. Literature Review

The application of a Lean philosophy to the warehouse activities may result on big improvements like: the reduction of the processing time and of the lead time of a certain order, as well as the increase of its efficacy (less mistakes), better control and more inventory variety (Frazelle 2002; Gu et al. 2010; Garcia 2004). According to one of the last mentioned authors, Garcia (2004), the key to obtain these results is to reduce or eliminate the highest possible number of warehouse activities, beginning with the execution of the initial state warehouse Value Stream Mapping (VSM) so then it is possible to identify every improvement opportunities (Garcia 2004).

According to Jones et al. (1997) the most commonly used practices to solve identified opportunities are the reduction of warehouse unit, the constant existence of commodities in warehouse, the use of flow racks, the normalization of the routs and work methods, balancing operators' work and structured analysis of the problems.

The seven types of waste associated with the Lean philosophies may be applied to the warehouse management (Ackerman 2007; Gergova 2010): Excessive inventory – The Inventory without demand to satisfy. The most important because it also creates all the others; People waiting; Material's unnecessary movement; Bad inventory management- causes stock-outs or excesses of inventory; Excessive verification- for example, scanner verification; Peoples' movement; Mistakes in the Work orders.

4. Case-Study

At the beginning of the second semester of 2015, Empresa X initiated some changes on its facilities: two production units with warehouse, plus a third warehouse for only one production unit.

There has been made some expansion work on the production unit with the remaining warehouse, in terms of production as well as in terms of warehouse. In total, there was a projection of an increase of 123% on the production capacity, going from 21 million to 30 million of boxes, and also, there was a projection of a decrease of the warehouse capacity of 44%, going from 3845 to around 2160 warehouse positions.

In the context of the project analysed, the four following warehouse operations were studied: Supplier receptions – Material receptions from suppliers; Internal production supply – Internal supplies of production material; Internal packing supply – Internal supplies of packing material; Expeditions – Finished product expeditions.

This project began in the second semester of 2015, with the necessity of redesign of the organization of the rebuilt warehouse, of Empresa X. Specifically this four main topics: Warehouse Layout; Material Allocation; Rack level design; Warehouse operations and picking strategy.

The solutions implemented were designed to improve three aspects: Warehouse productivity – Measured through the average time of the

main warehouse operations; Warehouse capacity – Measured through the number of existing positions; Travelled distances – Measured through the travelled distances associated with the main production materials.

5. Planning Phase

In this section, it is presented the fourth step of the proposed Research Methodology: Data collection and analysis

5.1. Initial State

This dissertation started with the observation of the initial state, through visiting the observation of the warehouse facilities and main operations, with the purpose of finding improvement opportunities.

This observation was made with the support of the involved people from Empresa X, and with the data collected from its information system, the warehouse management software.

In the initial state Empresa X had three warehouses:

Warehouse 1 – With 2005 warehousing locations, separated between a fixed rack area, and a moving rack area; Warehouse 2 – With 658 warehousing locations, only with a fixed rack area. It used to work as an advanced warehouse of warehouse 3, because it was smaller and was located near an industrial unit, contrary to the warehouse 3; Warehouse 3 – 1182 warehousing locations, only with a fixed rack area.

In this study, all the warehouses were considered for the general warehouse capacity, but only warehouse 1 was considered for all the other subjects studied.

The warehouse organization had to respect a set of restrictions: It is not allowed to have material from distinct production lots on the same pallet, even if it is the same material. The same applies to different references; The drugs must undergo to slow quality checks at all stages of the product, which prevents flow between the supply of raw materials the manufacture of drugs, their packaging and dispatch; Any material in risk of counterfeiting (example: printed drug packing boxes) must be stored in a separate location and closed with a code or a lock, as well as all raw materials and semi-finished products, including psychotropic ingredients.

5.2 Data Collection and analysis, and improvement proposals

The data of the initial situation of Warehouse 1 was collected as follows:

Initial Warehouse Layout:

The initial warehouse 1 was divided in two parts, as we can see in figure 2.

Figure 2 – Initial layout of warehouse 1 of Empresa X

As can be seen in Figure 2, the warehouse 1 was initially divided into two main areas, the first one, inside the red rectangle in Figure 13 , the area of the fixed racks and the second, inside the blue rectangle of the figure , the area of mobile racks.

Three major improvement opportunities related to the layout are easily seen in Figure 2, and even more clear when the acknowledge Gemba: The high distance between the two sets of racks responsible for a change of movement of people and materials; Width of the access corridor to mobile racks inadequate due to the movement in that area , which causes changes expected materials and high people; There is no displacement area for pedestrians.

A design of a new layout of the warehouse is proposed, taking special attention to the main concerns talked about in the restrictions found, specially the reduction of traffic in certain areas of the warehouse.

Initial Material Allocation:

For material allocation, there is figure 3:

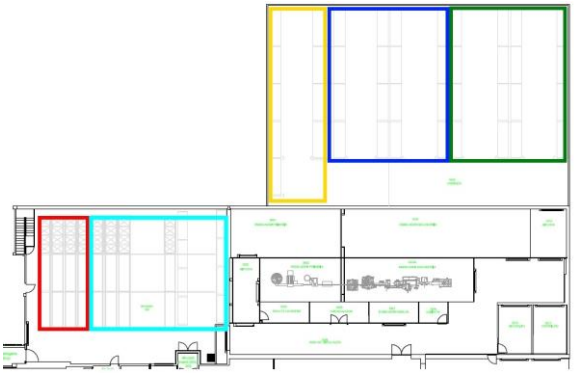

Figure 3 – Initial Material allocation of Empresa X

The main opportunities found by the analysis of figure 3, were: The area of raw material for the production of medicines – The red rectangle in Figure 3. In its area, there is packing material inadequately stored; The material for the supply of medicine packaging is distributed over four different areas of the warehouse, forcing the operator to have to move at least to three of them , which causes a waste of excessive movement of people and material and excessive operating time.

For the design of the new material allocation, it is intended to correct all the restrictions identified, targeting the reduction of travelled distance and average time of a warehouse operation, and trying to aggregate the products that are used in the same warehouse operations.

Initial Rack Level Heights:

Regarding, rack level heights, initially there was no rule, as we can see in figure 4.

Figure 4 – Initial rack levels of warehouse 1 of Empresa X

From the interpretation of figure 4, there can easily be identified three substantial restrictions: The initial rack level heights are all practically different; The maximum height for each pallet of material is not standardized; The volumetric space utilization is low for practically every position of the warehouse.

Through the collection of logistics data, it is targeted in the final rack levels design, the highest possible volumetric space occupation for all the material in the warehouse

Initial Warehouse Operations Mapping and Picking Strategy:

In a visit to *gemba*, there were identified a set of improvement opportunities regarding the warehouse as a whole: There is no standard for people travel in the throughout the warehouse Which in many cases, causes a lot of movement traffic, when entering the mobile racks area of the warehouse; There is not a standard place for hand pallet trucks, and neither to the forklifts, throughout the warehouse; The standards for material entering production are rarely respected, due to its inadequate dimensioning. Which in many cases, causes a lot of movement traffic, when entering the mobile racks area of the warehouse; There is no reception dock levelled with the expedition trucks, and neither with the suppliers' trucks. This generates a lot of excessive movement when both a supplier reception of material is done and when a client expedition is done; All the warehouse operations do not have standard of procedure; The organization of the work order is inadequate.

The initial work order was poorly organized: The picking list did not follow any specific order; The routes were not adequate to the initial layout of warehouse 1; The operators were constantly revisiting the same aisles.

To all the limitations identified, there were proposed solutions in the implementation phase.

6. Implementation Phase

The fifth step of the Research Methodology is the implementation of the improvement opportunities proposed.

- Phase 1 – Final Warehouse *Layout*;
- Phase 2 – Final Material Allocation;
- Phase 3 – Final Rack Levels;
- Phase 4 – Final Warehouse Operations Mapping and Picking Strategy;
- Phase 5 – Implementation of standardized meetings – to implement a continuous improvement culture.

Phase 1 – Final Warehouse Layout:

The layout implemented is presented in figure 5.

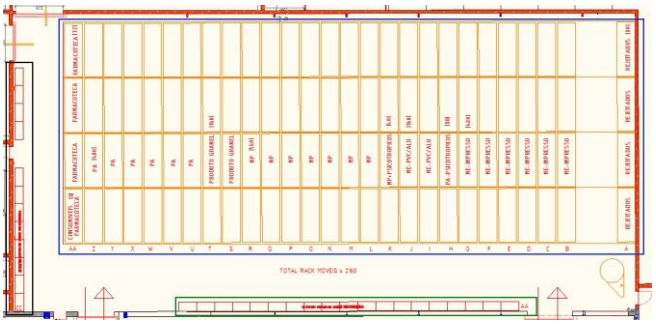

Figure 5 – Final Warehouse Layout of Warehouse 1

In the final Warehouse, there is a large mobile rack area, inside the blue rectangle, and two small fixed rack areas, inside the green and black rectangles.

With this design: The distances between the three warehouses decreased; The movement traffic was reduced due to the creation of an area for people to move.

Phase 2 – Final Material Allocation:

The material allocation determined is represented in figure 6.

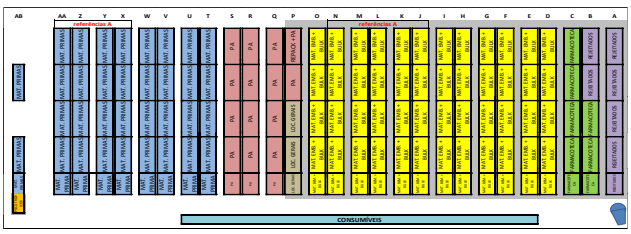

Figure 6 – Final Material allocation of Warehouse 1

As it can be analysed in figure 6, the materials related with the same operation are allocated

in the same areas, such as: all the packing material is in the yellow area.

Also, inside the production supply areas, the materials that are part of the products that are produced the most, are allocated in the best areas of their zone.

Phase 3 – Final Rack Levels:

In order to choose the best dimensions for the levels of each rack, there was made a collection of logistic data. The collection started with the materials that are produced the most in Empresa X, then: Based on the logistic data, the maximum heights for each material type were defined; Based on those maximum heights of each type of material, the ideal rack level heights were defined for each zone of the warehouse, identified with a different colour in figure 6; The combination of the previous two points maximizes the space utilization of the warehouse.

The number of positions obtained was 3389 positions, compared with the initial 3845.

Phase 4 – Final Warehouse Operations Mapping and Picking Strategy:

Based on the mapping of the initial situation, all the warehouse mappings were redesigned, with special attention to the picking list:

The picking list design aggregates all the materials asked from the production, organized by aisle, meaning the mobile rack aisles are only opened once for each work order, and the aisle opened is the nearest from the rack opened before.

Phase 5 - Implementation of standardized meetings:

In the last phase of implementation, Daily Kaizen was implemented in the warehouse team. Daily Kaizen is a Cultural change system that intends to implement continuous improvement in *gemba* teams. The meetings are short, and are based in the board in figure 7.

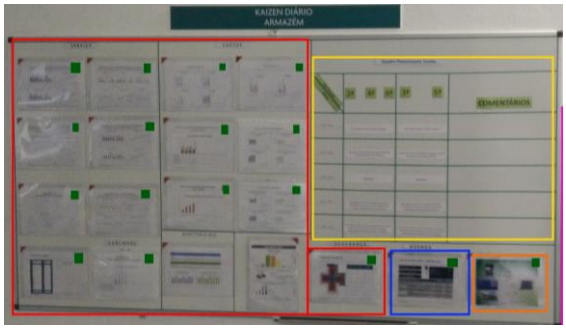

Figure 7 – Daily kaizen meeting board

To monitor the development, the meeting board in figure 7 was designed, where the main performance indicators are measured, and the main improvement actions are followed.

7. Results assessment and discussion

As the final step of the research methodology (Validation and evaluation of the solution and analysis of the results achieved) there is the result assessment and discussion. Where the performance indicators used are explained and the results are measured

7.1 Indicators

There were three indicators used to evaluate the warehouse operation, measured in the beginning and in the end of the project: Warehouse productivity – Measured through the average time of the main warehouse operations; Warehouse capacity – Measured through the number of existing positions; Travelled distances – Measured through the travelled distances associated with the main production materials.

7.2 Results Presentation and Assessment

Warehouse Productivity:

Regarding warehouse productivity, there was a reduction of 3 minutes and 11 seconds in the average time of a warehouse operation. When comparing initial with final stages, there was a reduction of 25% in the average time of a warehouse operation.

This improvement was due to the improvement solutions implemented in the phase of material allocation, the aggregation of materials used in the same operations, specially the aggregation of the materials that are part of the products that Empresa X produces more.

Warehouse Capacity:

The final warehouse capacity of Empresa X decreased from 3845 to 3389. But, when compared with the initial project proposed by Empresa X, there was a substantial increase, from 2160 to 3389 warehouse locations. Resulting in less 12% when comparing initial with final stages, and in more 36% when comparing the planning and the final stages.

The solution implemented that contributed more to this performance indicator was the collection of the logistic data for the accurate design of the final rack levels.

Travelled Distances:

Regarding travelled distances, the results were very positive. For each movement associated with each type of material, there were travelled 27 meters less than in the initial situation. Resulting in less 22% when comparing initial and final stages.

These results were due to the accurate material allocation designed in phase 2 of the implementation phase and due to the new mapping of the packing supply operation, specifically due to the aggregation of materials.

8. Conclusions

The case study in this paper is held at Empresa X, aiming to apply Kaizen Lean Methodologies to improve the operation of a warehouse.

There was developed a bibliographic revision that characterized the state of the art for relevant matters, such as Lean Thinking and Lean Warehousing. The result was the base for the work developed in the sections that followed.

Based on the structure proposed by Melton, first, the main processes were identified. Then, initial data was collected and analysed. Based on the opportunities that emerged, a design solution was proposed. Then, the designs proposed were implemented. After the implementation, the results were collected and evaluated. After the design implementation, standardized meetings were programed, in order to implement continuous improvement culture.

Resuming, the improvement solutions implemented were: Minimization of distance between warehouse areas through the new layout design; Aggregation of the materials that are used in the same operations, through the final allocation of materials, in order to minimize the distances between them; With the redesign of the rack levels, based on logistic data, it was possible to maximize volumetric space utilization; The warehouse operations were standardized, through the mapping of the new warehouse operations; The standardized meetings were designed, and the continuous improvement culture started to be implemented in the warehouse team of Empresa X.

As the final results were collected, the results of the improvement solutions were presented:

A 25% decrease in the average time of a warehouse operation; A 12% decrease in the warehouse capacity; A 22% reduction in the average travelled distance.

The next steps of implementation are divided in four main subjects: Maintain discipline in the culture of continuous improvement; Continue to implement Kaizen Lean methodologies in the other areas of Empresa X; Study the possibility of renting or buying another warehouse, in order to increase warehouse capacity of Empresa X; Change the warehousing system, to one that creates less impact in productivity than a mobile racking system.

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