Chapter N

**An Hypothesis of a Lean Warehouse Design for an Italian Textile-Apparel Company**

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**Abstract.** Nowadays, Italian companies are experimenting a very competitive scenario: rapid shake-ups and innovations, changes in consumer behavior, competitiveness and dynamism of the markets put firms in the position of rethinking and improving the organization and processes, to increase efficiency and performance: companies, to adapt to this context, can gain insight from Lean Management. In this work the principles of Lean Thinking were applied to the case of an Italian company operating in the textile-apparel sector, in designing a new warehouse functional to its business activity; the actual and real constraints given by the structure of the building that was intended to be used as a warehouse were respected, but the economic aspect, the costs to be incurred and the detailed quantity of goods that the company intended to store there (cause to privacy reasons) have not been reported. Through typical processes and tools of Lean Thinking, such as 5S and kaizen, various advantages can be obtained.

**Keywords.** Lean Warehouse, Italian Company, Textile-Apparel Sector, Warehouse Design, 5S Methodology.

# 1. Introduction

Recent trends, as for instance product range proliferation, the increasing market volatility, the expansion of e-commerce as well as the movement of production to the Far-East, the increasing speed in operations and the shortening lead times, mean that smooth and efficient logistic operations have a crucial role in raising the firms’ competitiveness. In particular, within today’s supply chains, a high performing warehouse (W) is an important element in cutting logistic costs (Gu et al., 2007; Gu et al., 2010; Rouwenhorst et al., 2000; van den Berg and Zijm, 1999). The prime goal of most Ws is to facilitate the movement of products through the supply chain to the final consumer. Delivering the correct order in the right quantity requires the merchandise to be labelled correctly and loaded onto the proper vehicle with sufficient time to fulfil the delivery deadline. Delivering to the exact customer at the exact place, on time, relies on the W picking and despatching products accurately. The W therefore plays a very crucial role in ensuring that the order is delivered flawlessly. Lean Thinking (LT) has been one of the most powerful managerial philosophies in recent history, and the increasing need to enhance supply chain performance has forced to focus on reducing non-value-added activities not only in offices and in manufacturing operations, but also in W activities. During the last decades an increasing number of companies all over the world, in different market areas, adopted LT philosophy in W management (WM), giving rise to Lean Warehousing (LW). Although the ultimate goal of LT is to reach the so-called “zero stock”, actually the companies that can work without the W are rare (e.g. for goods to be marketed, Ws are necessary to optimize deliveries), so it must be made as lean as possible (Abushaikha et al, 2018). Several lean tools may be efficaciously used within a company in WM, such as Value Stream Mapping (VSM)*,* 5S Methodology and kaizen approach (Richards, 2014; Seth and Gupta 2005). In particular the VMS technique allows to visualize the whole process activities and to identify the waste (Muda in Japanese) according to the lean principles (see Table 1), in order to reduce or eliminate them.

Table 1. Muda and examples of W waste.

|  |  |
| --- | --- |
| *Muda* | *Examples of W waste* |
| Transportation  | Driving an empty forklift or parking vehicles away from unloading. |
| Inventory | Excess stock reducing storage spaces and creating congestion in W areas.  |
| Motion  | Uncomfortable items placing, or unnecessary movements in searching for equipment left (forklifts, hand pallet trucks, etc.). |
| Waiting | Employees ready but unable to work due to product or machine unavailability. |
| Overproduction | Holding too much inventory, picking for orders before they being requested. |
| Over-processing | Multiple barcodes scanning, unnecessary packing, moving products through more than one forklift. |
| Defects | Correcting errors such as mis-picks (i.e., picking the wrong item or quantity) or incorrect shipments. |

Source: personal elaboration from (Richards, 2014) and (Abushaikha et al., 2018).

An essential step of becoming lean is using the 5S tool: it must be implemented in the correct order and workers must be subject to their individual responsibilities for every task and for their respective work areas within the W; Kaizen can then be employed to improve the work as a whole.

**2. Materials and methods**

Data and information, relative to the case study, were collected by consultation of company reporting and by interviews with the company COO-CFO and his collaborators.

**3. Case study presentation**

Company X started its activity in Italy in the 1940s as a family business. It was born as a spinning mill, over time its core business has been transformed into production and distribution of three brands (A, B and C) of sportswear. The production process is outsourced to multiple suppliers and the products are sold in over 50 Countries. To date the company owns two physical Ws (W1 and W2), a third W (W3) is being set up near the company's headquarters, which will be precisely dedicated exclusively to the C brand. The company's current logistics organization involves non-homogeneous processes between W1 and W2, both in terms of technologies used and in terms of storage and receipt of goods.

The purpose of this work will be to set an optimal structure for W3 taking into account theoretical and technical knowledge concerning LW and information about the company. It is not possible to refer to account a general expense to be incurred (or actually incurred by the company), nonetheless some real structural impediments (that will therefore limit some choices) will be taken into account.

**4. Results and discussion**

The venue of W3 is that of a pre-existing building used for the storage of another type of goods by another company. The external layout of the building is rectangular with entrance and exit forming the so-called L shape; an entire area identifiable with the short side on the right (from the entrance side) must be used for offices and W staff services, while the entire central part of the building is free for storage of items, taking into account, however, the presence of a row of immovable pillars (Fig. 1, Table 2).

|  |  |
| --- | --- |
|  | 1 Goods entrance2 Shipping3 Offices4 Quality Control5 Double-deep racks6 Pallets7 Row of pillars |

Fig. 1. Simplified representation of the internal layout of W3.

Source: personal elaboration.

The choices to be made regard the arrangement of the shelves, the technology used and the various related areas. Company X uses plastic boxes and cardboard boxes as loading units in its Ws (Table 2).

Table 2. Main features outlined for W3.

|  |  |
| --- | --- |
| *Feature* | *Details*  |
| Layout Shape  | L-shape  |
| W Size (~)  | 28.6 × 49 m; 1,400 m2  |
| Structural Impediments  | Pillars in the central area Flooring  |
| Internal Layout  | One floor about 7 m high  |
| Storage Area Size (~)  | 15 × 33 m; 495 m2  |
| Loading Units Size  |  |
| • Small plastic boxes • “Double” plastic boxes • Cardboard boxes  | 40 depht × 60 lenght × 33 height cm 40 depht × 60 lenght × 65 height cm 60 × 60 × 60 cm  |
| Racking System  |
| • For the storage of plastic baskets  | 6 Double-deep racks with 5 very narrow aisles with 12 bays and 13 or 7 levels (four racks of 13 and two of 7)  |
| • For pallets in shipping area | Drive-In LIFO with push back channels  |
| Order-Picking  | On foot and with mechanically driven upright forklifts  |
| Picking based on  | System-managed locations integrated with staff devices  |
| Picking method  | Wave picking with arrangement according to the order size  |
| Management Control System  | WM System and radio frequency identification  |
| Quality Control  | Near the entrance area and integrated into the system  |

Source: personal elaboration.

W3 will contain C brand sportswear and accessories, items that vary in weight and volume: their disposition must be managed accordingly.

The best solutions to offer to the company in a Lean perspective will be preferred based mainly on three criteria: (1) space used, with reference to both the area available for storage and the loading units available; (2) ease and efficiency of the various W operations, such as, for example, the ease and time spent in collecting orders, checking quality, counting the goods; (3) adaptability, both in the sense of the ability of this W to adapt to the different future needs of the company, and in the sense of being able to offer solutions that can be integrated immediately but also in the near future with the other two Ws of the company.

For technical reasons, the only feasible solution in the W considered is that of shelving (not that of hanging garments moving on carousels or manual or automated conveyors), due to the heterogeneity of item sizes and the fact that goods are not only addressed to large retailers or stores but also directly to the end consumer through online purchasing. For reasons of available space and to reduce the time required for movements (in observance of Muda reduction), the optimal solution is double-deep racking, set in shelves consisting of 12 bays, arranged in such a way as to narrow the passage aisles as much as possible. Considering a safety height of about 6 m, the shelves will have a maximum of 13 levels by placing only small plastic boxes (33 cm height) and a maximum of 7 levels by placing double boxes (65 cm height). As regards the third loading unit used in the company (cardboard boxes), given the marginality of its use and thus of the space occupied, being normally used in the stages of shipment on pallets, the optimal solution is to place them in the immediate proximity of the goods exit area. Considering the arrangement established so far, a drive-in push-back racking system is the right choice, and therefore the method of withdrawal (for order-picking) will follow the LIFO (“last in, first out”) mode.

The second layout-related decision problem concerns the design part of the internal layout, and concerns everything revolving around the placement of equipment, the storage space and the routes to be followed. Even in this case, however, the main issue remains the reduction of “transportation” and “motion”. Regarding the orderly arrangement of the stock keeping units (SKUs), the chosen methodology is slotting analysis, which requires an initial overview of the types of loads, the load units to be used in the W, how the items will be stored, and the tools that will be used for collection. The articles of the current season (items handled most frequently) must be placed on the nearest shelves, going backwards with the seasons as moving away. The existing W3 flooring will not make it feasible to install copper conducting wires in the floor: it will be necessary to install metal sheets, a sort of “skirting board”, at the base of each shelf in direct contact with the flooring, so that the driver can channel the vehicle between the aisles of the W. Dealing with the picking methodology, thanks tothe *Interactive Erasmus Logistics Warehouse Website* model[[1]](#footnote-1) which allows to calculate the distance travelled by a picker, and taking into account the sorting problem, the final choice (after having eliminated single-order, zone and batch picking methodologies) falls on wave-picking. This implies that the order pickers start collecting each in their respective area and all at the same time, and only after all the pickers have completed their tour does the following wave round begin. In this way, orders can be released at different times in different areas based on the time taken to select orders. But even here a subsequent sorting phase is required, having to combine the partial orders. Basically, W3 should be designed so that at least 6 vertical forklifts are placed at the end of each aisle on the right side, referring to the goods entrance gate (again thinking of a 6-shelf layout, there are 5 central aisles plus two external aisles), while the pickup staff should be placed at the beginning of each aisle so that they walk toward the forklifts. In this way, by having all SKUs entered into the WM system and integrated with staff personal digital assistants (PDAs), whenever an order arrives staff already knows the exact shelves and locations from which to draw all the items that make up that specific order. Essentially, therefore, imagine having an order of items perfectly located in the W, so each employee will stand at the beginning of their respective aisle of reference and walk to the end of the aisle collecting all the items. When they reach the end of the aisle, they will leave the items in a designated container and, getting on the respective vertical forklift, they will travel the same route backwards, then leave the items again in a designated container. Thanks to this system, the picker would not have to walk through the entire warehouse individually, nor, as an aisle is reserved for each, would there be hindrances and bottlenecks, or worse accidents between an employee on foot and one driving the vehicle. As for radio frequency identification technology, it contributes to overall visibility by enabling W workers to keep track of both identification and location at the individual item or product lot level, and by helping operators avoid two types of Muda, namely "overproduction" and "inventory". In addition, once the initial setup of the W is done, based on technical and LT considerations, the 5S tool can help in the further organization of the W3 (Table 3).

Table 3. 5S Methodology applied to W3.

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| *S* | *Actions* |
| Seiri (sort, clear out) | Remove obsolete and defective materials, undue and excessive stock, faulty equipment, damaged pallets and packaging waste from the working area Remove impediments in front of the entry and exit areas Eliminate unnecessary equipment, documents, movements Reduce the amount of time needed for material handling Reduce unnecessary vehicle parking Use radio frequency system to avoid item counting phase Use vacuum for packaging  |
| Seiton (set in order, configure) | Define and label locations Use slotting analysis Use directional signals Place the necessary tools and means near the point of need  |
| Seiso (shine, clean)  | Assign specific, daily or periodic tasks to each worker Identify and remove broken pallets Install boxes at the end of each aisle for the purpose of waste collection Make cleaning tools (brooms and dust pans) easily accessible Employ Total Productive Maintenance Keep the transit areas of vehicles and people clean and neat  |
| Seiketsu (standardize, conform) | Walk through each process with the relevant staff Develop corrective and preventive maintenance actions for tools and equipment and standardizing them according to work requirements Display best practice procedures within the W Create and document new standards and introduce them in each work field Communicate standards with easily readable and understandable documents |
| Shitsuke (sustain, self-discipline) | Encourage staff not to return to previous work practices but to continue to follow best practices and to accept change Provide regular supervisory discussions between workers and team leaders Educate workers properly Carry out regular checks and audits  |

Source: personal elaboration.

**5. Conclusions**

The organization of the new W (W3) of Company X as a Lean W is a first step on the intended road of redesigning the spaces of Company X, that will continue with the complete restructuring of W1 and the subsequent joint configuration of the three Ws. According to previous LW experiences, as also reflected in the literature cited above, several advantages can be obtained with the application of LM to W3: reduced delivery times due to increased flexibility and availability of the product in less time; increased productivity; reduced work in progress and inventory; reduced product costs due to increased efficiency; increased competitiveness, increased focus on customer satisfaction, cleanliness and safety of the workplace; good working environment and development of staff motivation.

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1. http://www.roodbergen.com/warehouse/ [↑](#footnote-ref-1)