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<http://hdl.handle.net/11067/7384>

<https://doi.org/10.34628/C763-TF57>

Metadados

Data de Publicação

2023

Resumo

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Tipo

bookPart

Editora

Universidade Lusíada Editora

Esta página foi gerada automaticamente em 2024-11-22T12:24:53Z com informação proveniente do Repositório

Warehouse makeover: Rethinking warehouse organization after growth

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Abstract. Year after year, companies must review their growth and activity in order to plan their strategy for the upcoming periods. During the pandemic, a company took the decision to acquire its own warehouse anticipating the company's expected growth after the recovery of the sector in which it operates - provision of services and technology in the hotel sector - having, however, suffered with the cancellation of contracts and future projects. In 2022, the company experienced extraordinary growth after its customers reopened their activity, investing in new solutions with the lifting of Covid-19 restrictions. In this situation, it was necessary to rethink the organization of the warehouse, which acts as a place to store stock, organize projects, consolidate purchases, and dispatch goods and projects. After acquiring the property and transferring the stock to the new premises, the warehouse was first organized into areas that had become inefficient with the company's growth in the last period. Following the action-research methodology, the warehouse was rearranged, and the main logistic processes were mapped. Installing racks organized by geographical areas increased its capacity by 468% and allowed to solve accessibility problems and safety risks. The inventoring process became

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easier and more reliable. Search engines were created in Excel to map the corresponding physical warehouse location to the PHC warehouse. This article is written after the warehouse reform and focuses on how the warehouse reorganization process impacts the logistics of the activity, what are the advantages and challenges of restructuring the areas for outgoing material and highlights the importance of creating up-to-date tools for the new logistical reality.

Keywords: Logistics; Warehouse management; Business process mapping.

1. Introduction

Warehouse management is a critical aspect of supply chain management, especially in industries with fluctuating demand patterns. An efficient and effective management of stock and physical display of its products is essential for the productivity of any operation and its workers. In response to the Covid-19 pandemic, many companies had to undergo restructures as to stay afloat. The company that inspired this article (hereafter named “Company N”) provides technology solutions primarily for the hospitality sector. This company invested in a warehouse to expand its facilities at the start of 2020, with hopes that they could keep on growing after the crisis. The company experienced a shortage of space and logistical challenges after the reopening of the economy and the hospitality sector. The warehouse purchase and upgrade were initially successful in accommodating the Manufacturing and Logistics department, but then there was a build-up of sleeping stock, and other issues which created multiple challenges for the logistics team.

The current study will touch on the challenges Company N’s warehouse faced prior to the remodel and how it impacted its operation shortly after the makeover. The article is first introduced by a literature review on warehouse management, picking, and redesign as to provide a theoretical background to the research. Section 3 gives a brief introduction to the company, as well as its growth since foundation. Section 4 describes the state of the warehouse between the upgrade to the new building and the remodel; the following section presents the new layout, the improvements and the new challenges encountered after the change. On the last section the conclusion of this paper can be found and observations about the future of the warehouse.

2. Literature review

The importance of warehouses in a supply chain is well documented throughout the literature [1]. It poses a strategic role in the logistics networks; therefore, the constant

improvement and analysis of its operation are key to keep up with the sector's permanent evolution. Competition and external forces pressure companies to improve the efficiency of their operations [2]. These authors consider that internal logistics and warehousing are two areas that have great potential for improvement in most companies.

“Logistics is a traversal discipline focused on the flows of materials” [3]. A warehouse system can vary based on its products specifications, customer requirements and service levels [4], but some of its main flows are: receiving, putting away, storing, order picking and shipping [4, 5]. With various activities, the design and management of a warehouse must be flexible and thoughtful. According to [6], five main decisions play an important role in the design of a warehouse: overall structure, department layout, operation strategy selection, equipment selection and the overall sizing and dimensioning – these determine “the material flow pattern within the warehouse, the specification of functional departments, and the flow relationships between departments”.

Multiple studies identify order picking – the process of retrieving items from storage locations in order to fulfil customers' orders [2] – as responsible for more than 50% of the operating costs of a warehouse [7], as it is one of the most time and labour intensive operations within its facilities. Even though there are many solutions involving technology and automation on this area, manual order picking is the dominant practice and researchers estimate that 80% of all these orders are fulfilled manually [2, 8–11]. It can constitute from 50 to 75% of the operating costs for a typical warehouse and most companies that continually use manual picking do so because of the of the following factors: SKUs (stock keeping units) dimensions, demand, seasonality, investment required to implement an automated system [12]. These factors can vary vastly and act as a barrier to automation and a warehouse rethinking.

The impact of picking, storage and routing policies must also be considered when analyzing a warehouse operation [12] as it can greatly influence the efficiency of a warehouse. The placement and retrieval of an SKU is conditioned by its picking policy which can be improved by implementing models adapted to the needs of the warehouse and by studying the picking process [2]. Most of the research available has tried to develop heuristics to maximize efficiency of the picking processes [13–15]; only more recently has scholars started to consider problems such as picker blocking and routing congestion on their heuristics. [16–18]. In [7], authors have determined that the time required to complete a manual order can be split into four components: (1) setup, (2) travel, (3) pick, (4) time. In the set up the authors include the administrative tasks completed before the picking tour; picking is the act of extracting the items from its locations and they consider that travel is the more time-consuming part of the manual order. From [2], a study about the effects of learning

on the manual picking process, it was concluded that it is fair to assume that search time also affects the order picking process and can be a considerable factor on the productivity of the process. As one can assume, the accessibility of the items will greatly impact the search, although this will reduce as the picker gets familiarized with the placement and picking order [2]. Nonetheless, an organized and accessible warehouse will impact the whole activity and must be a key factor when designing or improving a warehouse facility.

3. Company's growth

Company N is a Portuguese technology company that provides solutions for the hospitality sectors. Founded in 2005, it has been establishing itself in both the Portuguese and international market as a reference as provider of technology for hotels and other hospitality businesses. Its main goal is to improve guests' experiences and streamline its clients' operations.

Since its foundation, the business has been organically growing, overcoming adversity and the fluctuation of the tourist market in Portugal and around the globe. More recently, as represented in the Figure 1, before the 2020 pandemic, the operation revenue was in an upward trajectory, as a result of the growing presence in the international market and the growth of their client base. With the advent of the covid-19 pandemic and the collapse of the hospitality industry, Company N took multiple measures to help their customers: it allowed the suspension of accounts and subscriptions, the termination of contracts, and tried to support its clients.

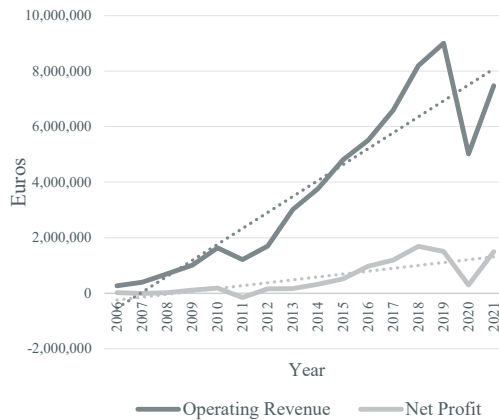


Figure 1. Company's N Growth

Although the scenario was not favourable, Company N decided to invest and buy a warehouse, upgrading its facilities, with the hopes that the crisis would subside, and its business would pick up once the sanitary crisis was resolved. The warehouse accommodated the Manufacturing and Logistics department, which includes three teams: Factory, Purchases and Logistics. The space growth allowed the factory to expand, as well as exponentially increased the storage capacity. This change allowed the department to rearrange itself and to create new rules for the warehouse organization.

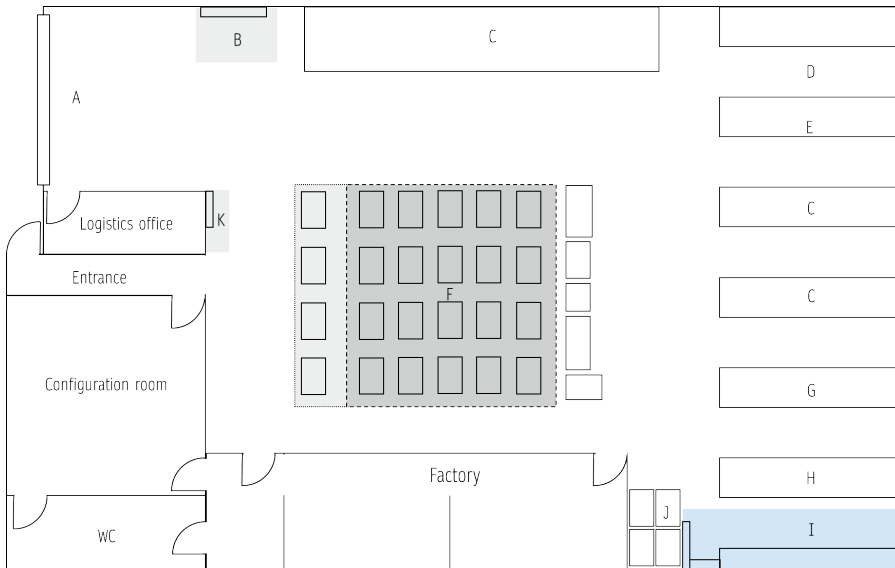
4. Warehouse Diagnosis: The Before

The warehouse was acquired in 2020 and designed to accommodate and define different tasks. On the top floor a backup, samples and fixed-asset zone were set up, along with a facilities area. Additionally, a kitchen and offices were also created on this floor.

The plant floor, as displayed on Figure 2, was designed to have a logistics cabinet near the entrance as to facilitate and control in and outbound traffic. The floor comprised of a production area – Factory –; multiple stock zones organized by brands and equipment type (C); a storage area for the finished goods produced by the factory (E); raw material shelves (G); a storage area for RMAs** and equipment under revision (H) and a small perimeter of pallets used to store the stock of other subsidiaries (Regional Strategic Units, referred as RSU), such as Spain’s (J). Initially there was a shipping zone composed of a 20 pallets perimeter on the floor plan (F), which later overflowed and had to be expanded due to lack of space within the set area.

During the pandemic, the warehouse plan and organisation proved to be sufficient since the majority of projects were paused. Even if the company needed to, restocking was a challenge since the global trade was greatly affected by the pandemic and ordering new equipment or raw material was unfeasible due to the uncertainty in the market, record high lead times and unreliability of the providers and the supply chain. Notwithstanding these constraints, the warehouse plan was a great improvement from the small space the company previously used as storage.

** RMA – Return Material Authorization. “Arrangement in which the supplier of a good or product agrees to have a customer ship the item back to them in exchange for a refund or credit due to a product defect or malfunction” [19]. In this specific case, it refers to damaged or returned equipment that may or not be under warranty and pending a solution – destruction, repair, resale or return.



- A - Front gate B – In and outbound zone C – Stock zones
 D – Old equipment and mono storage E – Finished product F – Outgoing zone
 G – Raw material H – RMA and under revision equipment I – Packaging area
 J – RSU stock K – Transition area

Figure 2. Warehouse prior to the makeover

With the re-establishment and stabilisation of the international economy, clients slowly resumed business with the company as they tried to diversify their offers along with adapting and complying to the new public safety rules and guidelines. Between the years of 2021 and 2022, due to the lack of manpower, equipment, delayed shipments and increase of demand, the materials started accumulating on the shipping zone pallets, leading to multiple challenges and problems for the warehouse and the logistics team.

The warehouse lacked a clear methodology for the physical flow of inventory due to the multiple variables regarding orders. While before the pandemic and the warehouse relocation, lead times were faster and more reliable, during and after the Covid-19 crisis, the Purchases team was unable to coordinate the arrivals and departures of materials for its clients' premises, leading to a build-up of sleeping stock [20]. The warehouse fell on the logic of "random storage" [2] where the items arriving at the warehouse destined for a specific client were randomly assigned to an open location in the shipping area. According to [7], this is a valid measure when a warehouse is

under dynamic conditions – in this specific company all projects differ in quantity, brand, solutions and size so data is unreliable and Purchases’ team is unable to predict the demand and feed that information so that Logistics can better store and manage the warehouse.

Since all projects required different equipment and took different amounts of space, the warehouse implements rules on its outgoing area: there were 20 pallets on the floor, numbered and name on PHC from number 7501 to 7520 and the goal was to transfer the equipment from its location (raw materials; stock; newly arrived) to these positions so one could see on the system where the materials were precisely located. This worked to an extent. Since they had over 20 projects being build up or stored at any giving time, the next rule was to divide the pallet in four sections (Figure 3) so to try to limit the contact between the equipment although it would still be on the same location on the warehouse management system.

This rule soon started to be impossible to follow because of the increase of projects; therefore, two new measures were adopted: extra pallets were placed outside the outlined and an excel document was used to display the positions and projects, which had to be updated manually (Figure 4). Besides, it gave a picture of how much time it had passed since the project was first placed on that pallet.

In 2022, although the shipping area has grown to 25, already outside the floor perimeter, every time a full pallet of equipment arrived for the one client (*i.e.*, 205 phones to a hotel), the pallet had to be stored in a ghost warehouse in the WMS – Warehouse Management System – (75 or 7500) and the pallet was allocated to the outside of the already overflowed transition zone of shipping material.

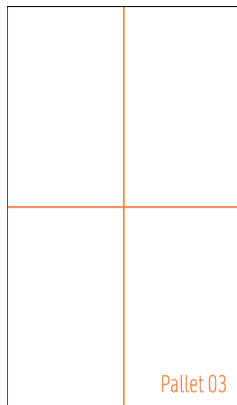


Figure 3. First rule applied: Pallet divided in four.

Figure 4. Excel display of the shipping zone.

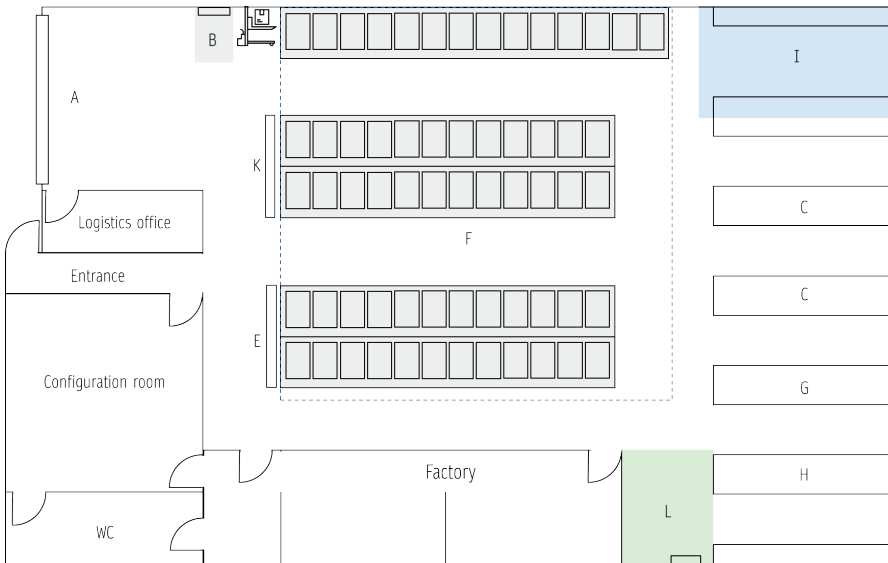
Even after overflowing the designated area, the pallets grew in height and the warehouse would have equipment piled up higher and higher which made the accessibility harder, which would greatly complicate the inventorying. This difficulty in accessibility also impacted the placement of more material for the consolidation of projects, as well as increasing the error rate, because by moving boxes in the middle of the pallets to access equipment that was underneath, it happened that project materials were forgotten and changed positions (on purpose, or not). Physically, a given serial number would be in a pallet, but in a location that would not correspond in the system.

All these problems lead to the need to rearrange the warehouse which will be discussed in the next chapter.

5. Warehouse Rearrangement: The After

In the last semester of 2022, the department director decided to instal 5 sets of racks, 3 pallets high, eliminating one of the stock areas next to the wall of the warehouse and the shipping zone. By installing these structures, the logic of the warehouse changed, so the packaging area, finished product and inbound and order checking locations were also changed, as one can see on Figure 5.

A new area was designed (L) in order to create a space where the materials could arrive and be carefully checked out without impacting and clogging the entrance. Zones D (Old equipment and mono storage) and J (RSU stock) were eliminated. The stock that was on zone D was reorganized on the top floor and the racks were organized by geographical areas.



A - Front gate B - In and outbound zone C - Stock zone E - Finished product
 F - Shipping zone G - Raw material H - RMA and under revision equipment
 I - Packaging area K - Transition area L - Conference zone

Figure 5. Warehouse plan after the remodel

The 25 locations on the WMS were transformed into 142 locations numbered from number 501 to 542. The installation of the racks allowed the warehouse to increase its capacity by 468% and to implement a different organization system on the shipping zone.

The racks were each given a letter from A to E and numbered horizontally through the three levels. So, a pallet is now located on the warehouse by its pallet number and rack letter (example, project X is on A31 location), however, this decision collided with the name of each location on the WMS. To avoid errors and facilitate the correspondence, a simple search engine was created on Excel, as per seen on Figure 6. It gives either the physical warehouse location of a PHC warehouse, or the opposite: the PHC warehouse of a physical location. This is granted by an array formula that matches an index to its correspondent value.

| Search: | Location: | Warehouse | Warehouse: | Location |
|---------|-----------|-----------|------------|----------|
| | a1 | 501 | 501 | A1 |

Figure 6. Warehouse search engine.

The multi-level pallets now allowed for the long-term storage of equipment separated by projects, or the arrival and storage of full pallets of equipment for one only client. This separation and isolation proved itself to be a great improvement for the warehouse. The projects had now limited contact with one another, helped avoid errors with storing and inventorying projects without touching neighbouring projects.

The racks were organized by the following logic: rack A and B were intended to store projects in Portugal or managed by the Portuguese subsidiary given its higher number of projects and proximity to the clients; rack B was divided between Spain, France, Brazil, the Netherlands, and the United States, following a vertical logic, where the zone continued upwards to make picking and storing easier. To help again visualise and identify the locations, a new warehouse map/display was created on Excel with the same time logic to help identify projects that were on the warehouse for longer periods of time (Figure 7).

| Zone | Rack | Project ID | Zone | Rack | Project ID | Zone | Rack | Project ID | Zone | Rack | Project ID |
|--------|--------|--------------|--------|--------|--------------|--------|--------|--------------|--------|--------|--------------|
| Zone A | Rack A | PT2022008060 | Zone A | Rack A | PT2022007462 | Zone A | Rack A | PT2022008085 | Zone A | Rack A | PT2022007635 |
| Zone A | Rack A | | Zone A | Rack A | PT2022008097 | Zone A | Rack A | PT2022008087 | Zone A | Rack A | PT2022008064 |
| Zone B | Rack B | PT2022005819 | Zone B | Rack B | PT2022005212 | Zone B | Rack B | PT2022005212 | Zone B | Rack B | PT2022005685 |
| Zone B | Rack B | | Zone B | Rack B | PT2022005212 | Zone B | Rack B | PT2022005685 | Zone B | Rack B | PT2022005214 |
| Zone B | Rack B | | Zone B | Rack B | PT2022005686 | Zone B | Rack B | UK2022000310 | Zone B | Rack B | PT2022000994 |
| Zone B | Rack B | | Zone B | Rack B | PT2022004650 | Zone B | Rack B | PT2022004650 | Zone B | Rack B | PT2022008450 |
| Zone B | Rack B | | Zone B | Rack B | PT2022008067 | Zone B | Rack B | PT2022008076 | Zone B | Rack B | PT2022008076 |
| Zone B | Rack B | | Zone B | Rack B | | Zone B | Rack B | PT2022008076 | Zone B | Rack B | PT2022008076 |

Figure 7. Upgraded warehouse display map.

Another advantage of the redesign of the warehouse was the creation of a packing area, with the installation of a scale for the pallets since there was now space to fit a stacker through the outlined zone. The warehouse also tried to store materials used only by the factory on the rack closest to them (E) as to avoid going through the whole warehouse to get some components. These were previously stored on the shelves opposite to the factory (Figure 2, C). The raw material area, only touched by the factory personnel and the logistics team when storing them, was already close to the factory so there was no need to change that location as well (Figure 1 & 2, G).

In contrast, the warehouse makeover brought some challenges. Even though there was more pallet space to organize projects into, small projects still existed, and the logistics team would have to put multiple projects together or soon there were no more locations available. With the restriction of the racks by geographical zones, it meant that the accessibility was harder once the space on the bottom pallets is exhausted. Elevating the pallets was not only time consuming, but also, at times, wasteful, since for safety reasons the pallets must be filmed. Once more material arrives for a project allocated on the top levels the pallets need to be lowered, stocked and filmed time again when volume and quantity changes.

6. Conclusion

This article analysed the problems a technology services company faced before and after the warehouse remodel. The warehouse was first organized into areas that had become inefficient with the company's growth. The warehouse reorganization process highly impacts the logistics of the activity, as documented in literature. At this company, installing racks organized by geographical areas increased its capacity by 468% and allowed to solve accessibility problems and safety risks due to overflowed transitions zones of shipping material. The separation of equipment by projects made the inventoring process easier and more reliable. The logistics team felt it was important to create up-to-date tools for the new logistical reality. Search engines were created in Excel to map the corresponding physical warehouse location to the PHC warehouse. Some challenges of restructuring the areas for outgoing material resided in the small projects storage that force repeated movements of filming and elevating the pallets. In every company, all decisions may have consequences, advantages, and disadvantages. The decision makers should always adopt models that aim at the continuous improvement.

Acknowledgements

This work is financed by Portuguese national funds through FCT - Fundação para a Ciência e Tecnologia, under the project UIDB/05422/2020.

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