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TraP

Executive summary

Organising the storage of the materials in the warehouse is a fundamental and critical activity of every industrial business. The paper analyses methods to increment the efficiency of a Procter and Gamble warehouse located in Pomezia (RM), Italy, which stores healthcare and detergent products. During this analysis a particular focus is dedicated to the management and tracking of finished goods organized in pallet and stored in the distribution centre of P&G for Italy, Spain and Portugal.

The main objective of the thesis project is to increase Inventory Record Accuracy (IRA) while identifying systems to track pallets in warehouses in such a way that be implemented in a low-density value case as for Pomezia P&G warehouse. The project requirements are price, feasibility, integration and scalability.

New technologies have therefore been explored and the state of the art has been defined. To understand which one could be the best solution to the case study, research on the different types of warehouses has been performed and real companies' cases and applied technologies have been investigated.

A final optimal solution has therefore been selected: being an innovative and not documented one, it required to be practically designed and adapted to the case study. In addition, a market analysis has been performed and five potential suppliers have been contacted. An investment evaluation has been conducted to benchmark the technology cost and to estimate the potential saving

Finally, since the solution couldn't be implemented in the real case because of the COVID outbreak, a simulated model based on MATLAB has been developed to statistically validate the solution.

Key Words

Inventory management, warehouse optimization, pallet tracking

Logistical efficiency:
Never lose anything

Project description written by the Principal Academic Tutor

In traditional warehouses, position of pallets is determined through manual or automatic scanning of pallet labels. The pallets' positions are recorded in the material system of records.

The project aimed at proposing an affordable tracking system for large scale operations in warehouses characterized by high density and low margin product, so as to eliminate the scanning procedure and be able to identify and track pallet movement thus reducing the number of errors for mis-placed products.

The partnering company has been P&G and the reference warehouse, for a pilot study, the P&G warehouse located in Pomezia (Italy).

The project plan was to first understand the current P&G environment and observe how operations were currently carried on at Pomezia warehouse, then assess what competition does and what are the available tools in the market and identify tools that could fulfill the need. The entire analysis had to be based on a comparative analysis of the available (or ad-hoc designed) tools, including financials.

The last phase had to be the selection, together with the P&G management, of the best alternative and, if affordable, test it as pilot study in the Pomezia warehouse.

Due to the COVID 19 pandemic, the project plan has to be changed.

Specifically, the financial assessment of the identified solution, to be evaluated on site (at Pomezia), aborted due to the lockdown phase.

The team was, in fact, prevented from going to Pomezia and setting up the details of the P&G management chosen solution, and its related costs.

The pilot on site study was then substituted by a simulation study, which, however, enlarged the focus to several scenarios, also different from the Pomezia case, thus giving indication about how different tracking systems can be adopted in different type of warehouses.

Team description by skill

In order to answer the needs and requirements of the project, it has been built a team of:

- 3 Management engineers (Dall'Ora Giulio, Merli Sara, Rizzalli Giovanni)
- 1 Mathematical engineer (Milinanni Federica)
- 2 Industrial Production and Technology Innovation engineers (Acheraf Salim El Khbazi, Gisotti Gianlorenzo)

The fields of expertise required by the project encompass several areas of study, from logistic and warehousing, to accounting and simulation.

Goal

The main objective of TraP project is to identify systems to track pallets in warehouses in a way that allows economical sustainability for companies that deal with low margin products. Specifically, the team partners with the company Procter & Gamble (P&G). The firm operates a warehouse in Pomezia (RM) to store healthcare and detergent products. Most articles stored in the warehouse are low margin goods. The company is interested in developing a system to track the position of pallets in the warehouse, since at the moment they do not have an efficient system to know where all the goods are located.

The initial objective delineated by the company is to identify opportunities to track pallets' movement through an affordable tracking system for large scale operations. Considering this context, the main requirement is that the cost of the tracking system should be reasonably low. Overall, the economic feasibility must refer both to the infrastructures (readers, processing systems) and to the technological equipment for each single pallet (labels, tags). Moreover, the new tracking system must be integrated within the current information system used by the company. The expected results would reduce the number of individuals needed on the floor and the number of errors for mis-placed products, thanks to the substitution of the traditional manual or automatic scanning of pallets labels. The expectations of the partner company were a full recommendation on how to implement a new pallets' localization solution or, if financially viable, a pilot in the P&G warehouse located in Pomezia, with financial and technological analyses of the proposed solution, and an analysis on the scalability of the solution on multiple warehouses.

Due to the complexity of these objectives, the project has been organized in milestones that all together result in the project scope:

1. Analysis of the state of the art of technological solutions of pallet tracking for warehouse and theoretical discussion about typologies of warehouse and respective requirements
2. Market research and case studies of automated tracking systems currently in use through gathering information from companies
3. Solution and concept development by evaluating all the possible solutions discussing the level of accuracy, automation and tracking frequency
4. Simulation and investment evaluation

Understanding the problem

The project has a clear and straightforward main player: P&G Pomezia distribution center. The main objective is to improve the reliability of the warehouse identified technically as the incrementation of the Inventory Record Accuracy (IRA). This measure represents the comparison between the official inventory record and the relative match on the physical inventory. In order to determine it, once a year each SKU quantity is manually counted and compared with the numbers available on the WMS of the distribution center. This number in developed industries oscillates between 97 and 100%.

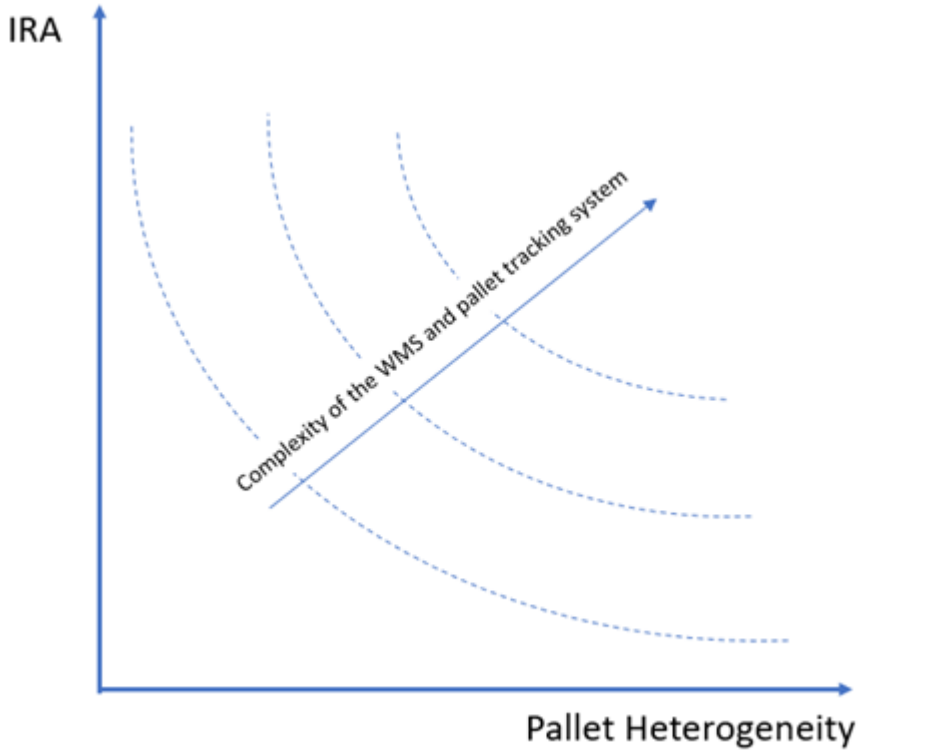
it is important to mention that P&G Pomezia distribution center's seeks greater performance as these decreased progressively through the years reaching a IRA of around 95%.

This lower IRA performance derives from the fact that the company decided to satisfy a wider range of customer, more in particular the smaller ones, allowing the shipment of more heterogeneously mixed pallet in term of SKUs than before.

It is obvious that managing a warehouse that offers mixed pallets is more complex than managing one that only ships pallets made up from one single SKU. The possibility for a customer to order mixed pallets does not only increase the time

spend setting up the order but also fosters the incurrence of errors and misplacement of items resulting in a poor accuracy of the warehouse inventory.

The objective of the plant is then to keep satisfying the customers and increase the accuracy of the inventory leading obviously to a more complex system of managing the tracking of pallets.



Complexity of the WMS and pallet tracking system according to IRA values

Exploring the opportunities

In order to analyse which pallet tracking systems fit every specific type of warehouse, a classification of warehouses is needed. For the purpose of the topic addressed in this paper, a size-based classification and a value-based classification of the goods handled has been considered, distinguishing Small warehouses, Large warehouses and high value and low value density goods. Based such characteristics, different opportunities for warehousing systems have been identified. In our case, for small warehouses with low value density goods, a cheap pallet tracking system could be considered, given the amount of goods handled and the size of the warehouse.

Based on this result, a market research looking at case studies and existing literature has been performed, in order to identify the main warehousing solutions currently used. This has allowed us to study the application of RFID technologies for warehousing, the use of forklifts equipped with lasers, warehouse zoning technologies through GPS, drones with computer vision and associates equipped with cameras.

The market research proved that no existing solution is able to entirely fulfil all the user requirements and constraints of the TraP project (maximising IRA and covering investment and operating costs from realized savings), and novel and more innovative technological alternatives have to be explored in the scope of this study in order to reach the research objective. This has been performed through a Brainstorming approach based on the technologies previously identified.

Generating a solution

Through a Brainstorming approach based on the solutions already present on the market, we could identify a set of potential technology solutions for the TraP project: RFID checkpoints, Barcode checkpoints, Cameras in the warehouse, Spider cameras, Cameras on people, Drones with barcode scanners, RFID readers on forklifts, Barcode readers on forklifts, Cameras on forklifts. Other than their strengths and weaknesses, these solutions have been compared in terms of their accuracy, automation and reading frequency and the results have been presented to the company and academic board.

The final decision considering the level of performances identified and the technical, material and investment constraints, has been to implement a Barcode checkpoint technology. The strengths of this solution, that could make its development smoother, are the following:

- The use of the as-is identification method (barcodes).
- High scalability of the solution: the accuracy of such tracking system is determined by how many portals are installed. Therefore, it is possible to calculate the optimal number of portals, balancing the benefits stemming from higher precision with the investment cost needed.

Since barcode readers in a checkpoint portal might be installed at operator's eye height, an important constraint due to safety reasons was to avoid the use of laser-equipped traditional barcode readers. Indeed, for safety reasons barcodes should be read by computer vision algorithm, thus avoiding the use of laser rays. The solution is consistent with the characteristics of a small warehouse dealing with low value products, since it is a cheap tracking solution, still ensuring a good level of performances (in terms of accuracy, reading frequency, automation).

A technology feasibility analysis has been performed, in order to understand whether such a technology can be adapted to our specific field and whether its performances are suitable for our project. In the context of stringent mobility constraints resulting from Covid-19, a mathematical simulation model has been set up in order to clarify with precision the level of accuracy of the solution in our specific context. This, together with the costs of the solution and input data from the company has been used to set up an investment analysis ready to be used and adapted for each specific situation. The cost of short shipment that makes it indifferent to introduce the solution can also be estimated.

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