Storage Location Optimization for a real-world stock warehouse: The non-food sector

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Abstract. The retail industry sector is becoming increasingly competitive. As a result, companies are seeking to squeeze inefficiencies out of their supply chains. This is the result of periods of pressures for reducing costs, improving quality and responsiveness created by the global competition. This project emerges to give an improvement to the internal layout of the non-food stock zone of the warehouse of a Portuguese Food Retailer company. At a first stage, we collected information about the non-food stock processes throughout informal interviews, non-participant direct observation and data about products in stock, their order's frequency and their locations. At a second stage, we plan to use a two-phase model to optimize the products' location in the warehouse. The model starts by segregating the products based in their affinity. This information is, subsequently, used to allocate the products to the available spaces. It is expected that the reassignment of products improves the pickers' productivity by reducing the distance travelled while building the pallets for the stores. This research has a higher practical value since a two-phase model is implemented in a totally new context, to solve a real world problem. Moreover, no optimal algorithm has been presented in literature for storage location problems in multi-aisle multi-product picking' warehouses and heuristic procedures for this kind of warehouse are also scarce.

Keywords. Warehouse Design, Stock Operations, Cluster, Storage Policy.

Introduction. Supply Chain Vital Operation

Efficient warehouse management is vital for supply chain operations (Pang & Chan, 2017). Even minor changes in warehouse operations can bring significant benefits to the customer's response time, leading to an increase on the level of the provided service (Fontana & Nepomuceno, 2017). According to Pang and Chan (2017), to improve the warehouse efficiency, managers must be able to significantly improve the picking operation to provide a faster response to customer' requests, with lower cost. Therefore, to optimize the picking operations has become a common goal for thousands of companies and for the academia (De Koster et al., 2007). One way of improving the picking activity, is to enhance the allocation of the warehouse' items into the available spaces (Bódis et al., 2018; Dijkstra & Roodbergen, 2017; Fontana & Nepomuceno, 2017; Glock et al., 2018; Reyes et al., 2019). This gives rise to the so called, storage location assignment problem that has been represented as a critical issue, in operations, since 1976 (Battista et al., 2011). According to Reyes et al. (2019), the number of the publications, in this area, has been increasing between 2005 and 2017. With this study, we aim to solve a real-world problem by applying a new integrated strategy that combines clustering analysis with correlated storage policy. This is relevant because, as stated by Dijkstra and Roodbergen (2017), no optimal algorithm has been presented, in literature, for storage location problems in multi-aisle multi-product picking' warehouses. Furthermore, heuristic procedures for this kind of warehouse are also scarce.

Case Study. Portuguese Retail Food Company

This study is performed on one of the warehouses (north region warehouse) of a Portuguese retail food company, with a focus on the non-food stock section of the non-perishables warehouse. The current layout consists in a closed area, divided in several aisles that are assigned to different families of products such as car tools, lights, cook instruments and so on, being the products placed, in the available spaces, according to its weights. Pickers perform a conventional manual picking operation. By this, we mean that pickers collect the products according to a given order and place them on a pallet that will be shipped to the consumer. Pickers perform an S-Shape route due to the one-way corridors. The products that are collected are the ones that are closest to the floor, therefore the company has a picker-to-parts system with a low-level picking. The pickers are guided by a voice speaking system that tells them the location of the products having a guide generated by the company management system, which already divides the orders according to the typology (food, non- food and drinks) and weight. Note that there are pickers exclusively allocated to the non-food area.

Methodology. A Two-Steps Model.

An integrated strategy that combines clustering with a correlated storage policy is applied. First, we analysed the orders that have arrived at the warehouse, during a stable month. Then, we grouped the products into different classes based in their affinity. To do so, we performed a cluster analysis, using as similarity measure the co-occurrence frequency of the products on each order, following the methodology of several authors such as Bag et al. (2019), Bindi et al. (2008); Lu et al. (2014) and Moshref-Javadi & Lehto (2016). After that, we made the products' allocation into the storage´s available places. At this stage, we developed a heuristic procedure, using the idea behind the correlation storage policy. This is, the more the correlated products are grouped together, the greater becomes the chance of reduction in the routing length, for a given list of orders. Therefore, we put the group of products that appear, simultaneously, more frequently on the orders closer to the vitafilm zone, which is the place where the picker starts and ends the operation. The model was inspired in a study of Bindi et al. (2018). As a performance measure we used the pickers travel distance, calculated by C++ program design at Visual Studio 2017 software.

Findings. First Results

In an explanatory stage, having as a basis a restricted number of orders, when comparing the current scenario of the company with the scenario in which the model is applied, it was possible to find out that the new disposal of products allowed a reduction up to 10% on the pickers´ travelled distance. This reduction was due to a decrease in the distance from the vitafilm zone to the first corridor, and from the first to the last corridor. It is a natural consequence of the incorporation of clusters organization that lead to a different disposal of the items within the warehouse. Another reason for the reduction was the inferior number of corridors that were occupied in the disposal of the items. Notwithstanding, this scenario does not encompass products heterogeneity restrictions.

Conclusion and Further Steps

The first results of the study already indicate a good percentage of improvement. However, they do not take into account products heterogeneity restrictions such as different weights and they were achieved with a restricted number of orders. For next steps, we plan to further explore the model considering those factors and test the model in a bigger sample of orders.

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