Logistics / Distribution | Retail | Inventory management / control | Linear / Non-Linear

Planogram Optimization in Support of Small Format Retail Inventory Management

BUSINESS PROBLEM

Planograms (POGs) are designed by Merchandising with a focus on presentation and the in-store guest experience. This results in POGs that may be over/under-sized for the desired levels for replenishment, resulting in incresed inventory levels which impact backroom space and store labor. On the other hand, decreased inventory levels can increase the frequency on stock out events. These challenges are more stated in Small Format stores which offer a limited selection of SKUs in sales environments with restricted shelf space and limited backroom capacity.

APPROACH

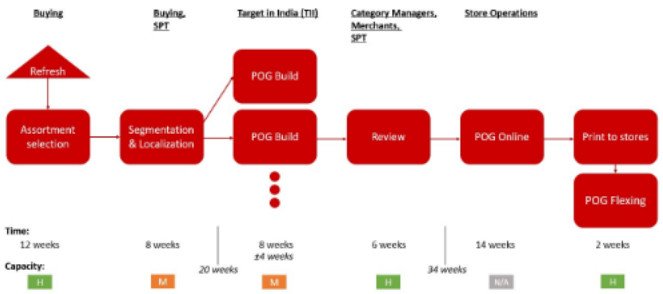
A mixed-integer linear program will be developed to maximize a 'Fit' objective function. This objective function will aim to minimize the risk of backroom inventory (which increases operational cost) while avoiding out of stocks (impacting customer experience). This will be considered through the lens of constraints around a strategic and focused assortment, such as product performance.

DATA SOURCES

Data is sourced from Hadoop by leveraging SQL queries and manipulated as dataframes in Python. Most data is quantitative or categorical, with limited unstructured qualitative data.

Data Types and Format

Data consists of inventory metrics and buying behavior collected a product, store, and date level.



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IMPACT

The optimization model provides the business with a novel way to incorporate Inventory Management considerations in POG design. By quantitatively defining 'Fit' as an objective function, a mathematical target can be minimized programmatically. This reduces the manual burden to optimize POGs and allows more individualized POGs to be built. Furthermore, by characterizing POG design using a value chain map, the points of inflexibility (bottlenecks) in the process become visible. To elucidate these areas of the recurring business process, the company can modify the process in minor ways in order to increase throughput of POG design. The impact of reducing bottlenecks is increased quality in this case (more time to review for errors), having a positive impact on the business. A final lasting impact of this solution is the ability to evaluate future in-store interventions by using Synthetic Control Design (SCD). Introducing the application of a new tool can allow experiments to continue in smaller populations of stores or stores where controls may not be easily accessible.

DRIVERS

In Summer of 2022, when this research began, supply chains had reacted to pent up consumer demand that occurred during Covid. Retailers were experiencing a surplus of inventory, and high inventory levels across the network included increased backroom inventory in stores. These issues were more prominent in Small Format stores due to their unique characteristics, making the research highly visible and important.

BARRIERS

Multiple selection criteria were necessary to align including an upcoming reset date for a POG, stakeholders eager to participate in our experiment, and a 'stable' category which experienced little variability or promotional activities.

ENABLERS

Target experienced many of the same challenges across the retail industry that led to a buildup of inventory. As a result of this dynamic, merchandisers were perhaps more focused on Inventory Management than they would have been previously. As this project offered a solution to inventory issues in stores, team members were willing to provide time and expertise to further this project.

ACTIONS

To implement the solution, it was critical to partner with stakeholders in merchandising, space planning, and at the store level. By meeting with team members and visiting stores, the vision of this work was clear and able to be implemented.

INNOVATION

This solution quantified 'Fit', a concept that is frequently discussed within Target but did not have a common definition. By defining Fit as a weighted average of backroom inventory risk and demand coverage, an innovative mixed-integer linear program could be built. Furthermore, the output of the model was evaluated with a novel statistical method, Synthetic Control Design (SCD).

IMPROVEMENT

The lift in unit sales provided by the intervention was not deemed to be statistically significant due to idiosyncratic noise in the sales data. However, the optimization methodology was incorporated into an existing POG design tool and stakeholders invested in the project are evaluating POG design based on the value chain developed as part of this research.

BEST PRACTICES

The best practice employed here was to select specific categories that exhibited stability (to focus on less variables) and specialize in these areas. This ensured that the optimization model met the dynamics of each business; while a future researcher can select any category, they should know it very well and adapt the model accordingly. For example, in a home category, a researcher may want to account for the compression level of pillows.

OTHER APPLICATIONS

Other potential applications of this solution include any optimization problems which follow the same structure as Knapsack Problems, but have additional constraints. Furthermore, objective functions with multiple weighted considerations could adopt the methodology of this research.