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SUPERMARKET OPTIMIZATION: SIMULATION MODELING AND ANALYSIS OF A GROCERY STORE LAYOUT

Jessica Dorismond

Department of Industrial and Systems Engineering
University at Buffalo, State University of New York
Buffalo, New York 14260, USA

ABSTRACT

The purpose of this research is to utilize optimization and simulation modeling to yield an optimal supermarket layout. This is a study on how to optimize the layout of a supermarket in order to increase its gross profit via the maximization of impulse sales. In most supermarkets many items often get unnoticed because on average customers only walk one-third of the store. Since customers use tangible products as a memory cues, increasing the visibility of certain items will prompt customers to purchase some of them. Recent advances in marketing research reveal that encouraging customers to walk longer paths can often increase spending because they are exposed to more products. Retailers can then increase their sales by using the store layout—i.e., the design of the aisles and the product location—to extend the customers' shopping paths and thus indirectly motivate them to purchase items that are not originally on their shopping list. Designing a store layout that increases impulse sales is however a challenging task. There are several requirements that must be considered for finding a successful design. In addition to increasing the length of the shopping path for the average customer, the layout must ensure that the customers encounter several products that may trigger potential impulse sales, without exceeding the point in which the extra length becomes noticeable and burdensome for the customers. In this study, we use a simulation model aimed to analyze the quality of different potential layouts of a supermarket. The main purpose of the simulation is to efficiently replicate the customer behavior, in order to accurately capture the customers flow in the supermarket. The simulation evaluates the layout by determining the visibility of the impulse items by predicting customer movement across the store. Decision makers can use this simulation as a tool for identifying the optimal location of the different products.

1 SIMULATING CUSTOMER BEHAVIOR

In order to accurately tune the input parameters for our simulation, we used both historical data and our findings from a survey we conducted. In our survey, we recorded the path selection decisions of the customers at a major supermarket chain in Buffalo, New York. Selecting 100 customers at random, each customer completed an entrance survey that asked: (1) Do you have a shopping list today; (2) How familiar are you with the store; (3) what items are on your shopping list. The customers were then free to shop and once they were finished, we checked their receipts to see what they acquired during their shopping trip. A student captured the path of the customers by discreetly observing the customer as they walked through the store. To complement the survey, we looked at historical point of sale (POS) and customer loyalty card data so that we could identify the common "must have" and "impulse" items. The POS data is used to find out the different customer types that enter the store, and to find their arrival rates.

In previous studies, the walking paths of customers in a grocery store has been compared to optimal solutions of the traveling salesman problem (TSP), and have found that in general customers do not take shortest routes. We view customers as individuals with bounded rationality that build shopping paths by looking forward one-step (purchase) at a time. Since, assuming that customers have the cognitive ability to solve the TSP is not realistic behavioral assumption; we use a mathematical model that mimics the one-step at a time approach to determine what a customer's path should be. To fine tune the parameters and validate accuracy of our model, we used a similarity method that compares the real customer paths collected from the surveyed data with the paths generated by the model.

The simulation is summarized by the flowchart shown in Figure 1. To start, a customer enters the grocery store and is represented by the creation of the customer entity. The customer is given a shopping list and assigned a customer type. Using our algorithm, the simulation decides which zone the customer will visit to begin retrieving items from the list. Once that item is obtained, our simulation checks the list to see if all items are completed. If it isn't completed, the process loops to determine which item to get next. Once the customer has completed shopping, the customer leaves the system.

This simulation demonstrates an approach that can be used to find different supermarket layouts in Arena. The motivation of our work was to develop a way to evaluate a layout of a supermarket, by analyzing the different customer flows associated with that layout change. The performance measure was to see how many times customers passed by impulse items, and we changed the layout to evaluate alternative store layouts until the best scenario was found.

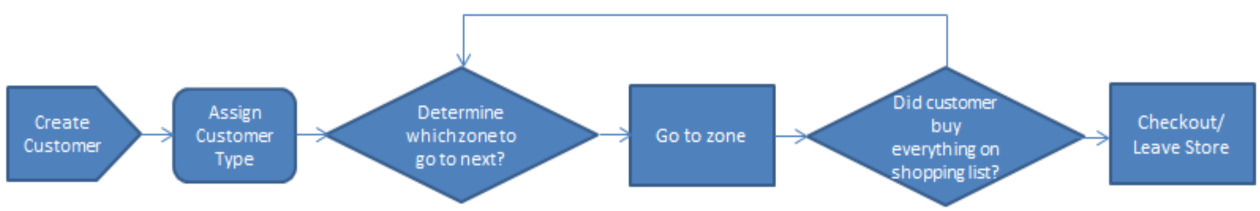

Figure 1: Simulation flowchart.

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