



# Consumption universes based supermarket layout through association rule mining and multidimensional scaling

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## ABSTRACT

The success of retail business is influenced by its fast response and its ability in understanding consumers' behaviors. Analysis of transaction data is the key for taking advantage of these new opportunities, which enables supermarkets to understand and predict customer behavior, has become a crucial technique for effective decision-making and strategy formation. We propose a methodological framework for the use of the knowledge discovery process and its visualization to improve store layout. This study examines the layout strategy in relation to supermarket retail stores and assists managers in developing better layout for supermarkets. We use the buying association measure to create a category correlation matrix and we apply the multidimensional scale technique to display the set of products in the store space. This is a new approach to supermarket layout from industrial categories to consumption universes that is consumer-oriented store layout approach through a data mining approach. This framework is useful for both academia and retail industry. For industry professionals, it may be used to guide development of successful layout. Retailers can utilize the proposed model to dynamically improve their in-store conversion rate. As the empirical study, a practical application proceeded for Migros Turk, a leading Turkish retailing company.

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## 1. Introduction

The store layout is the foremost concern of almost every supermarket retailer. Lewison (1994) states selling floor layouts are extremely important because they strongly influence shopping atmosphere, shopping behavior, and operational efficiency. Grewal and Baker (1994) note that store layout affects consumers' price acceptability, which is positively related to purchase intentions. The more well presented merchandise customers are exposed to, the more they tend to buy. By careful planning of the store layout, retailers can encourage customers to flow through more shopping areas, and see a wider variety of merchandise (Levy & Weitz, 2001). The layout of a supermarket has been found to significantly impact a retailer's overall performance (Underhill, 2000). Layouts are not only concerned with improved utilization of buildings and land but are very much concerned with increasing sales. Store layout is factor that contributes to the uniqueness of a store, because it helps attract customers' attention. So, the effects of retail store layouts are too big to overlook. The results of a survey conducted by Punjaisri and Wilson (2007) proved that layout has a big influence on customers and that the customers want stores to spend whatever it takes to create a layout that minimizes wasted steps and motion in the shopping process. In addition it was stated that

the shoppers attach more influence to the floor of a store than to its ceiling (Gajanayake, Gajanayake, & Surangi, 2011).

Layout decisions entail determining the placement of departments and product categories within a supermarket. The usual retail stores originally displayed their product categories in an industrial department approach, which have produced the store layouts based on fruits, vegetables, magazines, cds, and so on. Despite improvements, the store remains organized in product categories as defined by the manufacturers or category buyers. This approach is company oriented and it fails to respond to the needs of the time-pressured consumer. In the retail environment, layout must be consumer focused and displays should attract the attention of the purchasing public. Some retailers are trying to move from this organization to something new, and are struggling to become consumer oriented in their layout approach (Borges, 2003). The store sections should be re-designed with consumer desires. Most retailers nowadays face challenges such as how to respond consumer's ever-changing demands and how to adapt themselves to keen competition in dynamic market. Retailers can try to satisfy the diverse customers' demands and to affect customers' purchasing decisions by using the novel approach for product assortment and allocation. We must revamp our thinking about the design and layout of supermarkets and incorporate considerable changes in order to emphasize the products being sold. Retailers need to discover and predict customer behavior to survive and excel in

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the new competitive landscape. According to FMI (2000) 94% of American grocery shoppers seem to consider that a store layout that makes shopping easier as important when choosing their supermarket. Time conscious and empowered consumers will be more attracted by supermarket chains who adopt one stop shopping store layouts. One possibility to do so is to make the store layout construction through the introduction of the market basket analysis which is the analysis of transactions or the items purchased by a customer, improving one stop shopping experience. The goal of market basket analysis is to determine which products are purchased together by a customer, that is, which products a customer puts into his/her shopping cart or market basket. So, market basket analysis helps retailer better design store layout by combining and displaying all products that are likely to be purchased together. Current commercial applications emphasize using information about the household's basket of purchases and affinity analysis, the design of store layout according to the coincidence of pairs of items in a market basket. Both types of applications are based upon the belief that sales in different product categories in the market basket are correlated (Russell, 2000). The patterns in these correlations are then used to make marketing strategy recommendations.

Placing related departments or product categories close to each other have substantial impact on the retailer's profitability. Empirical studies (Jeffrey, Bradlow, & Fader, 2005), stochastic models (Farley & Ring, 1966) and agent-based modeling applications (Batty, 2003) support this fact. Placing of certain categories in proximity/away from each other can lead to increase/decrease in sale. As the famous beer and diapers example reveals, not considering the effects of side-by-side displays of items commonly purchased together may cause a retailer to miss out on tremendous revenue potential. The visual effect of adjacency can stimulate impulse purchases that account for 70% of buying decisions in a supermarket (Armata, 1996). The beer and diapers example has suggested the potential of utilizing spatial relationships. In another related example (Lee & Whang, 2001). Seven-Eleven Japan has a policy of adjusting its store layout and product placement multiple times every day to reflect the changing purchase patterns at different hours of the day, so that customers can easily find their favorite items. Thus, the success of any retailer depends on its ability to match its changing environment by continually deciding between how much of which products to shelve where and when. In the dynamic retail market, understanding changes in customer behavior can help managers to establish effective store layouts (Song, Kim, & Kim, 2001). To face the keen competition in retail market, retailers need to accurately and quickly respond the dynamic customers' requirements (Bonanno & Lopez, 2009).

This paper proposes a novel supermarket layout based on the association among categories. Competitive advantage will be gained by those retailers who are able to extract the knowledge hidden in the data, generated by those systems, and use it to improve their store layout decision making. In this context, knowledge about how customers are using the retail store is of critical importance and distinctive competencies will be built by those retailers who best succeed in extracting actionable knowledge from these data. The paper explore the potential usefulness of Association Rule Mining and Multidimensional Scaling in the retailing in the area of retail store layout and an application of data driven decision support is presented.

The remainder of the paper is organized as follows. Section 2 provides the preliminaries of basic concepts to facilitate the discussion, gives brief descriptions of possible layout strategies and reviews related research. The proposed methodology and an illustrative example are given in Section 3 and 4, respectively. Results and Discussion are given in Section 5. Finally, Section 6 concludes the paper.

## 2. Background

### 2.1. The store layout in supermarket retailing

The layout of a retail store is a key element in its success. Store layout is an important retailing decision that can help or hurt sales and store profitability. Most retailers know that their retail store layout has great impact on their business. And because of this they contemplate changes to increase their store layout, and increase their sales. The more well presented merchandise customers are exposed to, the more they tend to buy. By careful planning of the store layout, retailers can encourage customers to flow through more shopping areas, and see a wider variety of merchandise. Farley and Ring (1966) suggested that shoppers might be influenced to buy by the layout itself and that a good store layout forces each customer to travel past as many displays as possible. So, the effects of retail store layouts are too big to overlook. Layouts of retail have always been of interest and in many cases part of the remit of decision maker. Borges (2003) in his study mentioned that the store layout is a huge task for retail managers. The complexity of this task lies in the relationship between categories on sale as well as on the impact that it produces on the consumer spatial behaviour and in-store traffic. Layouts are not only concerned with improved utilization of buildings and land but are very much concerned with increasing sales. In the retail environment, layouts must be customer focused and displays should attract the attention of the purchasing public.

### 2.2. Retail store layout approaches

In the retail world, there are at least two layout approaches – the traditional retail store layout approach and the consumption universes retail store layout approach.

#### 2.2.1. Traditional retail store layout approach

Retail stores are originally organized as departments, which mean putting products that share some functional characteristics or origins in the same area. In other word, the usual store layout in the supermarkets based on the industrial logic implementation (Peterson, 1970). It is also called industrial department approach. So we will find product categories such as the bakery area (with bread, cakes, biscuits, and so on), the vegetable area (with carrots, beans, and so on). Despite improvements, the store layout remains organized in product categories as defined by the manufacturers or category suppliers. This approach is company oriented and it fails to respond to the needs of the time pressured consumer. The supermarket has not changed much since its conception in the 1970s. In the course of time some little improvements have been made in that highly sensitive area. As a matter of fact, some categories have been placed side by side in their a priori cognitively logical pairs. This traditional approach has been improved by the use of cross-elasticities, which should measure use association (Walters, 1991). To find the logical complementary categories, the econometricians have developed cross-elasticity, which measures the sales change of one category from a price change in another. It claims to capture the use association among categories, because the products would be used together. Regardless of the importance of use association, the main goal of the supermarket is to provide one stop shopping. Shoppers will buy both products with strong and weak use associations on the same store visit.

#### 2.2.2. Consumption universes approach for store layout

The new approach allows supermarkets to cluster products around meaningful purchase opportunities related to the buying association. Instead of finding coffee in the beverage section,

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