PRODUCT PORTFOLIO CONFIGURATION IN SUPERMARKETS: A CASE STUDY IN TURKEY

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PRODUCT PORTFOLIO CONFIGURATION IN SUPERMARKETS: A CASE STUDY IN TURKEY

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ABSTRACT

CHANGING SHOPPING HABITS IN SUPERMARKET DURING COVID-19

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Keywords: Product portfolio, supermarket products, market basket analysis, agglomerative clustering, transaction analysis, association rule mining

Nowadays, the selection of products for a specific portfolio has become a crucial topic in stores with the enormous proliferation of supermarkets. Today, many different stores are present in the same neighborhoods and the environment has become highly competitive in terms of customer traction, obtaining loyal customers, and maintaining customer satisfaction. Supermarkets offer a broad array of products, and customer expectations are endless in terms of demanding different products. Stores have limited space in which to offer products on their shelves, but, limitless product options can be offered to customers. On this point, it is important to optimize the product portfolio to make the maximum money by using the minimum space. However, market managers are usually/often confused about determining their product portfolio because demand dynamic and accuracy in selecting the best product is problematic. Also, it is not possible to select/determine a single certain product portfolio for each supermarket in different locations because demand varies in each different location due to their differing customers, and thus, customer profile. This study approaches the issue for some specific stores and provides a solution method on determining product portfolio by using clustering method with respect to sales performance of products in portfolio, and combining these results with association rule mining. The proposed method is constructed on the data from real stores in Turkey. The findings are presented as evaluation of products in the portfolio and monthly portfolio recommendations are proposed in monthly basis. The created model can be preserved and the portfolio can be updated every year to keep pace with the changing demand of customers.

ÖZET

SÜPERMARKETLERDE ÜRÜN PORTFÖYÜ DÜZENLEMESİ: TÜRKIYE'DE BIR VAKA ÇALIŞMASI

AHMET KÖSE

İŞ ANALİTİĞİ YÜKSEK LİSANS TEZİ, MAYIS 2022

Tez Danışmanı: Prof. Dr. FÜSUN ÜLENGİN

Anahtar Kelimeler: Süpermarket ürünleri, ürün portföyü, market basket analizi, aglomeratif kümeleme, alışveriş analizi, birliktelik kural çıkarımı

Günümüzde süpermarketlerin önemli ölçüde yaygınlaşması ile birlikte mağazalarda ürün portföyü belirlenmesi çok önemli bir konu haline gelmiştir. Artık tek bir mahallede bile birçok farklı süpermarket bulunmaktadır. Doğal olarak market müşteri çekme, sadık müşteriler edinme ve müşteri memnuniyetini sağlama açısından oldukça rekabetçi bir hale gelmiş bulunmaktadır. Süpermarketler müşterilerine çok geniş bir ürün yelpazesi sunar. Buna karşılık müşteri beklentileri farklı ürünler talep etme noktasında sınırsızdır. Süpermarketlerin sunabileceği ürün yelpazesi sınırsızken, mağazalardaki reyon alanları sınırlı kalmaktadır. Bu noktada minimum alan kullanarak maksimum gelir elde etmek için ürün portföyünü optimize etmek çok önemlidir. Ancak, değişen talebi karşılamak ve doğru ürünü rafa yerleştirmek zor olduğu için mağaza yöneticileri sıklıkla ürün portföylerini belirleme noktasında sıkıntılar yaşar. Ek olarak, farklı lokasyonlardaki her süpermarket için sabit ürün portföyü hazırlamak mümkün değildir. Çünkü her lokasyonda talep farklı müşteriler ve buna bağlı olarak değişen müşteri profili nedeniyle değişkenlik göstermektedir. Bu çalışma, belirli mağazalar için bu konuyu ele almaktadır. Ürünlerin satış performansına göre kümelenmesi ve bulguların birliktelik analizi ile değerlendirilmesi ile ürün portföyünün nasıl belirleneceği konusunda bir çözüm yöntemi sunmaktadır. Önerilen yöntem Türkiye'deki gerçek mağazalardan alınan veriye uygulanmıştır. Elde edilen bulgular portföydeki ürünlerin değerlendirilmesi ve aylık portföy önerileri olarak sunulmuştur. Oluşturulan model değişen taleplerine ayak uydurabilmek için her yıl güncellenebilir ve elde edilen sonuçlarla ürün portföyü yeniden belirlenebilir.

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BCPNN Bayesian Bayesian Confidence Propagation Neural Network 8

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MCMC Monte Carlo Markov Chain 6

1. INTRODUCTION

Supermarkets are stores that offer a wide range of products. These stores mostly operate as parts/outlets of a chain of a company and satisfy people's daily basic shopping needs. These stores are widespread, but what they offer for each separate store may differ. Thus, the determination of the product portfolio is a key concept for supermarkets. They offer an enormously different range of products including groceries, vegetables, fruits, cosmetics, beef, dairy products, household cleaners, snacks, and drinks. Decision-making about what to offer for common products is easy. However, for less demanded products, since there are limitless options, decision-making is not easy about what to offer, or even about whether offer a product or not. The selection of wrong, less demanded, or costly inefficient products damage profit optimization while an optimized portfolio enables to operate with limited resources (Hallinger & Fager, 2016). For this reason, optimizing the product portfolio is crucial for stores. The limited space of supermarkets restrains them from offering everything, further highlighting the importance of this optimization.

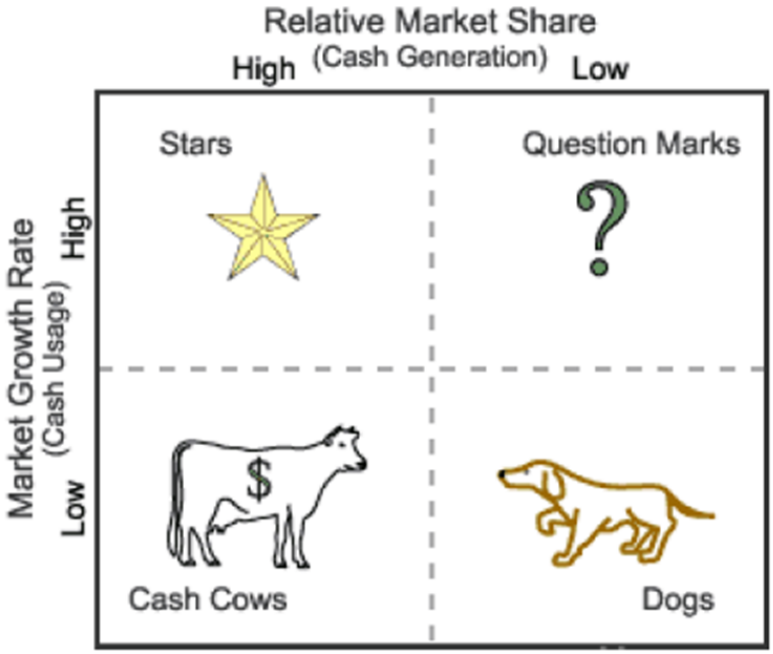
Previous studies exhibit how optimizing the product portfolio benefits the company in terms of profitability, the number of customers, sales numbers, etc. Opportunities in terms of profitability and sales performance can be missed due to problems in product portfolio management and it damages the business (Tolonen, Kropsu-Vehkaperä & Haapasalo, 2014). On the flip side, experimental studies show that around 25% of the products in retailers can be removed with limited negative influence on the market in terms of customer attitude (Broniarczyk, Hoyer & McAlister, 1998). Kumar (2007) also determined that 29% of the products evaluated by using scanner data of a retailer the store will not lose almost any customers if they eliminate these products and even there may be an increase in the total profit if these cost-inefficient products are eliminated.

To clarify our major interest requires an understanding of dynamics in terms of how the market works. A common belief as a rule of thumb is that a general principle exists in markets like the Pareto principle, also known as the 80/20 rule and observed by Italian economist Vilfredo Pareto. The Pareto principle claims that

80% of consequences result from 20% of their causes (Erridge, 2006). Similarly, a vast majority of turnover is provided by some specific minority of products; the rest of the products are attempts to increase company profit. ABC analysis is generated based on this idea. A, B, and C each indicate a different group of items. A includes 10% of items roughly generating 65% of turnover; B includes 20% of items roughly generating 25% of turnover; and C includes 70% of items roughly generating 15% of total turnover (Basson, Kilbourn & Walters, 2019). The ABC approach can be used for different purposes in inventory management like demand forecasting, if necessary, but specifically, the idea behind this approach is more important to comprehend this study in terms of how financial contributions are distributed among products.

On the other hand, in business life, most of the companies around the world use a crucial and prevalent matrix called the Boston Matrix which is first proposed by Boston Consulting Group as the name suggests (Dolnicar et al., 2018). The Boston Matrix is used to determine the strategic planning of a company based on choosing accurate places to invest, discontinue with specific products or develop managerial decisions. It uses the market share and market growth information and divides the graph into four parts: 1) items with high market share and high market growth, 2) items with high market share and low market growth, 3) items with low market share and high market growth, 4) items with low market share and low market growth. These four areas are named “Stars”, “Cash Cows”, “Question Marks”, and “Dogs”, respectively. A representative graph can be seen below:

Figure 1.1 Boston Matrix (Mohajan, 2018)



The general assumption is, naturally, that the Stars are the best products to invest in. The Cash Cows are important since they occupy a great financial place in the financial portfolio, and they are major items to continue cash flow. However, they mostly do not need any development and a long-term business strategy based on them, rather the question marks should be the items that are considered in that perspective. These are items with respectively low market share but provided significant growth over time and make future developments possible with the correct strategy. Finally, the Dogs are doubtful items that should be examined based on their contribution to the market in terms of pros and cons, and positive and negative effects (Mohajan, 2018).

These Pareto Principle and Boston Matrix are inspirations and head starts for the intellectual perspective of this study. A similar approach has been followed in this work. A scatter plot has been created for products based on sales amounts and inflation-adjusted growth rate to visualize the general sales performance of products and to determine items with low/high market share and low/high growth rate in the overall portfolio. Further, a clustering method has been applied to products concerning their features. This segmentation leads to assessing the product performance and it is the focus of a phase of this work. The objective is to group products to make more reasonable decisions on choosing accurate products to eliminate from the portfolio or keep them.

The procedure to find out the optimal configuration of products to be present in the store is still complicated. An obvious reason for this situation is that every store and every customer profile in different locations has its own characteristics. Therefore, product portfolio issues such as efficient maintenance and removal of products can be handled by using data models (Tolonen et al., 2014). Studies in the literature introduce a variety of methodologies and track different paths. For example, Kumar (2007) mainly focused on the cost-efficiency of products, demographic properties, as well as the preferences of customers in the market that he focused on by using loyalty cards. Some studies indicated Bayesian probability by utilizing Monte Carlo Markov Chain to extract meaningful association structures (Kim, 2013; Madigan & York, 1995). The data expansion gains acceleration with the digitalization of the world, and data mining has become one of the most important inputs in product portfolio management (Hannila, Kuula, Harkonen & Haapasalo, 2022). Market basket analysis (MBA), which is also called association rule mining, is a data mining tool that is used in extracting related products in the data (Aguinis, Forcum & Joo, 2013). In the field of marketing, market basket analysis is extensively used because it reflects customer behavior in terms of showing which items are preferred to be bought together by consumers (Kurniawan, Umayah, Hammad, Nugroho &

Hariadi, 2017). It generally helps marketing experts with promotion strategies and sales actions.

However, it is not possible to determine all possible products to offer by simply relying on models in the literature, mainly because every supermarket is in a different location, each of which has its buyers from different customer segments. Thus, all stores offering a portfolio of their specific products based on the needs of their specific customer profiles is desirable, but/yet the literature does not provide a single clear solution model that can be applied to all stores in order to solve this product portfolio configuration problem. Determining an optimal solution model to the product portfolio issue in selected supermarkets is the aim of this research but making the model applicable to all stores while creating the model is also the main goal of this research. Three mains questions were investigated by this study:

- Which products are preferable to others?

- Which products must stay in the portfolio?

- Which items should be removed from the store?

This is a case study in Turkey that aims to provide a solution by combining the product segmentation based on the sales performance and outcomes of market basket analysis to make portfolio recommendations to the company. The study provides an analytical solution to make reasonable wise product portfolio decisions and a repeatable solution model over the years.

In the second section, a literature review for market basket analysis is conducted. The third section provides the proposed methodology. The fourth section provides the application of the methodology in one of the biggest supermarket chains in Turkey and summarizes the findings. The fifth section provides conclusions and further suggestions.

2. LITERATURE REVIEW

Determination of association rules, which is also called market basket analysis, is a common topic for experts both in computer science and marketing departments. The main objective is to reveal relationships between existing items in the data. This method is extensively used for marketing purposes using statistical parameters generated by data mining algorithms. Besides, it is used in other fields such as immunology, nuclear science, and bioinformatics recently, although the idea origin is the field of marketing (Aguinis et al., 2013). The analysis has been studied for healthcare purposes, in order to reveal diseases occur together (Rao, Kiran & G, 2021). Market basket analysis also provides insights into other managerial decisions in several departments like human resource management, strategic management, and organizational behavior (Aguinis et al., 2013). An empirical application of market basket analysis is applied to a Japanese-style restaurant in order to find out ideal menu item assortments (Ting, Pan & Chou, 2010). They analyzed 3727 transactions for meal combinations and resulted in association rules. This study is conducted in Microsoft Excel by using a pivot table and was able to provide outcomes to understand customer preferences. Since they have less number of transactions and a limited number of products (24 entrees and 49 side dishes), the data enabled the researcher to perform the analysis in Microsoft Excel. However, when the data gets larger statistical calculations and the technical requirements for algorithms to process gain momentum by increasing exponentially. It gets impossible to handle the data and implement the algorithms by using Microsoft Excel since its technical capacity is limited. Kaur & Kang (2016) used market basket analysis to identify changing trends in the market using association rule mining. They used Apriori and claimed that it is the biggest improvement from other algorithms mentioned in the paper and easy to implement. Although the Apriori algorithm made them enable to perform a market basket analysis, the choice of parameter threshold values is still problematic. These are changing in different studies, data, or fields, and manually identified by authors. As stated by Kaur & Kang (2016), there is no automation for these variable choices and threshold values are a topic to focus on, which limits their work. Basket analysis is also a powerful tool to obtain knowledge about the

shopping behavior of customers and learn customer preferences (Griva, Bardaki, Pramatari & Papakiriakopoulos, 2018). Their study considers relationships between items a customer purchases during a visit. Rather than understanding the overall market trend, this study focuses on each single customer visit. They aimed to understand the shopping need of segment-specific customers per visit rather than focusing on entire sales. That is why the outcomes of this study are more tended to help marketing teams in terms of proceeding with accurate advertising campaigns, promotions, and targeting well-directed customer segments in their activities.

Sales of a store can be improved by using obtained association both directly and indirectly by promoting the associated product. Giudici & Passerone (2002) used Markov Chain Monte Carlo (MCMC) methods to find out these associated items in the data. The MCMC models essentially constitute the mathematical probabilistic approaches that are used in the association rules parameters. In recent studies, association rules mining by using computational algorithms is commonly preferred since it is a much more effective and efficient tool. It is essentially the same as the MCMC method in terms of theoretical background and mathematical computations because both the MCMC and the association rules parameters are based on the Bayesian probability theorem. The authors stated that MCMC performed well and the results of this study help to organize the layout of the supermarket and make promotion decisions by looking at associated products. Kim (2013) also followed a similar approach by using Markov Chain Monte Carlo methods. He created a probabilistic Bayesian model to deal with the market basket problem. His study also emphasizes considering seasonal issues and several factors while finding association rules. He introduced a promotion variable and included seasonal indicator variables and consumer demographics variables to see the effects of these changes on the association structures. The main concentration of his study was to see these effects on the data. Therefore, the study was not able to come up with an overall portfolio solution model. Nevertheless, as mentioned by Kim as well in his paper, this study is a clear illustration for managers to understand how cross-category products are associated in a store.

Apriori and FP-Growth are the most common algorithms developed for market basket purposes (Sağın & Ayvaz, 2018). These algorithms find the frequent itemsets by extracting association rules which is valuable information hidden in the data. Sağın & Ayvaz (2018) studied data mining by using Apriori and FP-Growth algorithms and identified product groups that tended to be sold together. They claimed 40% confidence and 0.5% support thresholds as the best rules founded in their specific case. They also considered the lift values of these associations and presented the outcomes of the study in a table. However, this study did not consider the seasonal effects and

left this topic as a future study. FP-Growth algorithm was implemented in the study of Ünvan (2020) who studied supermarket sales data received from the Vancouver Island University website for market basket analysis by using association rules. He limited the study to the best 10 rules and presented these top 10 associated products as a result of his study. While doing this, different correlation measures are tried on the data. His final statements were about product assortment and underlined that these related products are sold together, that is why these should be exhibited closer to each other to attract the customer. Kurniawan et al. (2017) analyzed the supermarket transaction data to identify customer behavior. They confirmed that Apriori is a well-performed algorithm and presented thirty associations generated by the mining process using Apriori. Seasonal effects were not considered in the paper. Sinha (2021) conducted a similar study that enlightens shopping patterns during the lockdown. The study also extracted association rules by considering the operational KPIs of products. A fluctuation graph for support, confidence, and lift values of the top thirty rules was also presented. However, the seasonality effect was not discussed and the results were not interpreted appropriately. FP-Growth algorithm can be used for the same purpose as well. Isa, Kamaruzzaman, Ramlan, Mohamed & Puteh (2018) preferred to compare outcomes of three different correlation measure thresholds on a café's transaction data. They obtained associated menu orders but only five months of data were used and only the top five rules were illustrated. Both Apriori and FP-Growth can be applied to the same data (Mustakim, Herianda, Ilham, GS, Laumal, Kurniasih, Iskandar, Manulangga, Ary Indra Iswara & Rahim, 2018). They acquired two candidate itemsets. The claim in the study was that FP-Growth is preferable to Apriori because it costs less computationally since it fills less memory, and consumes less time. Even so, the FP-Growth algorithm does not perform well in larger datasets and As can be seen, the Apriori method is preferable in many cases. Venkatachari (2016) focused on a much more specific case from a broader perspective. The study examines Indian customers of a mall in Spain. Even though it is a nice topic to investigate and presents associated products preferred by Indian customers in the mall; the outcomes show patterns about its specific case and do not enable us to see a general perspective of consumer behavior around the world. Guiding companies in marketing and promotional strategies are a possible outcome of association rules mining (Ansari, 2019). Ansari examined transactions, emphasized the importance of the time factor, and illustrated associated products while showing a comparison line graph for support, confidence, and lift values. However, only three months of data were used and transactions with more than eight items were included in the analysis.

Another important issue while applying market basket analysis is the choice and

implementation of correlation parameters. It is hard to determine effective and efficient parameters because different correlation measures provide different results (Duan, 2012). Duan's study provides a nice representation for the comparison of correlation parameters. The study claims each correlation measure has positive and negative effects on the model, and which ones to use depends on the situation handled. It examines correlation measures of market basket analysis such as support, confidence, lift, leverage, and BCPNN. Duan (2012) preferred to illustrate the advantages and disadvantages of correlation measures in different industries and on different datasets, and leave the choice to the reader rather than ended up with a final result. A brief summary table for studies in the literature is presented below.

Table 2.1 Literature Review Summary

Article	Industry	Scope of data	Items	Objective	Restrictions	Method	Findings	Limitations
Ting, Pan, Chou (2010)	Food Service Management	Transactions of a restaurant in Taiwan	Entrees and side dishes	Finding ideal menu items assortment	-	Support and Confidence	*Findings were not presented *The study discovers a piece of knowledge for employees to make menu recommendations by sharing related products	*Unable to be applied on large amount of data *Focuses on a local restaurant in Taiwan
Kaur, Kang (2016)	Computer Science	Extended bakery datasets	Bakery	Observing customer behavior	-	Apriori	*Presented patterns *Tracked changes *Outliers determined	*Greatly influenced by manual thresholds
Sağın, Ayvaz (2018)	Operations Research	Transactions of a hardware company	Hardware items	Understanding shopping trends	Rearranged products to 13 basics and 93 sub-categories	Apriori and FP-Growth	*Antecedents are consequents of MBA *Illustrated on a graph with their confidence and lift indicated revenue contribution of MBA	*Seasonal factors were ignored
Giudici, Passerone (2002)	Computational Statistics	Transactional data of a supermarket Piemonte provided by AC Nielsen Italy	Supermarket products	Investigating consumer behavior	Strict odds ratio threshold for edges used in graph to reduce complexity	MCMC Bayesian Model	*Interrelated products are illustrated as a graph with links between products *Associations can be used in organizing supermarket layout and promotion activities	*Did not use train and test split on the data. *The effects of this issue change depend on the size of the data. *If the data is not big enough, misleading results might be derived
Kim (2013)	Mathematics and Economics	Sales data of six grocery stores in Chicago	Supermarket products	Explore association structures	Product categories determined with minimum edge probability Seasonal indicator added	MCMC Bayesian Model	*Linked products are visualized *Enabled retailers direct their promotion effort *Managerial implications were explained by the author in detail.	*Outcomes cannot be generalized; results are specific to this study due to the structure of the data used
Ünvan (2021)	Statistics	Sales data from the website of Vancouver Island University	Supermarket products	Product placement	-	FP-Growth	*The top ten rules were exhibited, and these relevant products are recommended to be placed closer to each other	*Seasonal effects were not handled and only the top ten rules determined
Kurniawan, Umayah, Hammad, Nugroho, Hariadi (2017)	Data Science	About 890,000 transactions from the supermarket of UIN Malang Busines Center	Supermarket products	To identify customer behaviors	Two itemset used in basket size Minimum two items in a single transaction	Apriori	*Apriori performed well *Thirty rules were generated with minimum support and confidence levels	*Seasonality was not handled
Ansari (2019)	Statistics and Information Management	78,839 transactions of 42,468 customers from a supermarket chain in Belgium	Supermarket products	To guide the company in marketing and promotional strategies	Transactions include the purchase of at least eight products were included	Association rule mining	*The importance of the time factor emphasized *Visualized association rules in three months period and fluctuations of confidence, support, and lift were represented in comparison on a line graph	*Only three months of data were used *Only transactions with more than 8 items were considered
Isa, Kamaruzzaman, Ramlan,Mohamed, Puteh (2018)	Data Mining	Cafe at Jasin,Melaka	38 different types of food and drink	Analyzing buying patterns of customers	-	Frequent itemset mining FP-Growth	*The results were shown for three experiments with different support and confidence thresholds to see the associated menu ordered by the customer.	*Only five months of data were used *Only the top five rules were chosen
Sinha (2021)	Information Technology	7501 exchange records of a market from Kaggle	Supermarket products	To examine shopping patterns during lockdown	-	Apriori	*Rules were extracted and Confidence,support, and lift fluctuations of the top 30 rules were drawn on a line graph *Tracked operational KPIs like sales & cost	*Seasonality is missed *Results were not interpreted properly
Venkatachari (2016)	Management Research	Sales record of Indian customers from a Mall in Spain	Products of stores in a mall	To see associated products in a mall	-	Association rules	*Discovered association rules Support, confidence, and lift values of determined rules were shown on a table	*Straightly directed to a minority, *The data reflects Indian customers who shop from Spanish retailers
Mustakim et al. (2018)	Research Data Technology and Information Systems	Sales of a retail company in Indonesia, Berkah Mart	Products of a retailer minimarket	To analyze customer spending patterns	2 candidate itemset	Apriori and FP-Growth	*Related products determined and FP-Growth is claimed as superior to Apriori	*FP-Growth was preferred but it performs less when the data gets larger and more complex
Köse (2022)	Business Analytics	Two years of transaction data in Besiktas from one of the largest supermarket chains in Turkey	Supermarket products	Product Portfolio Optimization	Two items basket size Low volume products eliminated to ensure data quality	Apriori	*Associated products exhibited with their statistical features *Provided portfolio recommendations	Created differences: *Market basket analysis considers the seasonality issue *Portfolio recommendations are based on sales and inflation-adjusted growth rates of products while considering outcomes of MBA that indicate associated products

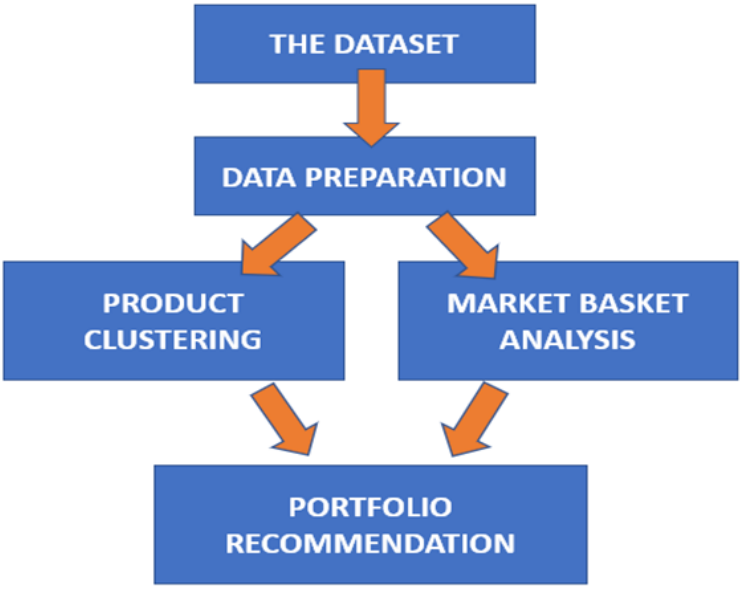
In the light of all this research in the literature, this study aims to provide the best solution to the product portfolio in the supermarket stores. For this purpose, market basket analysis are used, seasonality issue is considered and the results are evaluated

based on optimal correlation parameters. This research also pays attention to the market share and growth rate of the products as well as the inflation effect on these product groups, and provides a clustering approach to these product groups by using their related properties. The proposed methodology that integrates of the cluster and market basket analysis approaches is summarized in the next section.

3. THE PROPOSED METHODOLOGY

The main objective of this research is to carry out an analytical systematic approach on supermarket product portfolio decisions. A flow chart of the path this study follows in line with this purpose is illustrated below:

Figure 3.1 Flow Chart of Methodology



3.1 The Methods Used

As can be seen in the flowchart, this study combines the outcomes of two different paths to find out optimal product portfolio items. The first phase focuses on the performance of the products in the portfolio. The performance matrix is illustrated by visualizing it on a graph. The factor while measuring the performance of the products are sales amount and inflation-adjusted growth rate information over a

year. This phase leads us to have information about the general financial distribution of items in the portfolio. Then, an analytical clustering approach is followed to group products and label them. In that way, the items will be categorized based on their relative performances. This process catalyzes to define items as groups rather than dealing with each one by one and adopting a course of action about them. The second part operates market basket analysis to retrieve information by finding associated products. In that way, it is seen which items lead to the purchase of others, which are called antecedents and consequents. This process is implemented on monthly basis to save the model from seasonal effects and provide common monthly portfolio recommendations for the future. Final statements are based on combined information from these tracked ways.

3.1.1 Cluster Analysis

Cluster Analysis is an unsupervised machine learning technique that helps the grouping of the items in the dataset. This approach provides a list of grouped items with similar features in the data (Gan & Ng, 2017). In this study, the product segments help to understand products from a general perspective by looking at their belonged group and similar products. In that way, the portfolio decisions about the products will be more reasonable and wiser. Hierarchical and partitional clustering techniques are two different approaches that are used in machine learning. Partitional clustering divides the dataset into the given number of clusters. At first, random data points, which are called centroids, are determined for the specified number of clusters. Then, each item in the data is assigned to a data point with the minimum distance principle. Then, new centroids are generated for the central point of each cluster. Again, all data points are assigned to their new closest centroids and the clusters will be shaped again. This is an iterative process and goes on until the best subsets occur with minimum error. The error score is calculated based on the total distance of all data points to their belonged cluster centroids (Syakur, Khotimah, Rohman & Dwi Satoto, 2018). On the other hand, hierarchical clustering adopts a cluster tree approach. The tree built by hierarchical clustering is also known as a dendrogram and it shows the linkages between items. There are two types of hierarchical clustering: divisive and agglomerative. A divisive method is a top-down approach which means it moves on by splitting data into clusters. On the contrary, agglomerative is a bottom-up approach and it is preferred in this study. This approach starts with assigning a cluster to each data point. Then, the two most similar clusters will be merged. Again, this process goes on until one single cluster

remains which includes all the items in the dataset. This tree approach helps to decide on the number of clusters by visualizing the possible item groups in the data (Omran, Engelbrecht & Salman, 2007). K-means and agglomerative clustering are frequently used clustering methods to identify segments in the data (Xu & Wunsch, 2015). These two different approaches k-means and agglomerative clustering have been implemented on the data with several parameters such as market share, LN market share, inflation-adjusted growth rate, scaled values of market share and inflation-adjusted growth rate. Different clustering methods with different features provide different solutions. In this study, the optimal clusters were found in agglomerative clustering with the features scaled market share and scaled inflation-adjusted growth rate. That is why, the clustering result obtained by agglomerative clustering adopted and it was presented in this paper.

Figure 3.2 Simplified K-means Visualization (Dolnicar et al., 2018)

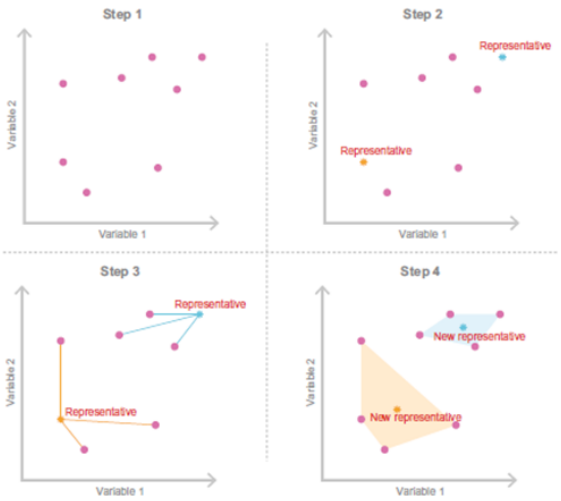
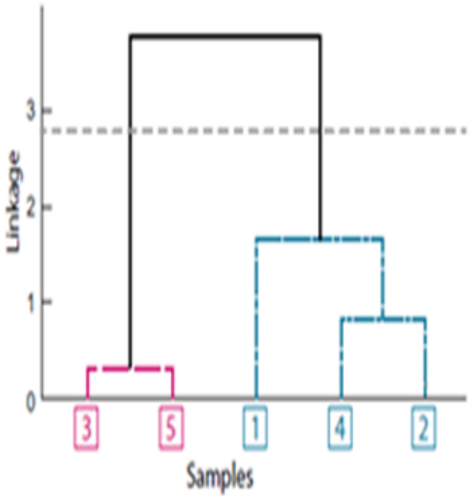


Figure 3.3 A Simple Dendogram (Kimes et al., 2017)



3.1.2 Market Basket Analysis

There is limited space on market shelves to exhibit products, hence, it is significant to choose the exact product to offer. After all, the new product will take the place of an old product. That's why the choice of added product should be wisely. At this point, examination of transaction data and use of data mining techniques such as market basket analysis is the model offered by this work. Market basket analysis is a commonly used algorithm also called association rule mining. It aims to reveal associations between items on the dataset (Aguinis et al., 2013). Based on transaction

data, the aim is to find out associations between products and frequent shopping patterns of customers such as which products can be claimed as bought together based on support and confidence levels that are extracted from the data. Apriori algorithm is one of the most used algorithms in market basket analysis (Verma & Singh, 2017). Apriori algorithm finds the frequent itemsets by learning association rules of the relevant database. This algorithm starts with singular frequent items and continues by adding new items one by one until the point that the total set has support below the minimum support threshold. Support measurement refers to the percentage of transactions containing a given item among all transactions in the database (Verma & Singh, 2017). In the use of the Apriori algorithm for market basket analysis, first frequently bought items are selected, and then another item is added by checking the support rate of these items bought together by customers. Then again, another item is added, and checking the basket support rate again based on the determined threshold value. This process goes on until each possible basket is extracted. Besides support, some other association rule parameters can be used such as confidence (Aguinis et al., 2013). Confidence indicates the strength of the association. It refers to how frequently item B appears in transactions including item A. Support and confidence are commonly used correlation parameters, and they are indicators of significance of the extracted association rules (Rana & Mondal, 2021). Nevertheless, correlation measures lift, leverage and conviction are proposed to test the reliability of the association due to the weak side of support and confidence. It is claimed: "These (support and confidence) can produce misleading results because of the lack of comparison to the expected probability under the assumption of independence." (Duan, 2012). This is a critical topic emphasized by Duan and this issue must be considered while applying market basket analysis. Lift directly refers to the times an item set occurred more than expected. The major weakness of this coefficient is it favours large size itemsets and might miss the important trends. An association with a lift value lower than 1 means that the relationship is negative and the rule should not be considered (Aguinis et al., 2013). Conviction searches for the rule $A \rightarrow B$ rather than accepting A and B as a pair. Leverage computes the difference between expected and actual probability considering all items are independent in an itemset. Leverage is biased towards high support items (Duan, 2012). Knowing the opportunities these correlation measures provide and their downsides, this study tries to exploit these metrics in the best possible way. This study considers these parameters with certain thresholds. When A and B represent two different products, the probabilistic formulas of these features are represented below:

Table 3.1 Correlation Measure Formulas

Correlation Measure	**Formula**	**Range**
Support(A $\rightarrow B$)	P(A$\cap B$)	[0,1]
Confidence(A$\rightarrow B$)	$\frac{P(A \cap B)}{P(A)}$ or $\frac{Support(A \rightarrow B)}{Support(A)}$	[0,1]
Lift(A $\rightarrow B$)	$\frac{P(A \cap B)}{P(A) * P(B)}$ or $\frac{Confidence(A \rightarrow B)}{Support(B)}$	[0, ∞]
Leverage(A$\rightarrow B$)	P(A $\cap B) - P(A) * P(B)$ or Support(A$\rightarrow B) - [Support(A) * Support(B)]$	[-1,1]
Conviction(A$\rightarrow B$)	$\frac{P(A) * P(\overline{B})}{P(A \cap \overline{B})}$ or $\frac{1 - Support(B)}{1 - Confidence(A \rightarrow B)}$	[0,∞]

Market basket analysis also helps retailers to use customer-based advertising and determine which product will be offered as a promotion to which customer. During this process, the algorithm goes over the database so many times to evaluate each potential pair and set (Venkatachari & Chandrasekaran, 2016). By using this methodology on some specific stores that are bigger and offer a wider product range, we aim to discover associations between products to suggest other smaller stores to offer determined sold together products together rather than offering one and not others.

The basket size for association rule mining has been determined as two in this study. Because the main interest is to find out if a specific product is related to any of the others. That is why one association is enough for us, sequential market basket analysis is not the concern of this study since it does not pay attention to promotions or customer groups. Moreover, it saves the study from a huge computational cost and enables it to be implemented on a regular computer. Also, the train and test splitting method was not used in this study. Instead, a better approach was implemented to check the safety of the work. For different years 2018 and 2019, the same process on a monthly period was implemented, and overlapped associated products were kept. In that way, the work is safe in terms of overfitting since it uses different years for same month periods to check the reliability of the outcome, and also, the

associated products that were consistent over years have been detected and it makes recommendations more appropriate for the future. It also saves the model if there is an association effect for only one specific date in previous years, in case of any unusual situation.

This study pays attention to both product sales performance and associated products that single items are related to. In the light of these product sales performance clustering and data mining outcomes, suggestions on the product portfolio will be provided to the company for monthly periods. The findings of these works are presented in the next chapter.

4. CASE STUDY IN A SUPERMARKET CHAIN

4.1 The Dataset Used

In this research, the proposed methodology is applied to one of the largest supermarket chains in Turkey. The firm offers all kinds of daily basic products to customers such as meat, bread, fish, junk foods, chocolate, cigarette, drinks, tea, coffee, milk, yogurt, egg, pasta, water, ice cream, articles, newspapers, books, appliances, cosmetics, kitchenware, accessories, apparel, dresses, flower, battery, stationery, etc. The raw data consist of 12,045,709 unique transactions that appeared in 10 physical stores. At first, the raw data had around 295 product types on the category level "Sub-group" which includes bread, cigarette, daily drinks, meat, cheese and so on. The raw data was including typos and they were corrected. The data managed to figure out product categories that we are interested in. Some product categories have been merged and some irrelevant products were eliminated. After organizing the data and eliminating outliers with low sales volume, the algorithms applied in this study were based on 126 different product types that the company offers consistently over two years. The scanner data includes the transaction records of 10 stores in the years 2018 and 2019 from Besiktas, Istanbul. The study must have been restricted in some areas, otherwise, it was impossible to handle enormously large data on a simple computer. Besiktas district has been chosen on purpose because the town has a high population, and it is kind of a metropole that includes lots of people from different customer groups. That is why, the location reflects the customer behavior properly with high sales numbers, and the outcomes provide a respectively reliable perspective for general product performance and customer behavior. Additionally, the global pandemic Covid-19 had a great impact on our lives, thus, on all the markets. The change in human life such as quarantines, isolation, and safety protocols have affected the shopping patterns of people, especially dur-

ing earlier stages of the pandemic (Truong & Truong, 2022). Although humanity started to turn their normal life back day by day with the declining effect of the pandemic, this research focused on data before the pandemic that have not been exposed to the changes originating from Covid-19. It is believed that working on the past data not affected by the Covid-19 factors provides healthier results for the future. For this reason, despite this research being conducted in 2022, the data for the 2018-2019 years have been preferred to work on.

The information in the raw data received from the company consists of these main columns:

Table 4.1 Data Column Descriptions

COLUMN NAME	**DESCRIPTION**
Month	Month and year information of the transaction
Day	Specific date of transaction
City Code	City code in the state
City Name	Name of the city the store exists
Format Code	Specified format code of the retailer
Format Name	A specified format name of the retailer
Degree Code	Specified degree code of the retailer
Degree Name	Specified degree name of the retailer
Store No	Specified store number
Store Name	Name of the store
Cash No	The specified number of payment point
Receipt No	The receipt number of the transaction
Main Group Number	Specified group number
Main Group Name	The most general grouped version of products
Sub-group Number	Specified sub-group number
Sub-group Name	The grouped version of the main classes
Main Class Number	Specified main class number
Main Class Name	The class name of the sub-group product
Sub-class Number	Specified class number of the product
Sub-class Name	Lowest level product name
Sales Price	The sales price of the product
Quantity Sold	Total amount paid

The data that was extracted and the proposed methodology were discussed with the data science team of the company to get real insights from the market and follow the right path to get the best results. Different possible methods can be implemented

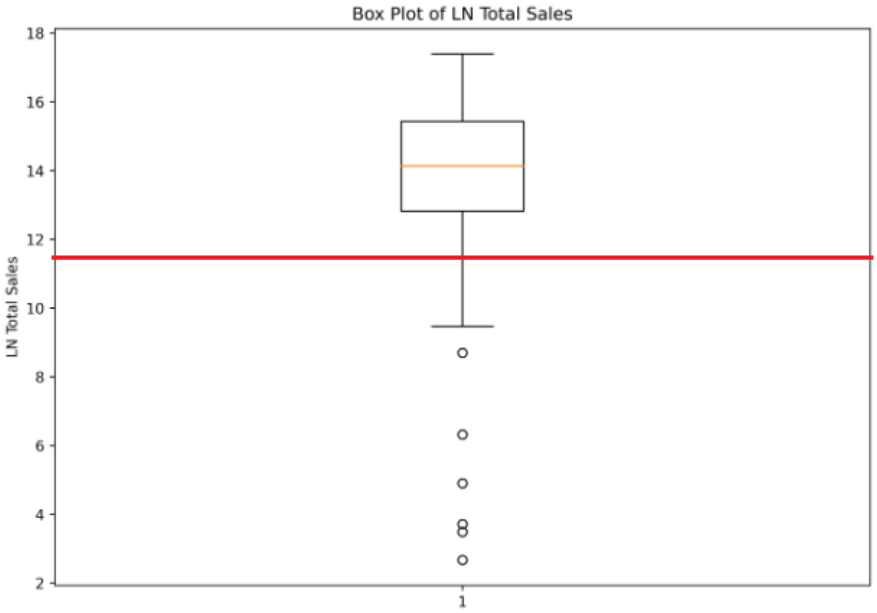
for this study. This research proposes a hybrid model consisting of different tasks and consecutive steps for sales performance evaluation and market basket analysis to achieve a valid and applicable solution.

4.2 Data Cleaning and Pre-processing

The first step in starting the data analysis is ensuring the reliability of the data. Otherwise, the analysis may cause misleading information (Malley, Ramazzotti & Wu, 2016). In the pre-processing, the cells have been examined if any null values exist. All the variables were checked. Products in the rows have been counted to see the general distribution and check if there is inaccuracy in product names. Some of the payments were out of the intention of this study such as "nylon bag" and "parking fee". They have been dropped from the data. Some product categories have been merged because they were named separately due to small differences such as the brand name and these differences are not in the scope of this study. These small changes were not considered by this study, rather, the focus was mainly on what people have bought.

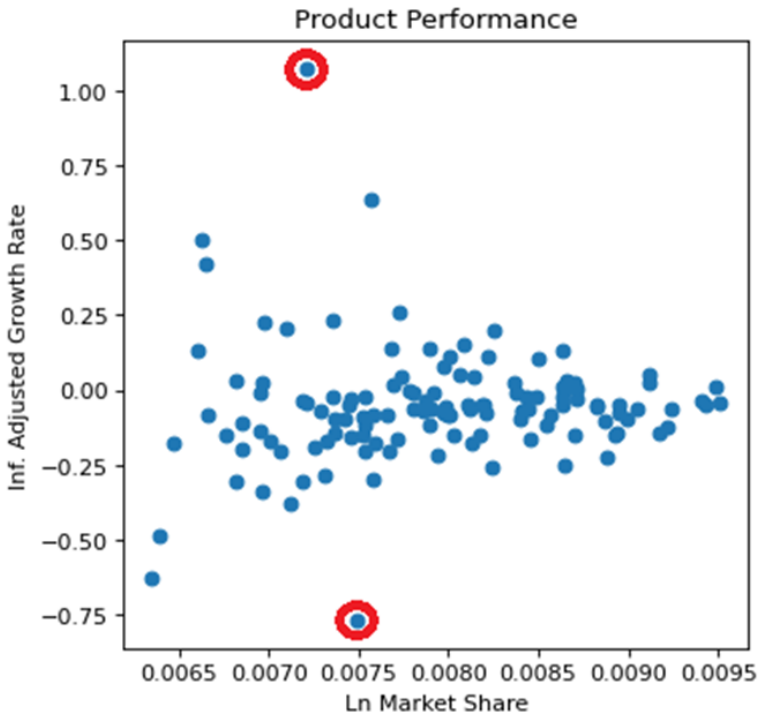
For the next step, the aim was the elimination of products that have appeared in very few transactions, and hence, with too small sales volumes. These products can be called "outliers". The reason is, since there is less volume and not enough data about them, they complicated the model and may cause misleading information because they have not been sold by the company consistently for the two years. Since this study considers the sales amount and growth rate of the product groups, these outliers would cause bias in the model. To that end, sales amounts for both the 2018 and 2019 years have been calculated and new variables were introduced. Further, the natural logarithm values of sales amounts have been added which is represented as "LN". Two variables have been added as aggregate total sales and total LN sales for 2018 and 2019. Natural logarithm values enabled us to see the distribution in a better view by concentrating the data points and made it easier to decide where to cut the data. A fraction point has been determined and the data has been cut from there. Below, you can see the box plot for total LN sales of products and the determined point where the fraction occurred as in sales amount marked with a red line.

Figure 4.1 Box Plot with Natural Logarithm Values of Total Sales



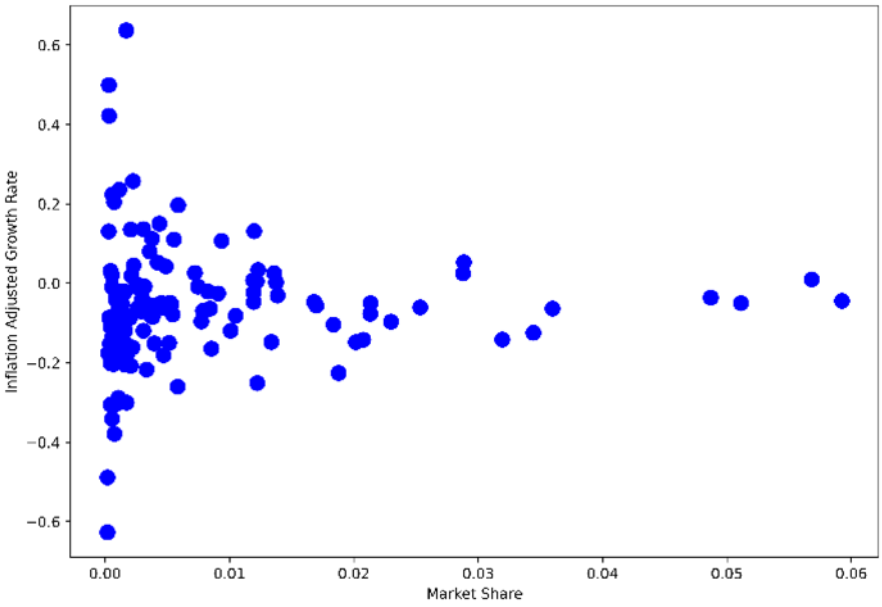
A scatter plot has been created to see the performance distribution of products and detect if any outliers exist. For this, two features have been used: LN market share and inflation-adjusted growth rate. The market share shows the relative share of the product in terms of sales volume between all the others. The reason natural logarithm value has been used is it was also used when eliminating low-volume products. Since it visually decreases the volatility between low and high-volume products, this method provides a better view to detect if there are any significant deviations in the data. The growth rate has been added for each product category based on the change between 2018 and 2019 in terms of sales amount. The inflation information for all product categories has been reached by the Turkish Statistical Institute (TURKSTAT, 2022). Afterward, inflation-adjusted growth rates of products have been produced. Based on the scatter plot, the product "liqueur" and "lottery ticket" have been determined as outliers and dropped from the data since these would negatively affect the accuracy of clustering results. These products should be examined distinctly. Below, you can see how these significantly variated items from the other products in the data as marked in red circles.

Figure 4.2 Product Performance Matrix



After the data cleaning steps, the distributions of the survived products are visualized below to illustrate the general dispersion of the data based on the specific performance metrics.

Figure 4.3 Dispersion of Products with respect to Market Share and Inflation-adjusted Growth Rate



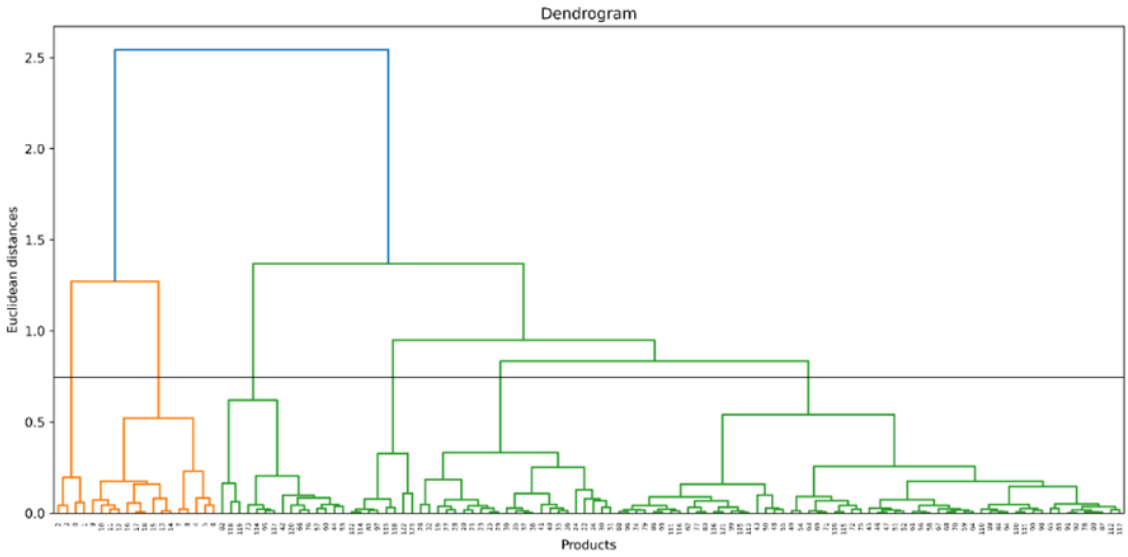
4.3 Findings

4.3.1 Clusters

The products have been grouped to specify the clusters they belong to. An analytical clustering approach has been applied for this purpose. Sales performance of the singular products has been determined as the basis of this method. Market share and inflation-adjusted growth rate were used as the indicators of product sales performance and the clustering has been done based on these features. As mentioned before, different clustering algorithms with different features provide different solutions. The optimal clusters were identified with the agglomerative clustering method using scaled market share and scaled inflation-adjusted growth rate. The corresponding normalized market share and inflation-adjusted growth rate values have been calculated and a model trained with these values. Normalized values were calculated by using statistical normalization.

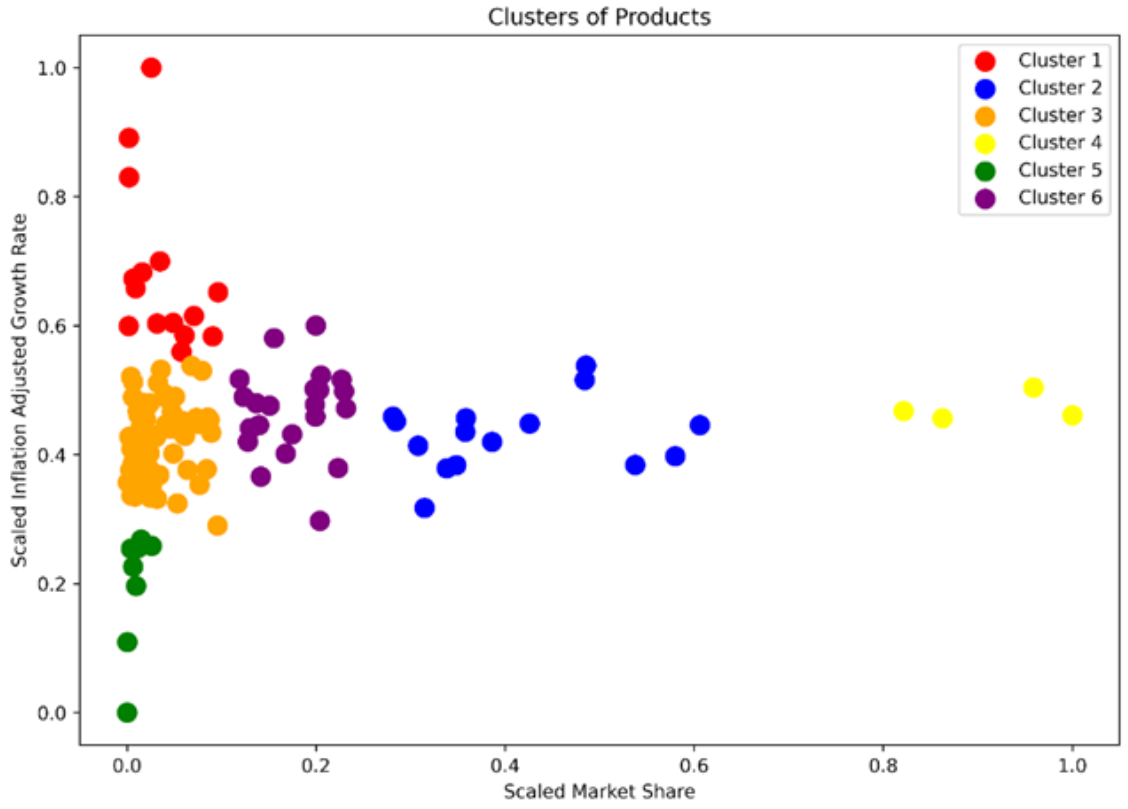
The method of agglomerative clustering is implemented on the data. Firstly, the dendrogram is presented in a tree structure and the links between products are illustrated. The construction of a dendrogram is a common procedure used in hierarchical clustering (Kimes et al., 2017). It is used to decide on the number of clusters and these are followed by the application of clustering. The Ward method has been used in this study in the process of creating a dendrogram.

Figure 4.4 Dendrogram for Scaled Market Share and Scaled Inflation-Adjusted Growth Rate



Six clusters were identified from the dendrogram. The line is demonstrated where the cluster levels are determined. The fitting six clusters were generated and the resulting groups were presented below visually:

Figure 4.5 Hierarchical Clusters for Scaled Market Share and Scaled Inflation-Adjusted Growth Rate



The result provides a solution in line with the purpose of this paper. Product groups were decomposed by paying attention to both their market share and inflation-adjusted growth rate properties. By looking at the graph, the product groups and their characteristics can be understood easily. The best performing model that serves the purpose of this study is the clusters generated by the hierarchical agglomerative method using scaled market share and scaled inflation-adjusted growth rate parameters. Six clusters are created by this method and the discrimination between clusters is appropriate for the major interest of the process. It distinguishes products with high market share, low market share but relatively high inflation-adjusted growth rate, and low market share and low inflation-adjusted growth rate. This information helps us to identify products such as eliminable, crucial, or well-performed. Before that, it is better to keep in mind that the average market share is 0.8% and the average inflation-adjusted growth rate is -5.8% for the items in the portfolio. The clusters are introduced below with their specific features:

4.3.1.1 Cluster 1: Maturing Actors

Figure 4.6 Cluster 1

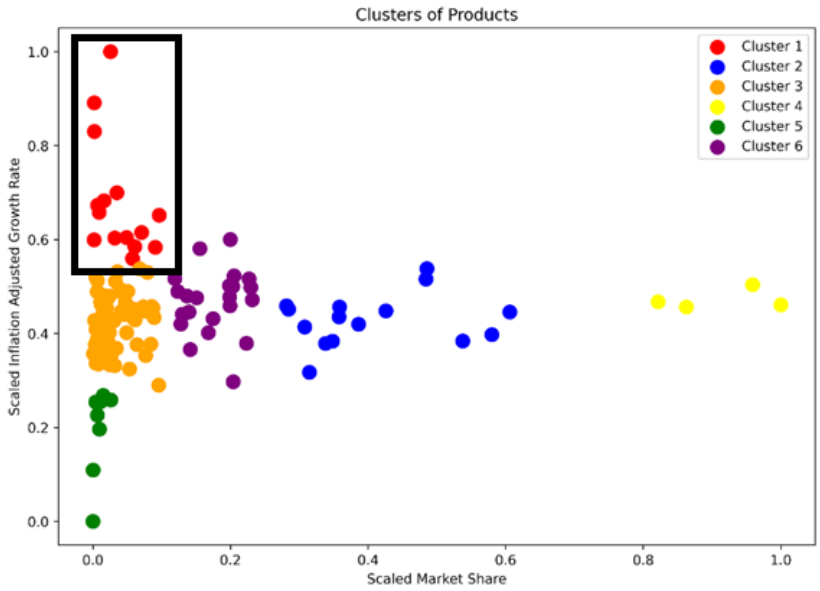


Table 4.2 Cluster 1 – Maturing Actors

TELECOMMUNICATION ITEMS	GUM	ACCESSORY
CHIPS	GIN	GARDEN ITEMS
PASTA	BATTERY	WOOD KITCHENWARE
TURKEY PRODUCTS	PORCELAIN&CERAMIC KITCHENWARE	CATERING PRODUCTS
BARS	BREAD	ALCOHOL

There are 15 products in this cluster. This cluster includes products with high inflation-adjusted growth rates and low relative market share. This cluster is the only one with a positive average inflation-adjusted growth rate. These are profitable products since having an increasing trend with a 23.53% inflation-adjusted growth rate. However, their average market share is 0.24%, which is low. These products should be seen as opportunities for the company to increase their sales amount and make a wise profitable movement on them. Promotional studies can be conducted for this purpose, but the marketing side of this outcome is not within the scope of this study.

4.3.1.2 Cluster 2: Cash Banks

Figure 4.7 Cluster 2

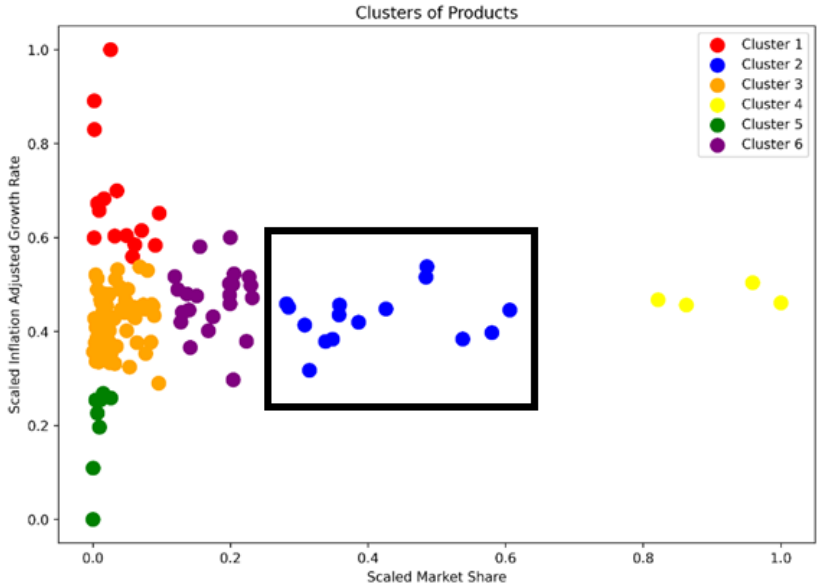


Table 4.3 Cluster 2 – Cash Banks

VEGETABLES	WINE	TOILET PAPER
SNACK	OIL	RAKI
BAKERY	DELI MEAT	EGG
BEER	MILK	YOGURT
TEA&COFFEE	LAUNDRY PRODUCTS	BREAKFAST FOODS

The products in this cluster bear the burden of the company's cash flow. These 15 products belonging to the cash banks cluster really have a large transaction amount. They constitute around 36% of total sales amount. These are major items that attract customers with an average 2.42% market share. Although they have a negative inflation-adjusted growth rate of -8.41% like the vast majority of the portfolio, the ratio is not very bad. It is not far from the average and these items must stay in the portfolio to not lose customers since they have a really high market share as compared to the rest of the portfolio and keeping cash flow alive is a crucial topic for the company

4.3.1.3 Cluster 3 - Uncertain Products

Figure 4.8 Cluster 3

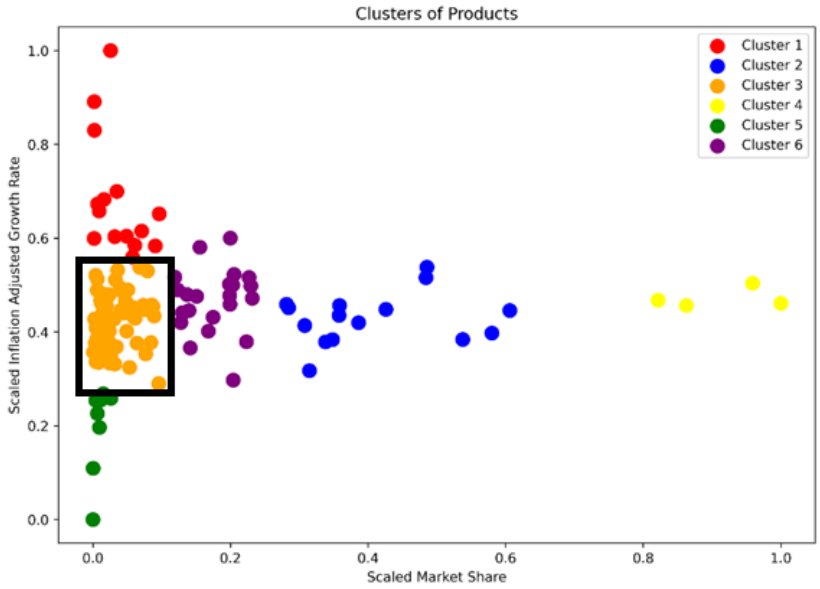


Table 4.4 Cluster 3: Uncertain Products

FROZEN FOOD	MILK PRODUCTS	ORNAMENT PRODUCT
DAILY DRINKS	STORAGE BOX&ORGANIZERS	CLOTHING
VODKA	DESSERT&PASTRY	DECORATION
SOAP	SHOWER&BATH	WAX&DEPILATORY
FRAGRANCE	SWEETS	MARGARINE
CHOCOLATE COVERED	HOME TEXTILE	HARDWARE PRODUCTS
HEALTHY LIFE PRODUCTS	FLOUR	HOME DECORATION
TOY	MAKEUP PRODUCTS	CREAM
HOUSEHOLD ELECTRICAL APPLIANCES	LIGHTING&ELECTRICAL MATERIALS	UNDERWEAR
HYGIENIC PRODUCTS	BATH&LAUNDRY PRODUCTS	PET ACCESSORY&HYGIENE PRODUCTS
JOURNAL&NEWSPAPER	SLIPPER	MILK POWDER&CREAM
CLEANING MATERIALS	BODY CARE PRODUCTS	COLD SNACKS
NUT	GIBLETS	TEQUILA
COOKING TOOLS	BOOKS	COMPUTER
SHAVING SUPPLIES	DISPOSABLE PRODUCTS	FRESH JUICE
FACIAL CARE	SOCKS	SPORT PRODUCTS
GLASS KITCHENWARE	PLASTIC KITCHENWARES	AUTOMOBILE PRODUCTS
STATIONERY	PICNIC ITEMS	SUN CARE PRODUCTS
CANDY	PICKLE	SPORTS DRINKS
MEDICAL PRODUCTS	METAL KITCHENWARES	

This is the largest cluster that we acquired in size. There are 59 items in this cluster. These can be defined as average products. They do not have any sharp characteristics in sales performance. These are neither efficient nor must be eliminated products. The average market share is 0.23% and the average inflation-adjusted growth rate is -9.11% in this cluster. The elimination of products in this cluster can be considerably discussed in principle. At that point, we do not suggest replacing any of these products if they have any association with other products to keep the customer's attention. However, an item in that cluster can be replaced there is a better alternative and it does not have an association with other items in the portfolio.

4.3.1.4 Cluster 4: Vital Products

Figure 4.9 Cluster 4

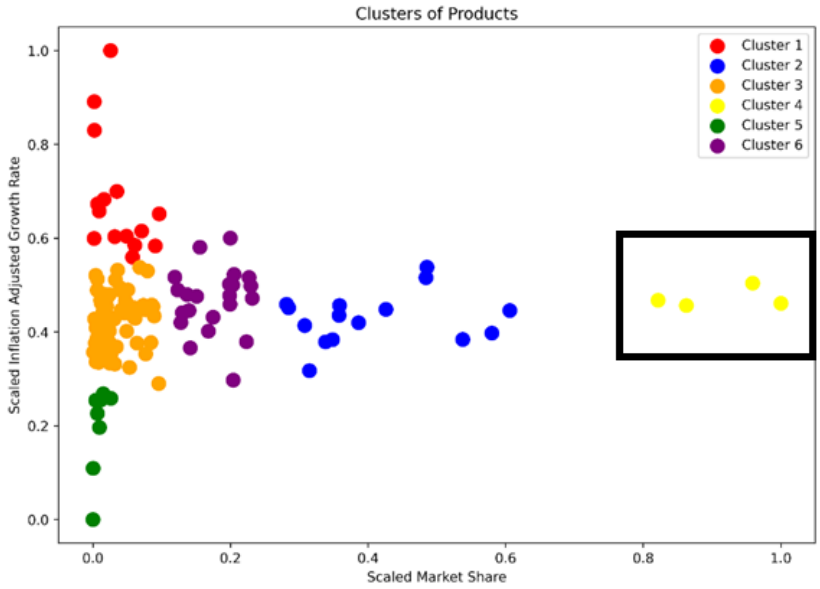


Table 4.5 Cluster 4 – Vital Products

CHEESE	**MEAT**
CIGARETTE	**FRUITS**

Products in this cluster have enormous sales amounts. There are only four products, yet, these four products have a 5.4% market share on average and constitute around 21.6% of the total sales on their own. These items are undeniably vital for the portfolio and it is impossible to replace them. The average growth rate is -3.03% per item in this cluster. This ratio is not bad compared to the general situation of the portfolio. Moreover, these products are precious to the company and must be offered in all the stores regardless of their growth rate.

4.3.1.5 Cluster 5: Slow Moving Goods

Figure 4.10 Cluster 5

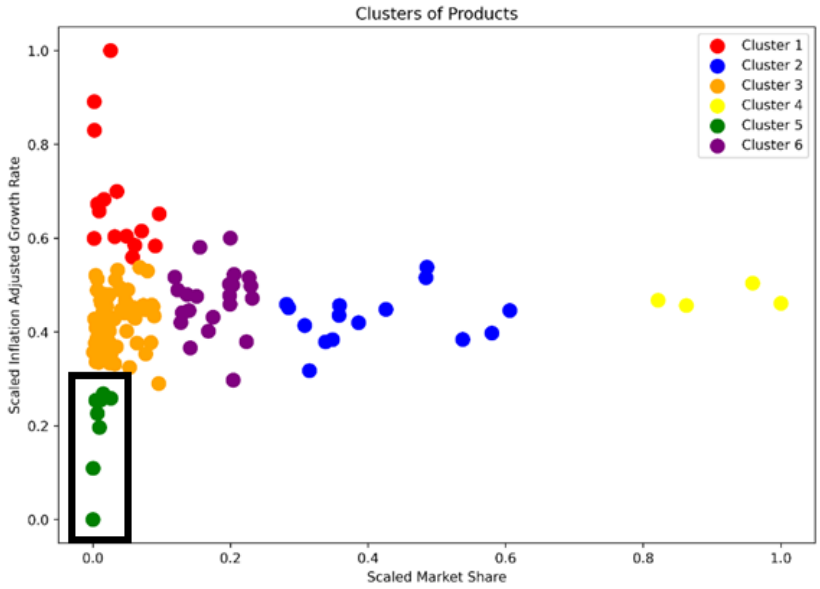


Table 4.6 Cluster 5 – Slow Moving Goods

FLOWER	PERFUMES
VIDEO&AUDIO SYSTEMS	CREDITS
TRAVELING GOODS	HYGIENIC PAPER PRODUCTS
HEATING &COOLING SYSTEMS	DIGITAL GAME

This cluster indicates low-performed items in the portfolio. There are eight products in this cluster. They have strong negative inflation-adjusted growth rates along with small market share ratios. The average market share is 0.07% and the average inflation-adjusted growth rate is -37.96% in this cluster. These inefficient items should be excluded from the product portfolio due to poor sales performance.

4.3.1.6 Cluster 6: Convenient Goods

Figure 4.11 Cluster 6

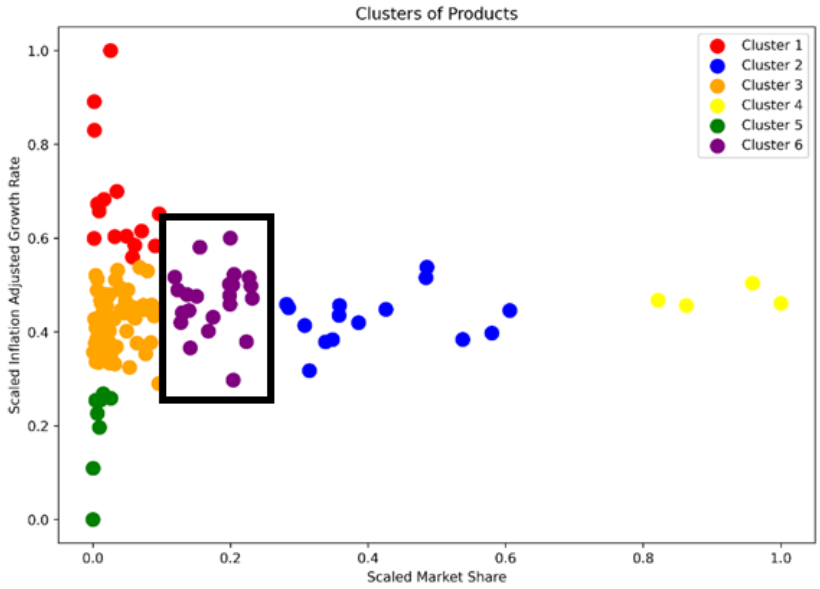


Table 4.7 Cluster 6 - Convenient Goods

HOME CARE PRODUCTS	SAUCES	BUTTER
WATER&MINERAL WATER	WHISKEY	UNFIZZY DRINKS
CANNED GOODS&GRAVY	BISCUITS	CONVENIENCE FOODS&APPETIZER
BABY PRODUCTS	GREEN	HOUSEHOLD CLEANERS
CHOCOLATE	ORAL CARE PRODUCTS	OLIVE
FISHERIES	DISH WASHERS	ICE CREAM
BEVERAGES	LEGUMES	PET PRODUCTS
CHICKEN PRODUCTS	HAIR CARE PRODUCTS	

The market share ratios are relatively high in this cluster. The average market share is 1.05% and the inflation-adjusted growth rate is -3.84% which can be qualified as good in comparison to the overall portfolio. It does not make sense to delist any of these 23 products from the portfolio unless a much more reliable and profitable alternative product exists. Even if it exists, these products are not the ones that should be removed from the portfolio while products with less market share and inflation-adjusted growth rate exist in other clusters. Dropping the items in cluster 5 and some of cluster 3 would be much wiser, at least in the first stage.

4.3.2 Market Basket Analysis Implementation

For the market basket analysis, a new variable "id" has been introduced, which indicates the id number of the transaction, to the dataset in addition to existing columns to define a unique number for every single transaction. The correlation measures support, confidence, lift, conviction, and leverage have been used for the association rule mining process. The thresholds are not certain and change over different studies mentioned in the literature review based on the results obtained in the specific data.

First, the support 0.1% and confidence 5% thresholds were set up to retrieve starting rules. Then, this study found the best rules under the adding thresholds lift = 2, conviction = 1.1, and leverage = 0.0015. All the association rules generated in this study satisfy the stated conditions with related thresholds. These survived rules are determined as the optimal association rules on the purpose. Product pairs that are associated with each other commonly both for years 2018 and 2019 generated by the market basket analysis with these correlation parameters are presented monthly below. Of course, different inferences can be made by using these associations, however, the main focus of this study is uncertain products for this part of the analysis. Because the rest of the clusters in the portfolio are already identified as "should stay" or "should be excluded" but, the uncertain products are within the cluster group in which the decisions should be made as described before. The uncertain items that are associated with any other item in the portfolio are detected and they are defined as items that should stay in the product portfolio in that specific month. All the association rules that include at least one item from the cluster of uncertain products are exhibited below as pairs in a monthly period.

4.3.2.1 Association Rules in January

Table 4.8 MBA January

ORAL CARE PRODUCTS - FRAGRANCE	DAILY DRINKS - EGG	HEALTHY LIFE PRODUCTS - TOILET PAPER
ORAL CARE PRODUCTS - SOAP	HYGIENIC PRODUCTS - TOILET PAPER	HEALTHY LIFE PRODUCTS - GREEN
FROZEN FOOD - LEGUMES	HYGIENIC PRODUCTS - LAUNDRY PRODUCTS	HEALTHY LIFE PRODUCTS - YOGURT
CLEANING MATERIALS - LEGUMES	NUT - FRUITS	HEALTHY LIFE PRODUCTS - EGG
SOAP - LEGUMES	NUT - CHEESE	HEALTHY LIFE PRODUCTS - TEA&COFFEE
DESSERT&PASTRY - LEGUMES	NUT - VEGETABLES	HEALTHY LIFE PRODUCTS - SNACK
FLOUR - LEGUMES	NUT - GREEN	MILK PRODUCTS - VEGETABLES
CANDY - LEGUMES	SOAP - BREAKFAST FOODS	DESSERT&PASTRY - VEGETABLES
DISH WASHERS - CLEANING MATERIALS	DESSERT&PASTRY - BREAKFAST FOODS	PICKLE - VEGETABLES
DISH WASHERS - SOAP	FLOUR - BREAKFAST FOODS	FLOUR - VEGETABLES
CANDY - DISH WASHERS	CANDY - BREAKFAST FOODS	CANDY - VEGETABLES
BISCUITS - CHOCOLATE COVERED	CREAM - CHEESE	FLOUR - OIL
SWEETS - BISCUITS	SOAP - CANNED GOODS&GRAVY	CANDY - OIL
CHIPS - CHOCOLATE COVERED	MILK PRODUCTS - CANNED GOODS&GRAVY	MILK PRODUCTS - SAUCES
SWEETS - CHIPS	DESSERT&PASTRY - CANNED GOODS&GRAVY	DESSERT&PASTRY - SAUCES
FROZEN FOOD - MEAT	PICKLE - CANNED GOODS&GRAVY	PICKLE - SAUCES
FROZEN FOOD - DELI MEAT	FLOUR - CANNED GOODS&GRAVY	FLOUR - SAUCES
FROZEN FOOD - CANNED GOODS&GRAVY	CANDY - CANNED GOODS&GRAVY	CANDY - SAUCES
FROZEN FOOD - PASTA	MARGARINE - PASTA	MILK PRODUCTS - MILK
FROZEN FOOD - CHEESE	SOAP - PASTA	DESSERT&PASTRY - MILK
FROZEN FOOD - VEGETABLES	MILK PRODUCTS - PASTA	PICKLE - MILK
FROZEN FOOD - SAUCES	DESSERT&PASTRY - PASTA	FLOUR - MILK
FROZEN FOOD - MILK	PICKLE - PASTA	CANDY - MILK
FROZEN FOOD - GREEN	FLOUR - PASTA	MILK PRODUCTS - GREEN
FROZEN FOOD - YOGURT	CANDY - PASTA	MILK PRODUCTS - YOGURT
FROZEN FOOD - EGG	MARGARINE - CHEESE	MILK PRODUCTS - EGG
FROZEN FOOD - TEA&COFFEE	MARGARINE - VEGETABLES	DESSERT&PASTRY - TOILET PAPER
SHOWER&BATH - HAIR CARE PRODUCTS	MARGARINE - SAUCES	DESSERT&PASTRY - BUTTER
FLOUR - MEAT	MARGARINE - MILK	DESSERT&PASTRY - FLOUR
MILK PRODUCTS - DELI MEAT	MARGARINE - YOGURT	DESSERT&PASTRY - GREEN
HOME CARE PRODUCTS - CLEANING MATERIALS	MARGARINE - EGG	DESSERT&PASTRY - YOGURT
HYGIENIC PRODUCTS - HOME CARE PRODUCTS	MARGARINE - TEA&COFFEE	DESSERT&PASTRY - EGG
HOME CARE PRODUCTS - SOAP	HEALTHY LIFE PRODUCTS - FRUITS	DESSERT&PASTRY - LAUNDRY PRODUCTS
MEDICAL PRODUCTS - HOME CARE PRODUCTS	PICKLE - FRUITS	DESSERT&PASTRY - TEA&COFFEE
HEALTHY LIFE PRODUCTS - HOME CARE PRODUCTS	FLOUR - FRUITS	DESSERT&PASTRY - SNACK
DESSERT&PASTRY - HOME CARE PRODUCTS	SOAP - CHEESE	DESSERT&PASTRY - CHOCOLATE
FLOUR - HOME CARE PRODUCTS	MEDICAL PRODUCTS - CHEESE	CANDY - DESSERT&PASTRY
CANDY - HOME CARE PRODUCTS	HEALTHY LIFE PRODUCTS - CHEESE	FLOUR - TOILET PAPER
HOUSEHOLD CLEANERS - CLEANING MATERIALS	MILK PRODUCTS - CHEESE	CANDY - TOILET PAPER
HOUSEHOLD CLEANERS - SOAP	DESSERT&PASTRY - CHEESE	BUTTER - FLOUR
CLEANING MATERIALS - BREAKFAST FOODS	PICKLE - CHEESE	CANDY - BUTTER
CLEANING MATERIALS - CANNED GOODS&GRAVY	FLOUR - CHEESE	PICKLE - GREEN
CLEANING MATERIALS - PASTA	CANDY - CHEESE	PICKLE - YOGURT
CLEANING MATERIALS - FRUITS	PICNIC ITEMS - CIGARETTE	FLOUR - GREEN
CLEANING MATERIALS - CHEESE	SOAP - VEGETABLES	FLOUR - YOGURT
CLEANING MATERIALS - SOAP	SOAP - SAUCES	FLOUR - EGG
CLEANING MATERIALS - VEGETABLES	SOAP - MILK	FLOUR - LAUNDRY PRODUCTS
CLEANING MATERIALS - OIL	TOILET PAPER - SOAP	FLOUR - TEA&COFFEE
CLEANING MATERIALS - SAUCES	SOAP - GREEN	CANDY - FLOUR
CLEANING MATERIALS - MILK	SOAP - YOGURT	CANDY - GREEN
CLEANING MATERIALS - TOILET PAPER	SOAP - EGG	CANDY - YOGURT
CLEANING MATERIALS - GREEN	LAUNDRY PRODUCTS - SOAP	CANDY - EGG
CLEANING MATERIALS - YOGURT	SOAP - TEA&COFFEE	CANDY - LAUNDRY PRODUCTS
CLEANING MATERIALS - EGG	SOAP - SNACK	CANDY - TEA&COFFEE
LAUNDRY PRODUCTS - CLEANING MATERIALS	MEDICAL PRODUCTS - TOILET PAPER	CHOCOLATE COVERED - CHOCOLATE
CLEANING MATERIALS - TEA&COFFEE	HEALTHY LIFE PRODUCTS - VEGETABLES	SWEETS - CHOCOLATE
DAILY DRINKS - MILK	HEALTHY LIFE PRODUCTS - SAUCES	SWEETS - CHOCOLATE COVERED
DAILY DRINKS - YOGURT	HEALTHY LIFE PRODUCTS - MILK	

173 association rules exist both in January 2018 and January 2019 extracted. 20 separate items were found in associations. These items are frozen food, daily drinks, soap, fragrance, chocolate covered, healthy life products, hygienic products, cleaning materials, nut, candy, medical products, milk products, dessert&pastry, showerbath, flour, picnic items, pickle, margarine, and cream. These can be labeled as "should stay" products for the product portfolio of January. The rest of the items in the uncertain products cluster can be excluded from the product portfolio for this specific month since they are low-performing items and they do not have a visible relationship with the sales of other products in the portfolio.

4.3.2.2 Association Rules in February

Table 4.9 MBA Februay

ORAL CARE PRODUCTS - FRAGRANCE	DAILY DRINKS - YOGURT	HEALTHY LIFE PRODUCTS - MILK
ORAL CARE PRODUCTS - SOAP	HYGIENIC PRODUCTS - TOILET PAPER	HEALTHY LIFE PRODUCTS - GREEN
FROZEN FOOD - LEGUMES	NUT - FRUITS	HEALTHY LIFE PRODUCTS - YOGURT
CLEANING MATERIALS - LEGUMES	NUT - CHEESE	HEALTHY LIFE PRODUCTS - EGG
DESSERT&PASTRY - LEGUMES	NUT - VEGETABLES	HEALTHY LIFE PRODUCTS - TEA&COFFEE
FLOUR - LEGUMES	NUT - GREEN	HEALTHY LIFE PRODUCTS - SNACK
CANDY - LEGUMES	MILK PRODUCTS - BREAKFAST FOODS	DESSERT&PASTRY - VEGETABLES
DISH WASHERS - CLEANING MATERIALS	DESSERT&PASTRY - BREAKFAST FOODS	PICKLE - VEGETABLES
DISH WASHERS - SOAP	FLOUR - BREAKFAST FOODS	FLOUR - VEGETABLES
CANDY - DISH WASHERS	CANDY - BREAKFAST FOODS	CANDY - VEGETABLES
BISCUITS - CHOCOLATE COVERED	CREAM - CHEESE	FLOUR - OIL
SWEETS - BISCUITS	MARGARINE - CANNED GOODS&GRAVY	CANDY - OIL
CHIPS - CHOCOLATE COVERED	SOAP - CANNED GOODS&GRAVY	MILK PRODUCTS - SAUCES
SWEETS - CHIPS	MILK PRODUCTS - CANNED GOODS&GRAVY	DESSERT&PASTRY - SAUCES
FROZEN FOOD - MEAT	DESSERT&PASTRY - CANNED GOODS&GRAVY	PICKLE - SAUCES
FROZEN FOOD - DELI MEAT	PICKLE - CANNED GOODS&GRAVY	FLOUR - SAUCES
FROZEN FOOD - BEVERAGES	FLOUR - CANNED GOODS&GRAVY	CANDY - SAUCES
FROZEN FOOD - CANNED GOODS&GRAVY	CANDY - CANNED GOODS&GRAVY	MILK PRODUCTS - MILK
FROZEN FOOD - PASTA	MARGARINE - PASTA	DESSERT&PASTRY - MILK
FROZEN FOOD - FRUITS	SOAP - PASTA	PICKLE - MILK
FROZEN FOOD - CHEESE	MILK PRODUCTS - PASTA	FLOUR - MILK
FROZEN FOOD - VEGETABLES	DESSERT&PASTRY - PASTA	CANDY - MILK
FROZEN FOOD - SAUCES	PICKLE - PASTA	MILK PRODUCTS - GREEN
FROZEN FOOD - MILK	FLOUR - PASTA	MILK PRODUCTS - YOGURT
FROZEN FOOD - GREEN	CANDY - PASTA	MILK PRODUCTS - EGG
FROZEN FOOD - YOGURT	MARGARINE - CHEESE	DESSERT&PASTRY - TOILET PAPER
FROZEN FOOD - EGG	MARGARINE - VEGETABLES	DESSERT&PASTRY - BUTTER
FROZEN FOOD - TEA&COFFEE	MARGARINE - SAUCES	DESSERT&PASTRY - FLOUR
SHOWER&BATH - HAIR CARE PRODUCTS	MARGARINE - MILK	DESSERT&PASTRY - GREEN
FLOUR - MEAT	MARGARINE - YOGURT	DESSERT&PASTRY - YOGURT
MILK PRODUCTS - DELI MEAT	MARGARINE - EGG	DESSERT&PASTRY - EGG
HOME CARE PRODUCTS - CLEANING MATERIALS	MARGARINE - TEA&COFFEE	DESSERT&PASTRY - TEA&COFFEE
SOAP - HOME CARE PRODUCTS	HEALTHY LIFE PRODUCTS - FRUITS	DESSERT&PASTRY - SNACK
HEALTHY LIFE PRODUCTS - HOME CARE PRODUCTS	DESSERT&PASTRY - FRUITS	DESSERT&PASTRY - CHOCOLATE
DESSERT&PASTRY - HOME CARE PRODUCTS	PICKLE - FRUITS	CANDY - DESSERT&PASTRY
FLOUR - HOME CARE PRODUCTS	FLOUR - FRUITS	FLOUR - TOILET PAPER
CANDY - HOME CARE PRODUCTS	SOAP - CHEESE	CANDY - TOILET PAPER
HOUSEHOLD CLEANERS - CLEANING MATERIALS	HEALTHY LIFE PRODUCTS - CHEESE	FLOUR - BUTTER
HOUSEHOLD CLEANERS - SOAP	MILK PRODUCTS - CHEESE	PICKLE - GREEN
CLEANING MATERIALS - CANNED GOODS&GRAVY	DESSERT&PASTRY - CHEESE	PICKLE - YOGURT
CLEANING MATERIALS - PASTA	PICKLE - CHEESE	FLOUR - GREEN
CLEANING MATERIALS - FRUITS	FLOUR - CHEESE	FLOUR - YOGURT
CLEANING MATERIALS - CHEESE	CANDY - CHEESE	FLOUR - EGG
CLEANING MATERIALS - SOAP	PICNIC ITEMS - CIGARETTE	FLOUR - LAUNDRY PRODUCTS
CLEANING MATERIALS - VEGETABLES	SOAP - SAUCES	FLOUR - TEA&COFFEE
CLEANING MATERIALS - SAUCES	SOAP - MILK	CANDY - FLOUR
CLEANING MATERIALS - MILK	TOILET PAPER - SOAP	CANDY - GREEN
TOILET PAPER - CLEANING MATERIALS	SOAP - GREEN	CANDY - YOGURT
CLEANING MATERIALS - GREEN	SOAP - YOGURT	CANDY - EGG
CLEANING MATERIALS - YOGURT	SOAP - EGG	CANDY - LAUNDRY PRODUCTS
CLEANING MATERIALS - EGG	LAUNDRY PRODUCTS - SOAP	CANDY - TEA&COFFEE
LAUNDRY PRODUCTS - CLEANING MATERIALS	SOAP - TEA&COFFEE	CHOCOLATE COVERED - CHOCOLATE
CLEANING MATERIALS - TEA&COFFEE	HEALTHY LIFE PRODUCTS - VEGETABLES	SWEETS - CHOCOLATE
DAILY DRINKS - MILK	HEALTHY LIFE PRODUCTS - SAUCES	SWEETS - CHOCOLATE COVERED

162 association rules exist both in February 2018 and January 2019 extracted. 19 different items were found in associations and these are exactly the same products as extracted in January except for medical products. These items are daily drinks, healthy life products, nut, pickle, fragrance, chocolate covered, cream, cleaning materials, frozen food, candy, hygienic products, milk products, dessert&pastry, shower&bath, flour, picnic items, margarine, and soap. These products should be commented as the continuing items for February. The items in the uncertain products cluster without any association can be replaced with superior products this month.

4.3.2.3 Association Rules in March

Table 4.10 MBA March

ORAL CARE PRODUCTS - FRAGRANCE	HYGIENIC PRODUCTS - LAUNDRY PRODUCTS	HEALTHY LIFE PRODUCTS - TEA&COFFEE
SOAP - ORAL CARE PRODUCTS	NUT - FRUITS	HEALTHY LIFE PRODUCTS - SNACK
CLEANING MATERIALS - LEGUMES	NUT - CHEESE	PICKLE - VEGETABLES
DESSERT&PASTRY - LEGUMES	NUT - GREEN	FLOUR - VEGETABLES
FLOUR - LEGUMES	SOAP - BREAKFAST FOODS	FLOUR - OIL
CANDY - LEGUMES	MILK PRODUCTS - BREAKFAST FOODS	CANDY - OIL
DISH WASHERS - CLEANING MATERIALS	DESSERT&PASTRY - BREAKFAST FOODS	MILK PRODUCTS - SAUCES
DISH WASHERS - SOAP	FLOUR - BREAKFAST FOODS	DESSERT&PASTRY - SAUCES
CANDY - DISH WASHERS	CANDY - BREAKFAST FOODS	PICKLE - SAUCES
BISCUITS - CHOCOLATE COVERED	CREAM - CHEESE	FLOUR - SAUCES
SWEETS - BISCUITS	SOAP - CANNED GOODS&GRAVY	CANDY - SAUCES
CHIPS - CHOCOLATE COVERED	MILK PRODUCTS - CANNED GOODS&GRAVY	MILK PRODUCTS - MILK
FROZEN FOOD - MEAT	DESSERT&PASTRY - CANNED GOODS&GRAVY	DESSERT&PASTRY - MILK
FROZEN FOOD - DELI MEAT	PICKLE - CANNED GOODS&GRAVY	PICKLE - MILK
FROZEN FOOD - CANNED GOODS&GRAVY	FLOUR - CANNED GOODS&GRAVY	FLOUR - MILK
FROZEN FOOD - PASTA	CANDY - CANNED GOODS&GRAVY	CANDY - MILK
FROZEN FOOD - FRUITS	FACIAL CARE - FRAGRANCE	MILK PRODUCTS - GREEN
FROZEN FOOD - CHEESE	SOAP - PASTA	MILK PRODUCTS - YOGURT
FROZEN FOOD - VEGETABLES	MILK PRODUCTS - PASTA	MILK PRODUCTS - EGG
FROZEN FOOD - SAUCES	DESSERT&PASTRY - PASTA	DESSERT&PASTRY - TOILET PAPER
FROZEN FOOD - MILK	PICKLE - PASTA	BUTTER - DESSERT&PASTRY
FROZEN FOOD - GREEN	FLOUR - PASTA	DESSERT&PASTRY - FLOUR
FROZEN FOOD - YOGURT	CANDY - PASTA	DESSERT&PASTRY - GREEN
FROZEN FOOD - EGG	MARGARINE - CHEESE	DESSERT&PASTRY - YOGURT
FROZEN FOOD - TEA&COFFEE	MARGARINE - VEGETABLES	DESSERT&PASTRY - EGG
FLOUR - MEAT	MARGARINE - MILK	DESSERT&PASTRY - LAUNDRY PRODUCTS
MILK PRODUCTS - DELI MEAT	HEALTHY LIFE PRODUCTS - FRUITS	DESSERT&PASTRY - TEA&COFFEE
PICKLE - DELI MEAT	DESSERT&PASTRY - FRUITS	DESSERT&PASTRY - SNACK
HOME CARE PRODUCTS - CLEANING MATERIALS	PICKLE - FRUITS	DESSERT&PASTRY - CHOCOLATE
HYGIENIC PRODUCTS - HOME CARE PRODUCTS	FLOUR - FRUITS	CANDY - DESSERT&PASTRY
SOAP - HOME CARE PRODUCTS	SOAP - CHEESE	FLOUR - TOILET PAPER
DESSERT&PASTRY - HOME CARE PRODUCTS	HEALTHY LIFE PRODUCTS - CHEESE	CANDY - TOILET PAPER
FLOUR - HOME CARE PRODUCTS	MILK PRODUCTS - CHEESE	FLOUR - BUTTER
CANDY - HOME CARE PRODUCTS	DESSERT&PASTRY - CHEESE	CANDY - BUTTER
HOUSEHOLD CLEANERS - CLEANING MATERIALS	PICKLE - CHEESE	PICKLE - GREEN
HOUSEHOLD CLEANERS - SOAP	FLOUR - CHEESE	PICKLE - YOGURT
CLEANING MATERIALS - CANNED GOODS&GRAVY	CANDY - CHEESE	FLOUR - GREEN
CLEANING MATERIALS - PASTA	PICNIC ITEMS - CIGARETTE	FLOUR - YOGURT
CLEANING MATERIALS - FRUITS	SOAP - SAUCES	FLOUR - EGG
CLEANING MATERIALS - CHEESE	SOAP - MILK	FLOUR - LAUNDRY PRODUCTS
CLEANING MATERIALS - SOAP	TOILET PAPER - SOAP	FLOUR - TEA&COFFEE
CLEANING MATERIALS - VEGETABLES	SOAP - GREEN	CANDY - FLOUR
CLEANING MATERIALS - OIL	SOAP - YOGURT	BODY CARE PRODUCTS - FACIAL CARE
CLEANING MATERIALS - SAUCES	SOAP - EGG	CANDY - GREEN
CLEANING MATERIALS - MILK	LAUNDRY PRODUCTS - SOAP	CANDY - YOGURT
TOILET PAPER - CLEANING MATERIALS	SOAP - TEA&COFFEE	CANDY - EGG
CLEANING MATERIALS - GREEN	SOAP - SNACK	CANDY - LAUNDRY PRODUCTS
CLEANING MATERIALS - YOGURT	MEDICAL PRODUCTS - TOILET PAPER	CANDY - TEA&COFFEE
CLEANING MATERIALS - EGG	HEALTHY LIFE PRODUCTS - SAUCES	CHOCOLATE COVERED - CHOCOLATE
LAUNDRY PRODUCTS - CLEANING MATERIALS	HEALTHY LIFE PRODUCTS - MILK	SWEETS - CHOCOLATE
CLEANING MATERIALS - TEA&COFFEE	HEALTHY LIFE PRODUCTS - GREEN	SWEETS - CHOCOLATE COVERED
DAILY DRINKS - YOGURT	HEALTHY LIFE PRODUCTS - YOGURT	
HYGIENIC PRODUCTS - TOILET PAPER	HEALTHY LIFE PRODUCTS - EGG	

There are 157 common associated pairs in March. 21 products appeared in relation to other products. These are picnic items, cream, body care products, pickle, candy, medical products, cleaning materials, facial care, flour, nut, sweets, chocolate covered, margarine, dessertpastry, milk products, frozen food, soap, hygienic products, healthy life products, fragrance, and daily drinks. These should stay in the portfolio in March. We believe that the removal of the other items in the uncertain products cluster does not cause a disadvantage to the company since they do not lead to the sale of any other product.

4.3.2.4 Association Rules in April

Table 4.11 MBA April

ORAL CARE PRODUCTS - FRAGRANCE	SOAP - BREAKFAST FOODS	DESSERT&PASTRY - VEGETABLES
CLEANING MATERIALS - LEGUMES	DESSERT&PASTRY - BREAKFAST FOODS	PICKLE - VEGETABLES
DESSERT&PASTRY - LEGUMES	CANDY - BREAKFAST FOODS	FLOUR - VEGETABLES
FLOUR - LEGUMES	CREAM - CHEESE	CANDY - VEGETABLES
CANDY - LEGUMES	TOY - STATIONERY	FLOUR - OIL
DISH WASHERS - CLEANING MATERIALS	SOAP - CANNED GOODS&GRAVY	CANDY - OIL
DISH WASHERS - SOAP	DESSERT&PASTRY - CANNED GOODS&GRAVY	MILK PRODUCTS - SAUCES
CANDY - DISH WASHERS	PICKLE - CANNED GOODS&GRAVY	DESSERT&PASTRY - SAUCES
BISCUITS - CHOCOLATE COVERED	FLOUR - CANNED GOODS&GRAVY	PICKLE - SAUCES
SWEETS - BISCUITS	CANDY - CANNED GOODS&GRAVY	FLOUR - SAUCES
CHIPS - CHOCOLATE COVERED	TOY - BOOKS	CANDY - SAUCES
SWEETS - CHIPS	SOAP - PASTA	MILK PRODUCTS - MILK
FROZEN FOOD - MEAT	MILK PRODUCTS - PASTA	DESSERT&PASTRY - MILK
FROZEN FOOD - DELI MEAT	DESSERT&PASTRY - PASTA	PICKLE - MILK
FROZEN FOOD - CANNED GOODS&GRAVY	FLOUR - PASTA	FLOUR - MILK
FROZEN FOOD - CHEESE	CANDY - PASTA	CANDY - MILK
FROZEN FOOD - VEGETABLES	MARGARINE - CHEESE	MILK PRODUCTS - GREEN
FROZEN FOOD - SAUCES	MARGARINE - VEGETABLES	MILK PRODUCTS - YOGURT
FROZEN FOOD - MILK	MARGARINE - MILK	MILK PRODUCTS - EGG
FROZEN FOOD - GREEN	HEALTHY LIFE PRODUCTS - FRUITS	DESSERT&PASTRY - TOILET PAPER
FROZEN FOOD - YOGURT	DESSERT&PASTRY - FRUITS	DESSERT&PASTRY - FLOUR
FROZEN FOOD - EGG	PICKLE - FRUITS	DESSERT&PASTRY - GREEN
FLOUR - MEAT	FLOUR - FRUITS	DESSERT&PASTRY - YOGURT
HOME CARE PRODUCTS - CLEANING MATERIALS	SOAP - CHEESE	DESSERT&PASTRY - EGG
HOME CARE PRODUCTS - SOAP	HEALTHY LIFE PRODUCTS - CHEESE	DESSERT&PASTRY - TEA&COFFEE
DESSERT&PASTRY - HOME CARE PRODUCTS	MILK PRODUCTS - CHEESE	DESSERT&PASTRY - SNACK
FLOUR - HOME CARE PRODUCTS	DESSERT&PASTRY - CHEESE	DESSERT&PASTRY - CHOCOLATE
CANDY - HOME CARE PRODUCTS	PICKLE - CHEESE	CANDY - DESSERT&PASTRY
HOUSEHOLD CLEANERS - CLEANING MATERIALS	FLOUR - CHEESE	FLOUR - TOILET PAPER
HOUSEHOLD CLEANERS - SOAP	CANDY - CHEESE	CANDY - TOILET PAPER
CLEANING MATERIALS - CANNED GOODS&GRAVY	PICNIC ITEMS - CIGARETTE	FLOUR - BUTTER
CLEANING MATERIALS - PASTA	SOAP - OIL	CANDY - BUTTER
CLEANING MATERIALS - FRUITS	SOAP - SAUCES	PICKLE - GREEN
CLEANING MATERIALS - CHEESE	SOAP - MILK	PICKLE - YOGURT
CLEANING MATERIALS - SOAP	TOILET PAPER - SOAP	FLOUR - GREEN
CLEANING MATERIALS - VEGETABLES	SOAP - GREEN	FLOUR - YOGURT
CLEANING MATERIALS - OIL	SOAP - YOGURT	FLOUR - EGG
CLEANING MATERIALS - SAUCES	SOAP - EGG	FLOUR - TEA&COFFEE
CLEANING MATERIALS - MILK	LAUNDRY PRODUCTS - SOAP	CANDY - FLOUR
TOILET PAPER - CLEANING MATERIALS	SOAP - TEA&COFFEE	CANDY - GREEN
CLEANING MATERIALS - GREEN	SOAP - SNACK	CANDY - YOGURT
CLEANING MATERIALS - YOGURT	HEALTHY LIFE PRODUCTS - VEGETABLES	CANDY - EGG
CLEANING MATERIALS - EGG	HEALTHY LIFE PRODUCTS - SAUCES	CANDY - LAUNDRY PRODUCTS
LAUNDRY PRODUCTS - CLEANING MATERIALS	HEALTHY LIFE PRODUCTS - MILK	CANDY - TEA&COFFEE
CLEANING MATERIALS - TEA&COFFEE	HEALTHY LIFE PRODUCTS - GREEN	CHOCOLATE COVERED - CHOCOLATE
DAILY DRINKS - YOGURT	HEALTHY LIFE PRODUCTS - YOGURT	SWEETS - CHOCOLATE
NUT - FRUITS	HEALTHY LIFE PRODUCTS - EGG	SWEETS - CHOCOLATE COVERED
NUT - VEGETABLES	HEALTHY LIFE PRODUCTS - TEA&COFFEE	
NUT - GREEN	HEALTHY LIFE PRODUCTS - SNACK	

145 rules were found for April. These 145 rules include a total of 20 uncertain products namely flour, dessert&pastry, stationery, sweets, fragrance, daily drinks, toy, frozen food, soap, nut, healthy life products, cleaning materials, chocolate covered, pickle, books, margarine, cream, picnic items, milk products, candy. The uncertain products which were not involved in any of the associations can be taken out from the product portfolio of April because they do not have any impact on customer shopping behavior.

4.3.2.5 Association Rules in May

Table 4.12 MBA May

ORAL CARE PRODUCTS - FRAGRANCE	NUT - VEGETABLES	HEALTHY LIFE PRODUCTS - EGG
SOAP - ORAL CARE PRODUCTS	DESSERT&PASTRY - BREAKFAST FOODS	HEALTHY LIFE PRODUCTS - TEA&COFFEE
CLEANING MATERIALS - LEGUMES	FLOUR - BREAKFAST FOODS	HEALTHY LIFE PRODUCTS - SNACK
DESSERT&PASTRY - LEGUMES	CANDY - BREAKFAST FOODS	PICKLE - VEGETABLES
FLOUR - LEGUMES	CREAM - CHEESE	FLOUR - VEGETABLES
LEGUMES - CANDY	MILK PRODUCTS - CANNED GOODS&GRAVY	DESSERT&PASTRY - OIL
DISH WASHERS - CLEANING MATERIALS	DESSERT&PASTRY - CANNED GOODS&GRAVY	FLOUR - OIL
DISH WASHERS - SOAP	PICKLE - CANNED GOODS&GRAVY	CANDY - OIL
BISCUITS - CHOCOLATE COVERED	FLOUR - CANNED GOODS&GRAVY	DESSERT&PASTRY - SAUCES
SWEETS - BISCUITS	CANDY - CANNED GOODS&GRAVY	PICKLE - SAUCES
CHIPS - CHOCOLATE COVERED	HAIR CARE PRODUCTS - FRAGRANCE	FLOUR - SAUCES
FROZEN FOOD - MEAT	BODY CARE PRODUCTS - FRAGRANCE	CANDY - SAUCES
FROZEN FOOD - DELI MEAT	FRAGRANCE - FACIAL CARE	MILK PRODUCTS - MILK
FROZEN FOOD - CANNED GOODS&GRAVY	SOAP - PASTA	DESSERT&PASTRY - MILK
FROZEN FOOD - PASTA	MILK PRODUCTS - PASTA	FLOUR - MILK
FROZEN FOOD - CHEESE	DESSERT&PASTRY - PASTA	CANDY - MILK
FROZEN FOOD - VEGETABLES	FLOUR - PASTA	MILK PRODUCTS - GREEN
FROZEN FOOD - SAUCES	CANDY - PASTA	MILK PRODUCTS - YOGURT
FROZEN FOOD - MILK	MARGARINE - CHEESE	MILK PRODUCTS - EGG
FROZEN FOOD - GREEN	MARGARINE - VEGETABLES	DESSERT&PASTRY - FLOUR
FROZEN FOOD - YOGURT	MARGARINE - MILK	DESSERT&PASTRY - GREEN
FROZEN FOOD - EGG	HEALTHY LIFE PRODUCTS - FRUITS	DESSERT&PASTRY - YOGURT
FROZEN FOOD - TEA&COFFEE	PICKLE - FRUITS	DESSERT&PASTRY - EGG
FLOUR - MEAT	SOAP - CHEESE	DESSERT&PASTRY - TEA&COFFEE
MILK PRODUCTS - DELI MEAT	MEDICAL PRODUCTS - CHEESE	DESSERT&PASTRY - SNACK
HOME CARE PRODUCTS - CLEANING MATERIALS	HEALTHY LIFE PRODUCTS - CHEESE	DESSERT&PASTRY - CHOCOLATE
SOAP - HOME CARE PRODUCTS	MILK PRODUCTS - CHEESE	CANDY - DESSERT&PASTRY
CANDY - HOME CARE PRODUCTS	DESSERT&PASTRY - CHEESE	CANDY - TOILET PAPER
HOUSEHOLD CLEANERS - CLEANING MATERIALS	PICKLE - CHEESE	PICKLE - GREEN
SOAP - HOUSEHOLD CLEANERS	FLOUR - CHEESE	FLOUR - GREEN
CLEANING MATERIALS - CANNED GOODS&GRAVY	CANDY - CHEESE	FLOUR - YOGURT
CLEANING MATERIALS - PASTA	PICNIC ITEMS - CIGARETTE	FLOUR - EGG
CLEANING MATERIALS - CHEESE	SOAP - OIL	FLOUR - LAUNDRY PRODUCTS
CLEANING MATERIALS - SOAP	SOAP - SAUCES	FLOUR - TEA&COFFEE
CLEANING MATERIALS - OIL	SOAP - MILK	CANDY - FLOUR
CLEANING MATERIALS - SAUCES	TOILET PAPER - SOAP	BODY CARE PRODUCTS - FACIAL CARE
CLEANING MATERIALS - MILK	SOAP - GREEN	CANDY - GREEN
CLEANING MATERIALS - TOILET PAPER	SOAP - YOGURT	CANDY - YOGURT
CLEANING MATERIALS - GREEN	SOAP - EGG	CANDY - EGG
CLEANING MATERIALS - YOGURT	SOAP - LAUNDRY PRODUCTS	CANDY - LAUNDRY PRODUCTS
CLEANING MATERIALS - EGG	SOAP - TEA&COFFEE	CANDY - TEA&COFFEE
LAUNDRY PRODUCTS - CLEANING MATERIALS	SOAP - SNACK	CHOCOLATE COVERED - CHOCOLATE
CLEANING MATERIALS - TEA&COFFEE	HEALTHY LIFE PRODUCTS - SAUCES	SWEETS - CHOCOLATE
DAILY DRINKS - CHEESE	HEALTHY LIFE PRODUCTS - MILK	SWEETS - CHOCOLATE COVERED
DAILY DRINKS - YOGURT	HEALTHY LIFE PRODUCTS - GREEN	
NUT - FRUITS	HEALTHY LIFE PRODUCTS - YOGURT	

136 pairs are extracted from the association rules. For May, we have 20 items from the uncertain products in relation to other products in the portfolio. These products are daily drinks, margarine, soap, picnic items, fragrance, frozen food, chocolate covered, healthy life products, sweets, candy, cream, body care products, medical products, milk products, cleaning materials, flour, nut, dessertpastry, facial care, pickle. The rest of the uncertain products does not assist the sale of any other product. This is why they can be eliminated from the portfolio in May.

4.3.2.6 Association Rules in June

Table 4.13 MBA June

SHOWER&BATH - ORAL CARE PRODUCTS	DAILY DRINKS - MILK	HEALTHY LIFE PRODUCTS - GREEN
ORAL CARE PRODUCTS - FRAGRANCE	DAILY DRINKS - YOGURT	HEALTHY LIFE PRODUCTS - YOGURT
ORAL CARE PRODUCTS - SOAP	DAILY DRINKS - EGG	HEALTHY LIFE PRODUCTS - EGG
DESSERT&PASTRY - LEGUMES	HYGIENIC PRODUCTS - TOILET PAPER	DESSERT&PASTRY - VEGETABLES
FLOUR - LEGUMES	NUT - FRUITS	PICKLE - VEGETABLES
CANDY - LEGUMES	NUT - VEGETABLES	FLOUR - VEGETABLES
DISH WASHERS - CLEANING MATERIALS	DESSERT&PASTRY - BREAKFAST FOODS	CANDY - VEGETABLES
DISH WASHERS - SOAP	DESSERT&PASTRY - CANNED GOODS&GRAVY	CANDY - OIL
DESSERT&PASTRY - BISCUITS	PICKLE - CANNED GOODS&GRAVY	DESSERT&PASTRY - SAUCES
BISCUITS - CHOCOLATE COVERED	CANDY - CANNED GOODS&GRAVY	PICKLE - SAUCES
SWEETS - BISCUITS	HAIR CARE PRODUCTS - FRAGRANCE	FLOUR - SAUCES
SWEETS - CHIPS	FRAGRANCE - TOILET PAPER	CANDY - SAUCES
FROZEN FOOD - MEAT	DESSERT&PASTRY - PASTA	MILK PRODUCTS - MILK
FROZEN FOOD - DELI MEAT	FLOUR - PASTA	DESSERT&PASTRY - MILK
FROZEN FOOD - CANNED GOODS&GRAVY	CANDY - PASTA	FLOUR - MILK
FROZEN FOOD - CHEESE	MARGARINE - CHEESE	CANDY - MILK
FROZEN FOOD - VEGETABLES	MARGARINE - VEGETABLES	MILK PRODUCTS - YOGURT
FROZEN FOOD - SAUCES	HEALTHY LIFE PRODUCTS - FRUITS	DESSERT&PASTRY - FLOUR
FROZEN FOOD - MILK	PICKLE - FRUITS	DESSERT&PASTRY - GREEN
FROZEN FOOD - GREEN	FLOUR - FRUITS	DESSERT&PASTRY - YOGURT
FROZEN FOOD - YOGURT	SOAP - CHEESE	DESSERT&PASTRY - EGG
FROZEN FOOD - EGG	MEDICAL PRODUCTS - CHEESE	DESSERT&PASTRY - TEA&COFFEE
SHOWER&BATH - HAIR CARE PRODUCTS	HEALTHY LIFE PRODUCTS - CHEESE	DESSERT&PASTRY - SNACK
HOME CARE PRODUCTS - CLEANING MATERIALS	MILK PRODUCTS - CHEESE	CANDY - DESSERT&PASTRY
SOAP - HOME CARE PRODUCTS	DESSERT&PASTRY - CHEESE	CANDY - TOILET PAPER
DESSERT&PASTRY - HOME CARE PRODUCTS	PICKLE - CHEESE	PICKLE - GREEN
CANDY - HOME CARE PRODUCTS	FLOUR - CHEESE	FLOUR - GREEN
HOUSEHOLD CLEANERS - CLEANING MATERIALS	CANDY - CHEESE	FLOUR - YOGURT
SOAP - HOUSEHOLD CLEANERS	PICNIC ITEMS - CIGARETTE	FLOUR - EGG
CLEANING MATERIALS - CHEESE	HAIR CARE PRODUCTS - SOAP	FLOUR - TEA&COFFEE
CLEANING MATERIALS - SOAP	SOAP - SAUCES	CANDY - FLOUR
CLEANING MATERIALS - VEGETABLES	SOAP - MILK	CANDY - GREEN
CLEANING MATERIALS - SAUCES	TOILET PAPER - SOAP	CANDY - YOGURT
CLEANING MATERIALS - MILK	SOAP - GREEN	CANDY - EGG
CLEANING MATERIALS - TOILET PAPER	SOAP - YOGURT	CANDY - LAUNDRY PRODUCTS
CLEANING MATERIALS - GREEN	SOAP - EGG	CANDY - TEA&COFFEE
CLEANING MATERIALS - YOGURT	LAUNDRY PRODUCTS - SOAP	CHOCOLATE COVERED - CHOCOLATE
CLEANING MATERIALS - EGG	SOAP - TEA&COFFEE	SWEETS - CHOCOLATE
LAUNDRY PRODUCTS - CLEANING MATERIALS	HEALTHY LIFE PRODUCTS - VEGETABLES	SWEETS - CHOCOLATE COVERED
CLEANING MATERIALS - TEA&COFFEE	HEALTHY LIFE PRODUCTS - MILK	

There are 119 different associated pairs in June. These include 19 uncertain products which are soap, pickle, cleaning materials, daily drinks, picnic items, frozen food, nut, hygienic products, fragrance, chocolate covered, healthy life products, candy, medical products, sweets, shower&bath, margarine, dessert&pastry, milk products, and flour. Products in the cluster of uncertain products except these ones can be dropped from the product portfolio of June since they are not bought with any of the products in the portfolio.

4.3.2.7 Association Rules in July

Table 4.14 MBA July

ORAL CARE PRODUCTS - FRAGRANCE	CLEANING MATERIALS - MILK	SOAP - TEA&COFFEE
SOAP - ORAL CARE PRODUCTS	TOILET PAPER - CLEANING MATERIALS	HEALTHY LIFE PRODUCTS - VEGETABLES
FLOUR - LEGUMES	CLEANING MATERIALS - GREEN	HEALTHY LIFE PRODUCTS - MILK
CANDY - LEGUMES	CLEANING MATERIALS - YOGURT	DESSERT&PASTRY - VEGETABLES
DISH WASHERS - CLEANING MATERIALS	CLEANING MATERIALS - EGG	PICKLE - VEGETABLES
DISH WASHERS - SOAP	LAUNDRY PRODUCTS - CLEANING MATERIALS	FLOUR - VEGETABLES
DESSERT&PASTRY - BISCUITS	CLEANING MATERIALS - TEA&COFFEE	CANDY - OIL
BISCUITS - CHOCOLATE COVERED	DAILY DRINKS - YOGURT	DESSERT&PASTRY - SAUCES
SWEETS - BISCUITS	DESSERT&PASTRY - CANNED GOODS&GRAVY	PICKLE - SAUCES
SWEETS - CHIPS	PICKLE - CANNED GOODS&GRAVY	FLOUR - SAUCES
FROZEN FOOD - MEAT	HAIR CARE PRODUCTS - FRAGRANCE	CANDY - SAUCES
FROZEN FOOD - DELI MEAT	DESSERT&PASTRY - PASTA	MILK PRODUCTS - MILK
FROZEN FOOD - CANNED GOODS&GRAVY	CANDY - PASTA	DESSERT&PASTRY - MILK
FROZEN FOOD - FRUITS	MARGARINE - CHEESE	FLOUR - MILK
FROZEN FOOD - CHEESE	MARGARINE - VEGETABLES	CANDY - MILK
FROZEN FOOD - VEGETABLES	HEALTHY LIFE PRODUCTS - FRUITS	MILK PRODUCTS - YOGURT
FROZEN FOOD - SAUCES	DESSERT&PASTRY - FRUITS	DESSERT&PASTRY - FLOUR
FROZEN FOOD - MILK	FLOUR - FRUITS	DESSERT&PASTRY - GREEN
FROZEN FOOD - GREEN	SOAP - CHEESE	DESSERT&PASTRY - YOGURT
FROZEN FOOD - YOGURT	HEALTHY LIFE PRODUCTS - CHEESE	DESSERT&PASTRY - EGG
FROZEN FOOD - EGG	MILK PRODUCTS - CHEESE	DESSERT&PASTRY - TEA&COFFEE
SHOWER&BATH - HAIR CARE PRODUCTS	DESSERT&PASTRY - CHEESE	CANDY - TOILET PAPER
HOME CARE PRODUCTS - CLEANING MATERIALS	FLOUR - CHEESE	FLOUR - GREEN
SOAP - HOME CARE PRODUCTS	CANDY - CHEESE	FLOUR - YOGURT
CANDY - HOME CARE PRODUCTS	PICNIC ITEMS - CIGARETTE	FLOUR - EGG
HOUSEHOLD CLEANERS - CLEANING MATERIALS	SOAP - SAUCES	FLOUR - TEA&COFFEE
SOAP - HOUSEHOLD CLEANERS	SOAP - MILK	CANDY - EGG
DISPOSABLE PRODUCTS - BEVERAGES	TOILET PAPER - SOAP	CANDY - LAUNDRY PRODUCTS
CLEANING MATERIALS - CHEESE	SOAP - GREEN	CANDY - TEA&COFFEE
CLEANING MATERIALS - SOAP	SOAP - YOGURT	CHOCOLATE COVERED - CHOCOLATE
CLEANING MATERIALS - VEGETABLES	SOAP - EGG	SWEETS - CHOCOLATE
CLEANING MATERIALS - SAUCES	LAUNDRY PRODUCTS - SOAP	SWEETS - CHOCOLATE COVERED

96 association rules were determined in the process of market basket analysis for July. The common pairs for the July 2018 and July 2019 are presented above. These pairs include sweets, disposable products, flour, pickle, picnic items, margarine, shower&bath, dessert&pastry, milk products, candy, cleaning materials, healthy life products, chocolate covered, fragrance, soap, daily drinks, frozen food. These 17 products are considered as tended to get sold together with other related products in the portfolio. For this reason, these should be kept in the product portfolio. For the ones without any association with other products, a move-out operation can be under consideration for July as it seems like a removal would not damage the company since they are low-performing and irrelevant items in the portfolio.

4.3.2.8 Association Rules in August

Table 4.15 MBA August

SHOWER&BATH - ORAL CARE PRODUCTS	CLEANING MATERIALS - EGG	HEALTHY LIFE PRODUCTS - MILK
ORAL CARE PRODUCTS - FRAGRANCE	LAUNDRY PRODUCTS - CLEANING MATERIALS	HEALTHY LIFE PRODUCTS - YOGURT
ORAL CARE PRODUCTS - SOAP	CLEANING MATERIALS - TEA&COFFEE	DESSERT&PASTRY - VEGETABLES
DESSERT&PASTRY - LEGUMES	DAILY DRINKS - CHEESE	PICKLE - VEGETABLES
FLOUR - LEGUMES	DAILY DRINKS - MILK	FLOUR - VEGETABLES
CANDY - LEGUMES	DAILY DRINKS - YOGURT	CANDY - VEGETABLES
DISH WASHERS - CLEANING MATERIALS	DESSERT&PASTRY - BREAKFAST FOODS	FLOUR - OIL
DISH WASHERS - SOAP	DESSERT&PASTRY - CANNED GOODS&GRAVY	CANDY - OIL
BISCUITS - CHOCOLATE COVERED	PICKLE - CANNED GOODS&GRAVY	DESSERT&PASTRY - SAUCES
SWEETS - BISCUITS	HAIR CARE PRODUCTS - FRAGRANCE	PICKLE - SAUCES
CHIPS - CHOCOLATE COVERED	FRAGRANCE - LAUNDRY PRODUCTS	FLOUR - SAUCES
SWEETS - CHIPS	SOAP - PASTA	CANDY - SAUCES
FROZEN FOOD - DELI MEAT	DESSERT&PASTRY - PASTA	MILK PRODUCTS - MILK
FROZEN FOOD - CANNED GOODS&GRAVY	FLOUR - PASTA	DESSERT&PASTRY - MILK
FROZEN FOOD - FRUITS	CANDY - PASTA	FLOUR - MILK
FROZEN FOOD - CHEESE	MARGARINE - CHEESE	CANDY - MILK
FROZEN FOOD - VEGETABLES	MARGARINE - VEGETABLES	MILK PRODUCTS - YOGURT
FROZEN FOOD - SAUCES	HEALTHY LIFE PRODUCTS - FRUITS	DESSERT&PASTRY - FLOUR
FROZEN FOOD - MILK	DESSERT&PASTRY - FRUITS	DESSERT&PASTRY - GREEN
FROZEN FOOD - GREEN	PICKLE - FRUITS	DESSERT&PASTRY - YOGURT
FROZEN FOOD - YOGURT	FLOUR - FRUITS	DESSERT&PASTRY - EGG
FROZEN FOOD - EGG	SOAP - CHEESE	DESSERT&PASTRY - LAUNDRY PRODUCTS
SHOWER&BATH - HAIR CARE PRODUCTS	HEALTHY LIFE PRODUCTS - CHEESE	DESSERT&PASTRY - TEA&COFFEE
HOME CARE PRODUCTS - CLEANING MATERIALS	MILK PRODUCTS - CHEESE	CANDY - DESSERT&PASTRY
HOME CARE PRODUCTS - SOAP	DESSERT&PASTRY - CHEESE	CANDY - TOILET PAPER
DESSERT&PASTRY - HOME CARE PRODUCTS	PICKLE - CHEESE	PICKLE - BAKERY
CANDY - HOME CARE PRODUCTS	FLOUR - CHEESE	PICKLE - GREEN
HOUSEHOLD CLEANERS - CLEANING MATERIALS	CANDY - CHEESE	FLOUR - GREEN
HOUSEHOLD CLEANERS - SOAP	PICNIC ITEMS - CIGARETTE	FLOUR - YOGURT
DISPOSABLE PRODUCTS - BEVERAGES	HAIR CARE PRODUCTS - SOAP	FLOUR - EGG
CLEANING MATERIALS - PASTA	SOAP - OIL	FLOUR - TEA&COFFEE
CLEANING MATERIALS - FRUITS	SOAP - SAUCES	CANDY - FLOUR
CLEANING MATERIALS - CHEESE	SOAP - MILK	CANDY - YOGURT
CLEANING MATERIALS - SOAP	TOILET PAPER - SOAP	CANDY - EGG
CLEANING MATERIALS - VEGETABLES	SOAP - GREEN	CANDY - LAUNDRY PRODUCTS
CLEANING MATERIALS - OIL	SOAP - YOGURT	CANDY - TEA&COFFEE
CLEANING MATERIALS - SAUCES	SOAP - EGG	CHOCOLATE COVERED - CHOCOLATE
CLEANING MATERIALS - MILK	LAUNDRY PRODUCTS - SOAP	SWEETS - CHOCOLATE
CLEANING MATERIALS - TOILET PAPER	SOAP - TEA&COFFEE	SWEETS - CHOCOLATE COVERED
CLEANING MATERIALS - GREEN	SOAP - SNACK	
CLEANING MATERIALS - YOGURT	HEALTHY LIFE PRODUCTS - VEGETABLES	

155 unique pairs which include at least one uncertain product are extracted with the association rule mining process for August. 17 different items from uncertain products cluster were detected. These items are frozen food, daily drinks, soap, fragrance, chocolate covered, healthy life products, cleaning materials, candy, milk products, dessert&pastry, shower&bath, sweets, flour, disposable products, picnic items, pickle, and margarine. The rest of the items belonging to the cluster of uncertain products can be removed from the product portfolio because they do not help to sales of any other product and are not accompanied by the sales of any product in August according to obtained results of the market basket analysis.

4.3.2.9 Association Rules in September

Table 4.16 MBA September

SHOWER&BATH - ORAL CARE PRODUCTS	DAILY DRINKS - CHEESE	HEALTHY LIFE PRODUCTS - YOGURT
ORAL CARE PRODUCTS - FRAGRANCE	DAILY DRINKS - MILK	HEALTHY LIFE PRODUCTS - EGG
ORAL CARE PRODUCTS - SOAP	DAILY DRINKS - YOGURT	HEALTHY LIFE PRODUCTS - TEA&COFFEE
CLEANING MATERIALS - LEGUMES	DAILY DRINKS - EGG	HEALTHY LIFE PRODUCTS - SNACK
SOAP - LEGUMES	HYGIENIC PRODUCTS - TOILET PAPER	DESSERT&PASTRY - VEGETABLES
DESSERT&PASTRY - LEGUMES	HYGIENIC PRODUCTS - LAUNDRY PRODUCTS	PICKLE - VEGETABLES
FLOUR - LEGUMES	NUT - FRUITS	FLOUR - VEGETABLES
CANDY - LEGUMES	NUT - VEGETABLES	CANDY - VEGETABLES
SOAP - BABY PRODUCTS	SOAP - BREAKFAST FOODS	FLOUR - OIL
DISH WASHERS - CLEANING MATERIALS	DESSERT&PASTRY - BREAKFAST FOODS	CANDY - OIL
DISH WASHERS - SOAP	SOAP - CANNED GOODS&GRAVY	MILK PRODUCTS - SAUCES
CANDY - DISH WASHERS	DESSERT&PASTRY - CANNED GOODS&GRAVY	DESSERT&PASTRY - SAUCES
BISCUITS - CHOCOLATE COVERED	PICKLE - CANNED GOODS&GRAVY	PICKLE - SAUCES
SWEETS - BISCUITS	FLOUR - CANNED GOODS&GRAVY	FLOUR - SAUCES
CHIPS - CHOCOLATE COVERED	CANDY - CANNED GOODS&GRAVY	CANDY - SAUCES
SWEETS - CHIPS	HAIR CARE PRODUCTS - FRAGRANCE	MILK PRODUCTS - MILK
FROZEN FOOD - DELI MEAT	FRAGRANCE - TOILET PAPER	DESSERT&PASTRY - MILK
FROZEN FOOD - CANNED GOODS&GRAVY	SOAP - PASTA	FLOUR - MILK
FROZEN FOOD - PASTA	MILK PRODUCTS - PASTA	CANDY - MILK
FROZEN FOOD - FRUITS	DESSERT&PASTRY - PASTA	MILK PRODUCTS - GREEN
FROZEN FOOD - CHEESE	FLOUR - PASTA	MILK PRODUCTS - YOGURT
FROZEN FOOD - VEGETABLES	CANDY - PASTA	MILK PRODUCTS - EGG
FROZEN FOOD - SAUCES	MARGARINE - CHEESE	DESSERT&PASTRY - TOILET PAPER
FROZEN FOOD - MILK	MARGARINE - VEGETABLES	DESSERT&PASTRY - FLOUR
FROZEN FOOD - GREEN	MARGARINE - MILK	DESSERT&PASTRY - GREEN
FROZEN FOOD - YOGURT	HEALTHY LIFE PRODUCTS - FRUITS	DESSERT&PASTRY - YOGURT
FROZEN FOOD - EGG	DESSERT&PASTRY - FRUITS	DESSERT&PASTRY - EGG
SHOWER&BATH - HAIR CARE PRODUCTS	PICKLE - FRUITS	DESSERT&PASTRY - LAUNDRY PRODUCTS
SHOWER&BATH - LAUNDRY PRODUCTS	FLOUR - FRUITS	DESSERT&PASTRY - TEA&COFFEE
HOME CARE PRODUCTS - CLEANING MATERIALS	SOAP - CHEESE	DESSERT&PASTRY - SNACK
HYGIENIC PRODUCTS - HOME CARE PRODUCTS	MEDICAL PRODUCTS - CHEESE	DESSERT&PASTRY - CHOCOLATE
HOME CARE PRODUCTS - SOAP	HEALTHY LIFE PRODUCTS - CHEESE	CANDY - DESSERT&PASTRY
DESSERT&PASTRY - HOME CARE PRODUCTS	MILK PRODUCTS - CHEESE	FLOUR - TOILET PAPER
FLOUR - HOME CARE PRODUCTS	DESSERT&PASTRY - CHEESE	CANDY - TOILET PAPER
CANDY - HOME CARE PRODUCTS	PICKLE - CHEESE	FLOUR - BUTTER
HOUSEHOLD CLEANERS - CLEANING MATERIALS	FLOUR - CHEESE	PICKLE - GREEN
HOUSEHOLD CLEANERS - SOAP	CANDY - CHEESE	FLOUR - GREEN
CLEANING MATERIALS - CANNED GOODS&GRAVY	PICNIC ITEMS - CIGARETTE	FLOUR - YOGURT
CLEANING MATERIALS - PASTA	HAIR CARE PRODUCTS - SOAP	FLOUR - EGG
CLEANING MATERIALS - FRUITS	SOAP - SAUCES	FLOUR - LAUNDRY PRODUCTS
CLEANING MATERIALS - CHEESE	SOAP - MILK	FLOUR - TEA&COFFEE
CLEANING MATERIALS - SOAP	TOILET PAPER - SOAP	CANDY - FLOUR
CLEANING MATERIALS - VEGETABLES	SOAP - GREEN	CANDY - GREEN
CLEANING MATERIALS - OIL	SOAP - YOGURT	CANDY - YOGURT
CLEANING MATERIALS - SAUCES	SOAP - EGG	CANDY - EGG
CLEANING MATERIALS - MILK	LAUNDRY PRODUCTS - SOAP	CANDY - LAUNDRY PRODUCTS
TOILET PAPER - CLEANING MATERIALS	SOAP - TEA&COFFEE	CANDY - TEA&COFFEE
CLEANING MATERIALS - GREEN	MEDICAL PRODUCTS - TOILET PAPER	CANDY - SNACK
CLEANING MATERIALS - YOGURT	HEALTHY LIFE PRODUCTS - VEGETABLES	CHOCOLATE COVERED - CHOCOLATE
CLEANING MATERIALS - EGG	HEALTHY LIFE PRODUCTS - SAUCES	SWEETS - CHOCOLATE
LAUNDRY PRODUCTS - CLEANING MATERIALS	HEALTHY LIFE PRODUCTS - MILK	SWEETS - CHOCOLATE COVERED
CLEANING MATERIALS - TEA&COFFEE	HEALTHY LIFE PRODUCTS - GREEN	

There are 155 pairs acquired by the market basket analysis. These pairs include at least one item from the cluster of uncertain products. These contain 19 separate items from the uncertain products. These products are margarine, pickle, picnic items, flour, sweets, shower&bath, dessert&pastry, milk products, medical products, candy, nut, cleaning materials, hygienic products, healthy life products, chocolate covered, fragrance, soap, daily drink, frozen food. Other items in the cluster of uncertain products are not effectively involved in the shopping pattern of customers. That is why they can be dropped from the product portfolio in September.

4.3.2.10 Association Rules in October

Table 4.17 MBA October

FRAGRANCE - ORAL CARE PRODUCTS	DAILY DRINKS - YOGURT	FLOUR - VEGETABLES
SOAP - ORAL CARE PRODUCTS	NUT - FRUITS	CANDY - VEGETABLES
CLEANING MATERIALS - LEGUMES	NUT - VEGETABLES	FLOUR - OIL
SOAP - LEGUMES	DESSERT&PASTRY - BREAKFAST FOODS	CANDY - OIL
DESSERT&PASTRY - LEGUMES	FLOUR - BREAKFAST FOODS	MILK PRODUCTS - SAUCES
FLOUR - LEGUMES	DESSERT&PASTRY - CANNED GOODS&GRAVY	DESSERT&PASTRY - SAUCES
CANDY - LEGUMES	PICKLE - CANNED GOODS&GRAVY	PICKLE - SAUCES
DISH WASHERS - CLEANING MATERIALS	FLOUR - CANNED GOODS&GRAVY	FLOUR - SAUCES
DISH WASHERS - SOAP	CANDY - CANNED GOODS&GRAVY	CANDY - SAUCES
BISCUITS - CHOCOLATE COVERED	SOAP - PASTA	MILK PRODUCTS - MILK
SWEETS - BISCUITS	MILK PRODUCTS - PASTA	DESSERT&PASTRY - MILK
CHIPS - CHOCOLATE COVERED	DESSERT&PASTRY - PASTA	FLOUR - MILK
FROZEN FOOD - MEAT	FLOUR - PASTA	CANDY - MILK
FROZEN FOOD - DELI MEAT	CANDY - PASTA	MILK PRODUCTS - GREEN
FROZEN FOOD - CANNED GOODS&GRAVY	MARGARINE - CHEESE	MILK PRODUCTS - YOGURT
FROZEN FOOD - CHEESE	MARGARINE - VEGETABLES	MILK PRODUCTS - EGG
FROZEN FOOD - VEGETABLES	MARGARINE - MILK	BUTTER - DESSERT&PASTRY
FROZEN FOOD - SAUCES	MARGARINE - EGG	DESSERT&PASTRY - FLOUR
FROZEN FOOD - MILK	HEALTHY LIFE PRODUCTS - FRUITS	DESSERT&PASTRY - GREEN
FROZEN FOOD - GREEN	PICKLE - FRUITS	DESSERT&PASTRY - YOGURT
FROZEN FOOD - YOGURT	FLOUR - FRUITS	DESSERT&PASTRY - EGG
FROZEN FOOD - EGG	SOAP - CHEESE	DESSERT&PASTRY - LAUNDRY PRODUCTS
SHOWER&BATH - HAIR CARE PRODUCTS	HEALTHY LIFE PRODUCTS - CHEESE	DESSERT&PASTRY - TEA&COFFEE
FLOUR - MEAT	MILK PRODUCTS - CHEESE	DESSERT&PASTRY - SNACK
HOME CARE PRODUCTS - CLEANING MATERIALS	DESSERT&PASTRY - CHEESE	DESSERT&PASTRY - CHOCOLATE
SOAP - HOME CARE PRODUCTS	PICKLE - CHEESE	CANDY - DESSERT&PASTRY
DESSERT&PASTRY - HOME CARE PRODUCTS	FLOUR - CHEESE	FLOUR - TOILET PAPER
FLOUR - HOME CARE PRODUCTS	CANDY - CHEESE	CANDY - TOILET PAPER
CANDY - HOME CARE PRODUCTS	PICNIC ITEMS - CIGARETTE	BUTTER - FLOUR
HOUSEHOLD CLEANERS - CLEANING MATERIALS	SOAP - SAUCES	PICKLE - GREEN
HOUSEHOLD CLEANERS - SOAP	SOAP - MILK	FLOUR - GREEN
CLEANING MATERIALS - PASTA	TOILET PAPER - SOAP	FLOUR - YOGURT
CLEANING MATERIALS - CHEESE	SOAP - GREEN	FLOUR - EGG
CLEANING MATERIALS - SOAP	SOAP - YOGURT	FLOUR - LAUNDRY PRODUCTS
CLEANING MATERIALS - VEGETABLES	SOAP - EGG	FLOUR - TEA&COFFEE
CLEANING MATERIALS - OIL	SOAP - LAUNDRY PRODUCTS	CANDY - FLOUR
CLEANING MATERIALS - SAUCES	SOAP - TEA&COFFEE	CANDY - GREEN
CLEANING MATERIALS - MILK	SOAP - SNACK	CANDY - YOGURT
TOILET PAPER - CLEANING MATERIALS	MEDICAL PRODUCTS - TOILET PAPER	CANDY - EGG
CLEANING MATERIALS - GREEN	HEALTHY LIFE PRODUCTS - VEGETABLES	CANDY - LAUNDRY PRODUCTS
CLEANING MATERIALS - YOGURT	HEALTHY LIFE PRODUCTS - SAUCES	CANDY - TEA&COFFEE
CLEANING MATERIALS - EGG	HEALTHY LIFE PRODUCTS - MILK	CHOCOLATE COVERED - CHOCOLATE
LAUNDRY PRODUCTS - CLEANING MATERIALS	HEALTHY LIFE PRODUCTS - GREEN	SWEETS - CHOCOLATE
CLEANING MATERIALS - TEA&COFFEE	HEALTHY LIFE PRODUCTS - EGG	SWEETS - CHOCOLATE COVERED
DAILY DRINKS - CHEESE	DESSERT&PASTRY - VEGETABLES	
DAILY DRINKS - MILK	PICKLE - VEGETABLES	

136 association rules containing uncertain products were found. These consist of 18 of them: cleaning materials, candy, dessert&pastry, flour, shower&bath, fragrance, healthy life products, medical products, chocolate covered, nut, pickle, milk products, margarine, frozen food, picnic items, soap, sweets, and daily drinks. For the rest of the items in uncertain products, they can be eliminated for the reason of poor sales performance and any (or too weak) association with the rest of the product portfolio.

4.3.2.11 Association Rules in November

Table 4.18 MBA November

FRAGRANCE - ORAL CARE PRODUCTS	NUT - FRUITS	PICKLE - VEGETABLES
SOAP - ORAL CARE PRODUCTS	NUT - VEGETABLES	FLOUR - VEGETABLES
CLEANING MATERIALS - LEGUMES	DESSERT&PASTRY - BREAKFAST FOODS	CANDY - VEGETABLES
DESSERT&PASTRY - LEGUMES	FLOUR - BREAKFAST FOODS	FLOUR - OIL
FLOUR - LEGUMES	CREAM - CHEESE	CANDY - OIL
CANDY - LEGUMES	MILK PRODUCTS - CANNED GOODS&GRAVY	MILK PRODUCTS - SAUCES
DISH WASHERS - CLEANING MATERIALS	DESSERT&PASTRY - CANNED GOODS&GRAVY	DESSERT&PASTRY - SAUCES
DISH WASHERS - SOAP	PICKLE - CANNED GOODS&GRAVY	PICKLE - SAUCES
CANDY - DISH WASHERS	FLOUR - CANNED GOODS&GRAVY	FLOUR - SAUCES
BISCUITS - CHOCOLATE COVERED	CANDY - CANNED GOODS&GRAVY	CANDY - SAUCES
SWEETS - BISCUITS	SOAP - PASTA	MILK PRODUCTS - MILK
CHIPS - CHOCOLATE COVERED	MILK PRODUCTS - PASTA	DESSERT&PASTRY - MILK
FROZEN FOOD - MEAT	DESSERT&PASTRY - PASTA	FLOUR - MILK
FROZEN FOOD - DELI MEAT	FLOUR - PASTA	CANDY - MILK
FROZEN FOOD - CANNED GOODS&GRAVY	CANDY - PASTA	MILK PRODUCTS - GREEN
FROZEN FOOD - PASTA	MARGARINE - CHEESE	MILK PRODUCTS - YOGURT
FROZEN FOOD - CHEESE	MARGARINE - VEGETABLES	MILK PRODUCTS - EGG
FROZEN FOOD - VEGETABLES	MARGARINE - MILK	BUTTER - DESSERT&PASTRY
FROZEN FOOD - SAUCES	MARGARINE - EGG	DESSERT&PASTRY - FLOUR
FROZEN FOOD - MILK	HEALTHY LIFE PRODUCTS - FRUITS	DESSERT&PASTRY - GREEN
FROZEN FOOD - GREEN	PICKLE - FRUITS	DESSERT&PASTRY - YOGURT
FROZEN FOOD - YOGURT	SOAP - CHEESE	DESSERT&PASTRY - EGG
FROZEN FOOD - EGG	HEALTHY LIFE PRODUCTS - CHEESE	DESSERT&PASTRY - TEA&COFFEE
FLOUR - MEAT	MILK PRODUCTS - CHEESE	DESSERT&PASTRY - SNACK
HOME CARE PRODUCTS - CLEANING MATERIALS	DESSERT&PASTRY - CHEESE	DESSERT&PASTRY - CHOCOLATE
SOAP - HOME CARE PRODUCTS	PICKLE - CHEESE	CANDY - DESSERT&PASTRY
DESSERT&PASTRY - HOME CARE PRODUCTS	FLOUR - CHEESE	FLOUR - TOILET PAPER
FLOUR - HOME CARE PRODUCTS	CANDY - CHEESE	CANDY - TOILET PAPER
CANDY - HOME CARE PRODUCTS	PICNIC ITEMS - CIGARETTE	FLOUR - BUTTER
HOUSEHOLD CLEANERS - CLEANING MATERIALS	SOAP - VEGETABLES	CANDY - BUTTER
HOUSEHOLD CLEANERS - SOAP	SOAP - SAUCES	PICKLE - GREEN
CLEANING MATERIALS - CANNED GOODS&GRAVY	SOAP - MILK	PICKLE - YOGURT
CLEANING MATERIALS - PASTA	TOILET PAPER - SOAP	FLOUR - GREEN
CLEANING MATERIALS - FRUITS	SOAP - GREEN	FLOUR - YOGURT
CLEANING MATERIALS - CHEESE	SOAP - YOGURT	FLOUR - EGG
CLEANING MATERIALS - SOAP	SOAP - EGG	FLOUR - LAUNDRY PRODUCTS
CLEANING MATERIALS - VEGETABLES	SOAP - LAUNDRY PRODUCTS	FLOUR - TEA&COFFEE
CLEANING MATERIALS - OIL	SOAP - TEA&COFFEE	CANDY - FLOUR
CLEANING MATERIALS - SAUCES	HEALTHY LIFE PRODUCTS - VEGETABLES	CANDY - GREEN
CLEANING MATERIALS - MILK	HEALTHY LIFE PRODUCTS - SAUCES	CANDY - YOGURT
CLEANING MATERIALS - TOILET PAPER	HEALTHY LIFE PRODUCTS - MILK	CANDY - EGG
CLEANING MATERIALS - GREEN	HEALTHY LIFE PRODUCTS - GREEN	CANDY - LAUNDRY PRODUCTS
CLEANING MATERIALS - YOGURT	HEALTHY LIFE PRODUCTS - YOGURT	CANDY - TEA&COFFEE
CLEANING MATERIALS - EGG	HEALTHY LIFE PRODUCTS - EGG	CHOCOLATE COVERED - CHOCOLATE
LAUNDRY PRODUCTS - CLEANING MATERIALS	HEALTHY LIFE PRODUCTS - TEA&COFFEE	SWEETS - CHOCOLATE
CLEANING MATERIALS - TEA&COFFEE	HEALTHY LIFE PRODUCTS - SNACK	SWEETS - CHOCOLATE COVERED
DAILY DRINKS - YOGURT	MILK PRODUCTS - VEGETABLES	
DAILY DRINKS - EGG	DESSERT&PASTRY - VEGETABLES	

142 association rules including uncertain products were detected in November. 17 unique products were found from the uncertain products in these pairs. These are pickle, flour, candy, soap, milk products, chocolate covered, cream, sweets, margarine, cleaning materials, nut, daily drinks, picnic items, fragrance, frozen food, dessertpastry, healthy life products. These products should stay in the portfolio in November. But the rest of the items in the uncertain products cluster can be excluded due to inefficiency.

4.3.2.12 Association Rules in December

Table 4.19 MBA December

ORNAMENT PRODUCT - LIGHTING&ELECTRICAL MATERIALS	DAILY DRINKS - YOGURT	HEALTHY LIFE PRODUCTS - SNACK
CLEANING MATERIALS - LEGUMES	NUT - FRUITS	MILK PRODUCTS - VEGETABLES
SOAP - LEGUMES	NUT - VEGETABLES	DESSERT&PASTRY - VEGETABLES
DESSERT&PASTRY - LEGUMES	DESSERT&PASTRY - BREAKFAST FOODS	PICKLE - VEGETABLES
FLOUR - LEGUMES	FLOUR - BREAKFAST FOODS	FLOUR - VEGETABLES
CANDY - LEGUMES	CANDY - BREAKFAST FOODS	CANDY - VEGETABLES
DISH WASHERS - CLEANING MATERIALS	CREAM - CHEESE	FLOUR - OIL
DISH WASHERS - SOAP	SOAP - CANNED GOODS&GRAVY	CANDY - OIL
BISCUITS - CHOCOLATE COVERED	MILK PRODUCTS - CANNED GOODS&GRAVY	MILK PRODUCTS - SAUCES
SWEETS - BISCUITS	DESSERT&PASTRY - CANNED GOODS&GRAVY	DESSERT&PASTRY - SAUCES
SWEETS - CHIPS	PICKLE - CANNED GOODS&GRAVY	PICKLE - SAUCES
FROZEN FOOD - MEAT	FLOUR - CANNED GOODS&GRAVY	FLOUR - SAUCES
FROZEN FOOD - DELI MEAT	CANDY - CANNED GOODS&GRAVY	CANDY - SAUCES
FROZEN FOOD - BEVERAGES	SOAP - PASTA	MILK PRODUCTS - MILK
FROZEN FOOD - CANNED GOODS&GRAVY	MILK PRODUCTS - PASTA	DESSERT&PASTRY - MILK
FROZEN FOOD - PASTA	DESSERT&PASTRY - PASTA	PICKLE - MILK
FROZEN FOOD - FRUITS	PICKLE - PASTA	FLOUR - MILK
FROZEN FOOD - CHEESE	FLOUR - PASTA	CANDY - MILK
FROZEN FOOD - VEGETABLES	CANDY - PASTA	MILK PRODUCTS - GREEN
FROZEN FOOD - SAUCES	MARGARINE - CHEESE	MILK PRODUCTS - YOGURT
FROZEN FOOD - MILK	MARGARINE - VEGETABLES	MILK PRODUCTS - EGG
FROZEN FOOD - GREEN	MARGARINE - SAUCES	BUTTER - DESSERT&PASTRY
FROZEN FOOD - YOGURT	MARGARINE - MILK	DESSERT&PASTRY - FLOUR
FROZEN FOOD - EGG	MARGARINE - DESSERT&PASTRY	DESSERT&PASTRY - GREEN
FROZEN FOOD - TEA&COFFEE	MARGARINE - YOGURT	DESSERT&PASTRY - YOGURT
FROZEN FOOD - SNACK	MARGARINE - EGG	DESSERT&PASTRY - EGG
FLOUR - MEAT	HEALTHY LIFE PRODUCTS - FRUITS	DESSERT&PASTRY - TEA&COFFEE
MILK PRODUCTS - DELI MEAT	PICKLE - FRUITS	DESSERT&PASTRY - SNACK
PICKLE - DELI MEAT	FLOUR - FRUITS	DESSERT&PASTRY - CHOCOLATE
HOME CARE PRODUCTS - CLEANING MATERIALS	SOAP - CHEESE	CANDY - DESSERT&PASTRY
SOAP - HOME CARE PRODUCTS	HEALTHY LIFE PRODUCTS - CHEESE	FLOUR - TOILET PAPER
DESSERT&PASTRY - HOME CARE PRODUCTS	MILK PRODUCTS - CHEESE	CANDY - TOILET PAPER
FLOUR - HOME CARE PRODUCTS	DESSERT&PASTRY - CHEESE	BUTTER - FLOUR
CANDY - HOME CARE PRODUCTS	PICKLE - CHEESE	CANDY - BUTTER
HOUSEHOLD CLEANERS - CLEANING MATERIALS	FLOUR - CHEESE	PICKLE - GREEN
SOAP - HOUSEHOLD CLEANERS	CANDY - CHEESE	PICKLE - YOGURT
CLEANING MATERIALS - CANNED GOODS&GRAVY	PICNIC ITEMS - CIGARETTE	PICKLE - SNACK
CLEANING MATERIALS - PASTA	SOAP - SAUCES	FLOUR - GREEN
CLEANING MATERIALS - FRUITS	SOAP - MILK	FLOUR - YOGURT
CLEANING MATERIALS - CHEESE	TOILET PAPER - SOAP	FLOUR - EGG
CLEANING MATERIALS - SOAP	SOAP - GREEN	FLOUR - LAUNDRY PRODUCTS
CLEANING MATERIALS - VEGETABLES	SOAP - YOGURT	FLOUR - TEA&COFFEE
CLEANING MATERIALS - OIL	SOAP - EGG	CANDY - FLOUR
CLEANING MATERIALS - SAUCES	LAUNDRY PRODUCTS - SOAP	CANDY - GREEN
CLEANING MATERIALS - MILK	SOAP - TEA&COFFEE	CANDY - YOGURT
CLEANING MATERIALS - TOILET PAPER	HEALTHY LIFE PRODUCTS - VEGETABLES	CANDY - EGG
CLEANING MATERIALS - GREEN	HEALTHY LIFE PRODUCTS - SAUCES	CANDY - LAUNDRY PRODUCTS
CLEANING MATERIALS - YOGURT	HEALTHY LIFE PRODUCTS - MILK	CANDY - TEA&COFFEE
CLEANING MATERIALS - EGG	HEALTHY LIFE PRODUCTS - GREEN	CHOCOLATE COVERED - CHOCOLATE
LAUNDRY PRODUCTS - CLEANING MATERIALS	HEALTHY LIFE PRODUCTS - YOGURT	SWEETS - CHOCOLATE
CLEANING MATERIALS - TEA&COFFEE	HEALTHY LIFE PRODUCTS - EGG	SWEETS - CHOCOLATE COVERED
DAILY DRINKS - MILK	HEALTHY LIFE PRODUCTS - TEA&COFFEE	

155 pairs with at least an uncertain product were generated. The products soap, frozen food, daily drinks, chocolate covered, healthy life products, cleaning materials, nut, candy, milk products, dessert&pastry, sweets, flour, lighting&electrical materials, picnic items, pickle, ornament product, margarine, and cream were detected in these pairs. These 18 items can be defined as "should stay" for December since their connection with different products in the portfolio. Based on the poor sales performance and no relation, the rest of the items in uncertain products can be removed from the product portfolio without much adverse effect in December.

4.4 Policy Implications

According to the research findings, for each month, the product portfolio should be revised to keep pace with seasonal fluctuations. As revealed by the clustering process, each product group has different characteristics. Maturing actors are perfect items for the future of the company as the name suggests. They have a fantastic inflation-adjusted growth rate. These items are currently performing well and might become the top items of the company in the next years. They are absolutely fine to keep in the portfolio, focus on strategic marketing movements to keep their pace, and increase market share for the future. Vital products and cash banks are crucial for the company because they cover a huge transaction load of the market. They keep the customer flow alive and provide a cash flow to the company. These are major products that the company must hold. Convenient products have aligned to these clusters. They have a relatively high market share and an average growth rate. This cluster is not the preferable one if someone tries to find out which products should be eliminated from the product portfolio. Even though they do not perform perfectly, still it can be said that these are beneficial for the company, at least under these circumstances. The sales performance of the uncertain cluster does not seem well. The products have a relatively low inflation-adjusted growth rate along with a low market share in this cluster. These items are not preferable for the company in the long term. Slow moving products should be excluded from the product portfolio. They have a significantly low inflation-adjusted growth rate and low sales volume. These do not help the company to profit and grow, conversely, even harmful to the company. New potential products can be tried instead of these items to see their demand. The outliers that are excluded from the study can be evaluated by the company on their own by using similar metrics that this study suggests.

These cluster groups should be used in the determination of priority principles. Some clusters are naturally superior to others as sorted above. If the company needs to decide a portfolio decision, the superiority and inferiority between these clusters should be used as the basic rule. The items in the superior clusters should be included in the portfolio in place of items in inferior clusters if they do not exist in the portfolio of a certain store. While doing that, the excluded items should also be determined based on the parameters offered by this study, the sales performance of products identified by market share, and the inflation-adjusted growth rate. Items in the cluster of slow moving goods should be deleted from the product portfolio anyway.

The other important indicator while applying these rules is the association rules that are extracted. The associations between items should be considered for all the products in all segments while making the portfolio decision. The related items should not be excluded from the portfolio because we believe that one leads the other in consumer shopping behavior. These items should be kept on the market together at the same time anyway to achieve maximum revenue. The extracted association rules help to make decisions on future uncertain products. Especially for the uncertain products, the market basket analysis leads critically in this study. If an item belonging to uncertain products is associated with another item in the portfolio, it should be kept to maintain customer attention in the store. Otherwise, it may cost the loss of customers. If not, the item can be replaced with a product in the superior clusters or any other potential product that can be exhibited in the store. While examining these associations between products in the market, the optimal design this study asserted is retrieving these association rules on the monthly basis to handle seasonal alterations.

Additionally, the score table below indicates how many times an item appeared in different associations with other products is presented below. The score column of the table shows the total number of association rules an item occurred within the associations that appeared in that month. This can be other criteria to evaluate the market basket analysis results and make decisions on a product if somebody is interested. A manager can investigate this table if there is any doubt about an associated product to remove from the portfolio or maintain. General association frequencies and their distribution over months are useful knowledge to obtain first insights into the data.

Table 4.20 MBA Score Table of Uncertain Products

Products	Market Share	Inf-Adjusted Growth Rate	January	February	March	April	May	June	July	August	September	October	November	December
FROZEN FOOD	0,58%	-26,07%	13	15	13	10	12	10	11	10	11	10	11	15
DAILY DRINKS	0,54%	-7,86%	3	2	1	1	2	3	1	3	4	3	2	2
VODKA	0,53%	-5,31%	0	0	0	0	0	0	0	0	0	0	0	0
SOAP	0,52%	-4,89%	20	16	18	18	17	15	14	18	20	17	16	16
FRAGRANCE	0,52%	-15,01%	1	1	2	1	4	3	2	3	3	1	1	0
CHOCOLATE COVERED	0,49%	4,25%	4	4	4	4	4	3	3	4	4	4	4	3
HEALTHY LIFE PRODUCTS	0,47%	-18,10%	12	11	9	10	9	7	4	5	10	7	10	10
TOY	0,47%	-6,15%	0	0	0	2	0	0	0	0	0	0	0	0
HOUSEHOLD ELECTRICAL APPLIANCES	0,45%	-4,97%	0	0	0	0	0	0	0	0	0	0	0	0
HYGIENIC PRODUCTS	0,42%	5,22%	3	1	3	0	0	1	0	0	3	0	0	0
JOURNAL&NEWSPAPER	0,40%	-15,16%	0	0	0	0	0	0	0	0	0	0	0	0
CLEANING MATERIALS	0,38%	-8,47%	20	18	19	19	17	14	14	17	19	17	19	19
NUT	0,37%	-8,33%	4	4	3	3	2	2	0	0	2	2	2	2
COOKING TOOLS	0,36%	-5,54%	0	0	0	0	0	0	0	0	0	0	0	0
SHAVING SUPPLIES	0,36%	-7,54%	0	0	0	0	0	0	0	0	0	0	0	0
FACIAL CARE	0,33%	-21,74%	0	0	2	0	2	0	0	0	0	0	0	0
GLASS KITCHENWARE	0,32%	-0,79%	0	0	0	0	0	0	0	0	0	0	0	0
STATIONERY	0,32%	-6,07%	0	0	0	1	0	0	0	0	0	0	0	0
CANDY	0,31%	-11,96%	20	19	19	20	17	17	11	15	19	17	19	19
MEDICAL PRODUCTS	0,30%	-3,80%	3	0	1	0	1	1	0	0	2	1	0	0
MILK PRODUCTS	0,29%	-7,07%	10	10	10	7	8	3	3	3	7	7	9	10
STORAGE BOX&ORGANIZERS	0,26%	-1,04%	0	0	0	0	0	0	0	0	0	0	0	0
DESSERT&PASTRY	0,26%	-6,24%	20	20	20	19	16	17	13	17	20	19	18	19
SHOWER&BATH	0,25%	-0,24%	1	1	0	0	0	2	1	2	3	1	0	0
SWEETS	0,23%	4,50%	4	4	3	4	3	4	4	4	4	3	3	4
HOME TEXTILE	0,22%	-16,16%	0	0	0	0	0	0	0	0	0	0	0	0
FLOUR	0,21%	1,92%	21	21	21	19	17	13	11	14	19	21	20	21
MAKEUP PRODUCTS	0,21%	-20,81%	0	0	0	0	0	0	0	0	0	0	0	0
LIGHTING&ELECTRICAL MATERIALS	0,20%	-8,69%	0	0	0	0	0	0	0	0	0	0	0	1
BATH&LAUNDRY PRODUCTS	0,18%	-17,89%	0	0	0	0	0	0	0	0	0	0	0	0
SLIPPER	0,17%	-8,28%	0	0	0	0	0	0	0	0	0	0	0	0
BODY CARE PRODUCTS	0,16%	-20,55%	0	0	1	0	2	0	0	0	0	0	0	0
GIBLETS	0,16%	-2,06%	0	0	0	0	0	0	0	0	0	0	0	0
BOOKS	0,16%	-11,91%	0	0	0	1	0	0	0	0	0	0	0	0
DISPOSABLE PRODUCTS	0,16%	-14,99%	0	0	0	0	0	0	1	1	0	0	0	0
SOCKS	0,16%	-8,80%	0	0	0	0	0	0	0	0	0	0	0	0
PLASTIC KITCHENWARES	0,14%	-16,07%	0	0	0	0	0	0	0	0	0	0	0	0
PICNIC ITEMS	0,14%	-3,08%	1	1	1	1	1	1	1	1	1	1	1	1
PICKLE	0,14%	-5,24%	9	9	10	8	6	6	3	7	6	6	7	11
METAL KITCHENWARES	0,13%	-9,64%	0	0	0	0	0	0	0	0	0	0	0	0
ORNAMENT PRODUCT	0,12%	-9,61%	0	0	0	0	0	0	0	0	0	0	0	1
CLOTHING	0,12%	-14,56%	0	0	0	0	0	0	0	0	0	0	0	0
DECORATION	0,11%	-2,01%	0	0	0	0	0	0	0	0	0	0	0	0
WAX&DEPILATORY	0,11%	-17,00%	0	0	0	0	0	0	0	0	0	0	0	0
MARGARINE	0,10%	-6,98%	8	9	3	3	3	2	2	2	3	4	4	7
HARDWARE PRODUCTS	0,09%	-19,37%	0	0	0	0	0	0	0	0	0	0	0	0
HOME DECORATION	0,09%	-4,34%	0	0	0	0	0	0	0	0	0	0	0	0
CREAM	0,08%	-3,61%	1	1	1	1	1	0	0	0	0	0	1	1
UNDERWEAR	0,07%	-20,38%	0	0	0	0	0	0	0	0	0	0	0	0
PET ACCESSORY&HYGIENE PRODUCTS	0,06%	-17,04%	0	0	0	0	0	0	0	0	0	0	0	0
MILK POWDER&CREAM	0,06%	2,08%	0	0	0	0	0	0	0	0	0	0	0	0
COLD SNACKS	0,06%	-0,91%	0	0	0	0	0	0	0	0	0	0	0	0
TEQUILA	0,06%	-13,75%	0	0	0	0	0	0	0	0	0	0	0	0
COMPUTER	0,05%	-11,00%	0	0	0	0	0	0	0	0	0	0	0	0
FRESH JUICE	0,05%	-20,17%	0	0	0	0	0	0	0	0	0	0	0	0
SPORT PRODUCTS	0,04%	3,11%	0	0	0	0	0	0	0	0	0	0	0	0
AUTOMOBILE PRODUCTS	0,04%	-15,18%	0	0	0	0	0	0	0	0	0	0	0	0
SUN CARE PRODUCTS	0,03%	-8,64%	0	0	0	0	0	0	0	0	0	0	0	0
SPORTS DRINKS	0,02%	-17,58%	0	0	0	0	0	0	0	0	0	0	0	0

This table provides scores, market share, and inflation-adjusted growth rate information for each item in uncertain products. It enables us to evaluate all uncertain products on a general view as well as a monthly basis. To identify an item's importance, the overall association values can be interpreted in the general view or the monthly scores may hint depending on the intention of the officer who uses this model. There are small changes between months, yet, it might be useful to pay attention to these differences and convert them to advantage. In this manner, the company may take the advantage of this knowledge and optimally use the limited space on their shelves. As clearly seen, such products as frozen food, soap, dessert-pastry, and flour have consistent relationships with different items. These can be accepted as crucial items in that cluster. The products with low sales volume, highly negative inflation-adjusted growth rate, and no association such as sports drinks,

fresh juice, underwear, hardware products, etc. can be removed from the portfolio or replaced with one of the better-performing items if any of them does not exist in a specific store. These decisions can be made for each specific month or by simply looking at the overall performance. Also, an expert may say that if an item is related to others in a specific month, then it should stay in the portfolio all over the year even if it does not appear in associations of other months relying on his/her intuition. It may vary depending on the way of combining analytical solutions and business insights. Options are available here, and these outcomes enable us to discuss and judge all these debates with concrete findings.

Besides that, the associated pairs that appeared in all the two years were determined. These are significant associations that are consistent in providing determined correlation measure thresholds over the months for two consecutive years. This indicates the products in these associations have been purchased together by the customer frequently without any seasonal effect. These products must be exhibited simultaneously by the company in all stores. The elimination of any of these products is unacceptable during any period of the year because these are involved in the shopping patterns of customers. The table for joint associations of the year is presented below. This table also draws not month specific, but the general flow of shopping patterns over the year. The product portfolio should include all these items for the year in all stores. The company should add these goods to their product portfolio since they promote sales of each other.

Table 4.21 Association Pairs Common for All the Year

FLOUR - LEGUMES	LAUNDRY PRODUCTS - CLEANING MATERIALS	CANDY - OIL
CANDY - LEGUMES	CLEANING MATERIALS - TEA&COFFEE	DESSERT&PASTRY - SAUCES
DISH WASHERS - CLEANING MATERIALS	DAILY DRINKS - YOGURT	PICKLE - SAUCES
DISH WASHERS - SOAP	DESSERT&PASTRY - CANNED GOODS&GRAVY	FLOUR - SAUCES
BISCUITS - CHOCOLATE COVERED	PICKLE - CANNED GOODS&GRAVY	CANDY - SAUCES
SWEETS - BISCUITS	DESSERT&PASTRY - PASTA	MILK PRODUCTS - MILK
FROZEN FOOD - DELI MEAT	CANDY - PASTA	DESSERT&PASTRY - MILK
FROZEN FOOD - CANNED GOODS&GRAVY	MARGARINE - CHEESE	FLOUR - MILK
FROZEN FOOD - CHEESE	MARGARINE - VEGETABLES	CANDY - MILK
FROZEN FOOD - VEGETABLES	HEALTHY LIFE PRODUCTS - FRUITS	MILK PRODUCTS - YOGURT
FROZEN FOOD - SAUCES	SOAP - CHEESE	DESSERT&PASTRY - FLOUR
FROZEN FOOD - MILK	HEALTHY LIFE PRODUCTS - CHEESE	DESSERT&PASTRY - GREEN
FROZEN FOOD - GREEN	MILK PRODUCTS - CHEESE	DESSERT&PASTRY - YOGURT
FROZEN FOOD - YOGURT	DESSERT&PASTRY - CHEESE	DESSERT&PASTRY - EGG
FROZEN FOOD - EGG	FLOUR - CHEESE	DESSERT&PASTRY - TEA&COFFEE
HOME CARE PRODUCTS - CLEANING MATERIALS	CANDY - CHEESE	CANDY - TOILET PAPER
SOAP - HOME CARE PRODUCTS	PICNIC ITEMS - CIGARETTE	FLOUR - GREEN
CANDY - HOME CARE PRODUCTS	SOAP - SAUCES	FLOUR - YOGURT
HOUSEHOLD CLEANERS - CLEANING MATERIALS	SOAP - MILK	FLOUR - EGG
HOUSEHOLD CLEANERS - SOAP	TOILET PAPER - SOAP	FLOUR - TEA&COFFEE
CLEANING MATERIALS - CHEESE	SOAP - GREEN	CANDY - EGG
CLEANING MATERIALS - SOAP	SOAP - YOGURT	CANDY - LAUNDRY PRODUCTS
CLEANING MATERIALS - SAUCES	SOAP - EGG	CANDY - TEA&COFFEE
CLEANING MATERIALS - MILK	LAUNDRY PRODUCTS - SOAP	CHOCOLATE COVERED - CHOCOLATE
TOILET PAPER - CLEANING MATERIALS	SOAP - TEA&COFFEE	SWEETS - CHOCOLATE
CLEANING MATERIALS - GREEN	HEALTHY LIFE PRODUCTS - MILK	SWEETS - CHOCOLATE COVERED
CLEANING MATERIALS - YOGURT	PICKLE - VEGETABLES	
CLEANING MATERIALS - EGG	FLOUR - VEGETABLES	

Another striking finding of the study is the dramatic differentiation in shopping

patterns between summer and winter periods. During summer, the association rules are almost the same as the results of the overall year. Only 9 associated pairs exist in addition to common pairs that are stable over the months all year. These associations also should be taken into consideration in summer and these goods should be offered together. These pairs are presented in the table below.

Table 4.22 Additional Associations for Summer

ORAL CARE PRODUCTS - FRAGRANCE	SHOWER&BATH - HAIR CARE PRODUCTS	FLOUR - FRUITS
ORAL CARE PRODUCTS - SOAP	CLEANING MATERIALS - VEGETABLES	HEALTHY LIFE PRODUCTS - VEGETABLES
SWEETS - CHIPS	HAIR CARE PRODUCTS - FRAGRANCE	DESSERT&PASTRY - VEGETABLES

However, the association rules fluctuate a lot from the common rules of the year. We have 62 commonly associated pairs in the winter months in addition to joint associations of the year. This shows a critical differentiation in different time periods. The additional pairs for the winter period are exhibited in the association table below.

Table 4.23 Additional Associations for Winter

CLEANING MATERIALS - LEGUMES	SOAP - CANNED GOODS&GRAVY	HEALTHY LIFE PRODUCTS - SNACK
DESSERT&PASTRY - LEGUMES	MILK PRODUCTS - CANNED GOODS&GRAVY	DESSERT&PASTRY - VEGETABLES
SWEETS - CHIPS	FLOUR - CANNED GOODS&GRAVY	CANDY - VEGETABLES
FROZEN FOOD - MEAT	CANDY - CANNED GOODS&GRAVY	FLOUR - OIL
FROZEN FOOD - PASTA	SOAP - PASTA	MILK PRODUCTS - SAUCES
FROZEN FOOD - TEA&COFFEE	MILK PRODUCTS - PASTA	PICKLE - MILK
FLOUR - MEAT	PICKLE - PASTA	MILK PRODUCTS - GREEN
MILK PRODUCTS - DELI MEAT	FLOUR - PASTA	MILK PRODUCTS - EGG
DESSERT&PASTRY - HOME CARE PRODUCTS	MARGARINE - SAUCES	BUTTER - DESSERT&PASTRY
FLOUR - HOME CARE PRODUCTS	MARGARINE - MILK	DESSERT&PASTRY - SNACK
CLEANING MATERIALS - CANNED GOODS&GRAVY	MARGARINE - YOGURT	DESSERT&PASTRY - CHOCOLATE
CLEANING MATERIALS - PASTA	MARGARINE - EGG	CANDY - DESSERT&PASTRY
CLEANING MATERIALS - FRUITS	PICKLE - FRUITS	FLOUR - TOILET PAPER
CLEANING MATERIALS - VEGETABLES	FLOUR - FRUITS	BUTTER - FLOUR
DAILY DRINKS - MILK	PICKLE - CHEESE	PICKLE - GREEN
NUT - FRUITS	HEALTHY LIFE PRODUCTS - VEGETABLES	PICKLE - YOGURT
NUT - VEGETABLES	HEALTHY LIFE PRODUCTS - SAUCES	FLOUR - LAUNDRY PRODUCTS
DESSERT&PASTRY - BREAKFAST FOODS	HEALTHY LIFE PRODUCTS - GREEN	CANDY - FLOUR
FLOUR - BREAKFAST FOODS	HEALTHY LIFE PRODUCTS - YOGURT	CANDY - GREEN
CANDY - BREAKFAST FOODS	HEALTHY LIFE PRODUCTS - EGG	CANDY - YOGURT
CREAM - CHEESE	HEALTHY LIFE PRODUCTS - TEA&COFFEE	

The huge gap between summer and winter must be considered by the company. The renewal of the product portfolio should be adapted to this drastic change between seasons. The company needs to keep pace with all these changes and offer all these associated goods simultaneously. The five of the common pairs that exist in summer but not the overall year are also covered by winter associations as well. These are sweets-chips, cleaning materials -vegetables, flour - fruits, healthy life products - vegetables, dessertpastry - vegetables. This means only four unique associations appear in summer compared to winter and these are oral care products - fragrance, oral care products - soap, shower&bath - hair care products, hair care products - fragrance. Apart from these, summer is a usual season without much differentiation and it would be easier to adopt small changes and modify the portfolio. On

the other hand, the winter is much more complex and the company should consider these changes by making wise portfolio choices. The submitted results of the market basket analysis are very helpful in determining the product portfolio for all time periods. All the associated product pairs presented above should be offered simultaneously in stores and the marketing action policies should pay attention to these associations. The portfolio design must handle these seasonal deviations in light of the information and method this study proposes.

Figure 4.12 Soap - Cheese

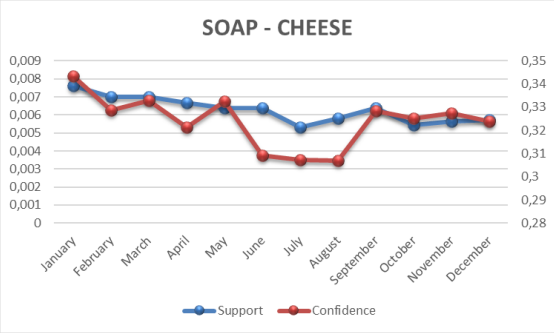


Figure 4.13 Cleaning Materials - Milk

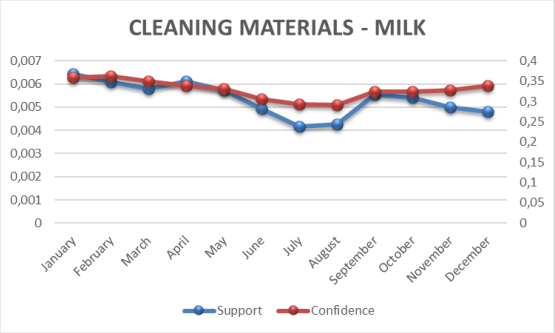


Figure 4.14 Picnic Items - Cigarette

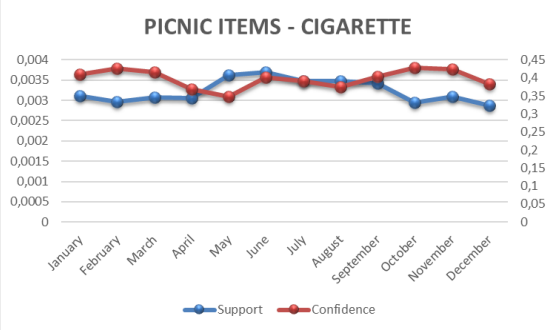
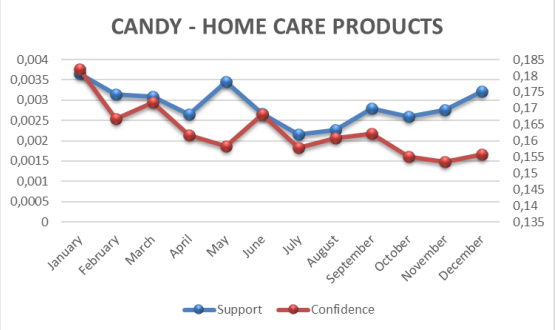


Figure 4.15 Candy - Home Care Products



The charts above illustrate how support and confidence values fluctuate over the year for some specific pairs. These pairs were chosen as sample from the consistent associations common for all year. This is also another approach that can be followed to monitor seasonal fluctuations of association rules.

5. CONCLUSION AND FURTHER SUGGESTIONS

In supermarket chains, product portfolio management is a crucial issue for stores in terms of choosing accurate items to exhibit in their limited shelf space. They have too many stores in different locations and the product portfolio is not constant since the demand and shopping behavior of customers fluctuate over different stores. The main objective of this paper is to find out an analytical approach to the product portfolio issue of supermarkets and provide portfolio recommendations by using data. The data was received from one of the largest supermarket chains in Turkey. Besiktas district in Istanbul has been chosen as a location since it is believed that the town is crowded and centered and ideally displays the shopping behaviors with the existing hybrid customer profile. To preserve the model and the outputs from the Covid-19 effect, the 2018 and 2019 data were used.

Methodologically, the paper asserts to use of clustering with respect to the sales performance of products and combines the result with association rule mining. The market share and growth rate features of products were used as indicators of sales performance. Also, the growth rates were adjusted by the inflation variable supplied by the Turkish Statistical Institute. Scaled values for both market share and inflation-adjusted growth rate were used to obtain the best results in the clustering process. The agglomerative clustering algorithm preferred to group products in clusters. Each of the clusters was identified and interpreted separately based on the assessment of general characteristics of products in that specific cluster. The following process was the implementation of market basket analysis on a monthly basis. The market basket analysis is a tool to extract knowledge based on data to discover the overall association structure in the data. The monthly period is preferred to save the model from seasonal effects and only consistent associations that appear in both 2018 and 2019 were preserved in the outputs. In that way, an unusual approach to the training and test validation model was proposed in this study. This study exploits several correlation measures while applying market basket analysis. Results of the clustering were combined with market basket analysis outputs and some insights, implications, and recommendations over product portfolio were pre-

sented. This paper suggests a from beginning to end analytical model to evaluate existing products and design a supermarket's product portfolio based on previous transactions.

In light of this study's outcomes, the company is able to configure a logical product portfolio for each month of the year. Firstly, the clusters were formed. They were labeled based on their specific characteristics. In that way, the superior and inferior product groups are determined. The company knows which items in the portfolio are superior and which are interior in comparison. This process defines the performance of products and hence, distinguishes them as vital products, valuable ones, beneficial, poor sales performance items, products that should be removed from the portfolio, and so on. If there would be any case like insufficient shelf space, the company will know which products are preferable over others and they will design the portfolio based on the clusters the items belonged to. Similarly, the worst performance product group was identified and inferred that these products should be removed from the portfolio respectively low market share and highly negative inflation-adjusted growth rate. Afterward, the cluster which includes respectively low performed products was recognized and named as uncertain products. Although products in this cluster were superior to the worst-performing cluster, still they have respectively low performance among the items in the portfolio. Association rule mining was critically exploited for this specific cluster in this study besides the point market basket analysis providing information on which items were sold together in the entire portfolio. Commonly associated product pairs were determined both for 2018 and 2019 on monthly basis. The uncertain products that were associated with any other product in the store were detected and it is suggested to keep these products in the portfolio. This operation targets to prevent any loss of clients due to the absence of any interesting items which are included in the shopping pattern of customers and missing any extra sales opportunities. For example, it is observed the products frozen food, soap, cleaning materials, candy, dessertpastry, flour, pickle, and margarine were highly purchased collaboratively with other products in the portfolio despite they were being comparably ineffective in terms of sales performance. That is why the suggestion was to maintain them in the portfolio even with their poor sales performance. It is concluded that the products in that group with any association can be removed or replaced if there is a better alternative. As a bonus, a table shows the number of associations that uncertain products have presented for further implications.

A possible limitation of this study is the data retrieved from a single supermarket chain in a particular location. This might cause a bias because the company might have its own customer profile and the region naturally has its own people. That

is why the results of this study cannot be generalized to different supermarkets and neighborhoods. This study can be applied to store segments with different characteristics countrywide. This approach can provide a generalized single product portfolio for large number of stores in the same segment. However, this was a limitation for us since we cannot handle that large dataset with simple computer due to computational cost of association rule mining. However, the model this study proposes is still valid and it can be implemented in any store.

The topic this study investigates is open for further research. The data of online selling channels can be included in future research. The change in real store habits and online shopping behavior will be revealed in such a study. This may create valuable insights into the differentiation in the optimal product portfolio of real stores and online stores in the same location. Moreover, the correlation parameter thresholds of market basket analysis are configuration tools that can be changed by experts depending on the aim, scope, or method of study. Different thresholds can be applied to derive association rules and it provides opportunities to analyze associations for different purposes. In that way, different association rules can be extracted. For example, a study can be done with significantly low thresholds which provides a much larger list of associated products. This information can be used to assess marketing policies or a more comprehensive and detailed product portfolio evaluation. Promotions can be designed by looking at inter-cluster and intra-cluster association rules. On the other hand, the top-k association rules method can be used. This method handles the optimal correlation parameter issue in association rule mining by selecting the top k-associated items in the basket.

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