MS-E2177 - Seminar on Case Studies in Operations Research

Optimizing Marketing Promotions for Grocery Retail

PROJECT PLAN

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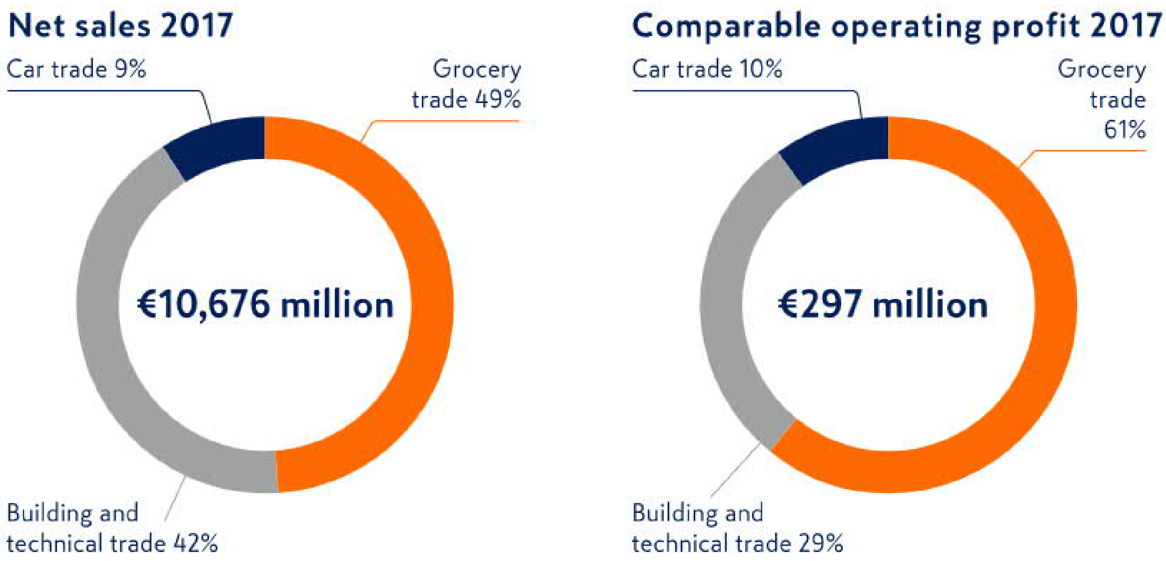
1. Background

K Group is the third largest retail operator in Northern Europe and operates in the grocery trade, the building and technical trade and the car trade. The group retail sales were €13 billion in 2017. [Kesko Interim Report 2018]



Graphic 1: Kesko Net sales & Operating Profits per divisions-
Source: Kesko's annual report 2017

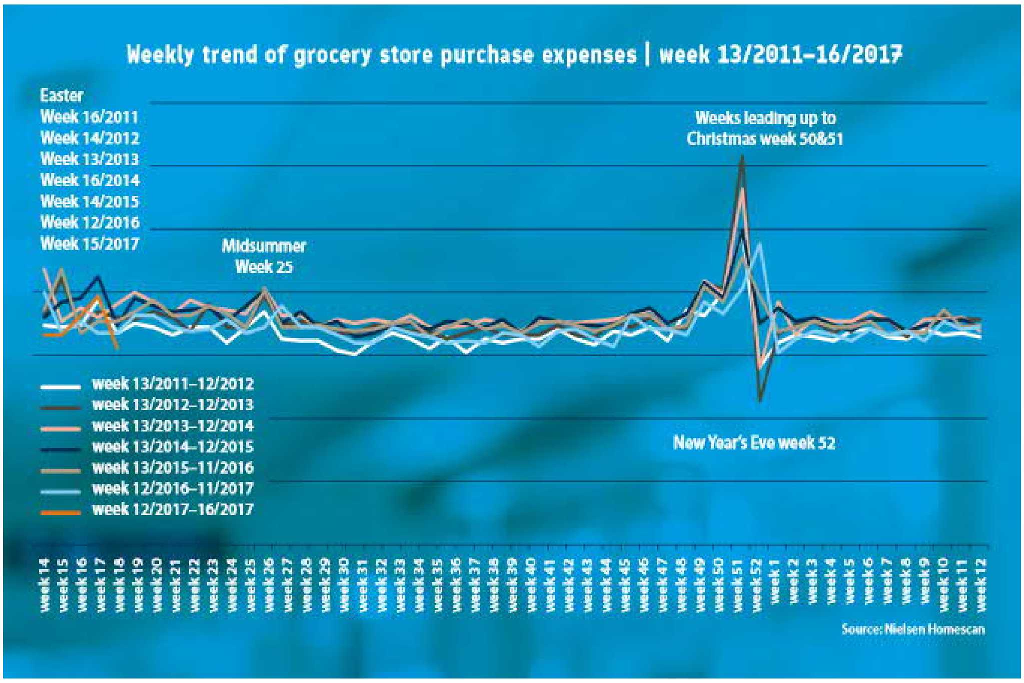
As of 2018, Kesko has 1,800 chain-operating stores in Finland, Sweden, Norway, Estonia, Latvia, Lithuania, Belarus and Poland. Kesko and more than 1,100 K-retailers form K Group.

K Group is the second biggest operator in the Finnish grocery trade with a market share of approximately 37.2% (after the acquisition of Suomen Lähikauppa). 1.2 million Customers' visit K-food stores every day. [Source K Group]. The K-food store chains are K-Citymarket, K-Supermarket, K-Market and Neste K service stations.

K-Citymarket chain has 81 stores all around Finland and looks "*to tailor product selections and services to suit the needs of local customers*". [Kesko annual report 2017]. Kesko has divided its customer base into five different segments: *A, B, C, D, E* and wants its weekly promotions to optimally "*cover the needs*" of those different segments. Customers segments are discrete groups that are designed according to specific psychographic, behavioral or needs criteria. [2]- [3]

The grocery retail industry is a highly competitive industry with razor thins margins. [1]. Promotion are strategic tools [6] and temporary price promotions are commonly used by retailers to increase sales and traffic into the stores, as well as for the introduction of new products and the improvement of customer loyalty [5].

Promotions have also an important impact on a retailer's profitability and thus scheduling sales promotions more accurately can lead to an important increase in profits.



Graphic 2: *Weekly trend of grocery store purchase expenses in Finland (2011–2017)*
Source Finnish Grocery Trade Association, 2017

2. Objectives

Kesko has multiple types of promotions, which are available all year round. Our focus will be on weekly promotional offers. These promotions are valid in all stores and regions in Finland and for all customers. There are always 4 products on sale and the products change twice a week. The first batch of products is valid from Monday to Wednesday and the second batch is valid from Thursday to Sunday.

The idea for the algorithm is to output 16 promotions at a time. This would correspond to 64 products and 8 weeks of promotions.

Thus, our task can be divided into two major parts:

1) Find 64 'attractive' products. With these 4 products, we target 4 segments, as a one-to-one mapping, i.e. each product targets a single customer segment.
2) Decide the discount percentage for each product.

By combining part (1) and part (2), we would obtain the desired algorithm.

3. Tasks

During the months of January and February we have screened the data provided by Kesko and carefully considered which key data would be needed to perform the tasks properly. We started the process by performing an exploratory data analysis of the provided data sets. We reviewed the explanatory values and created plots to obtain basic insight in the data as well. With those findings, we then identified the outliers, then run those data entries by the experts at Kesko and in the end removed them from consideration.

We also filtered out unnecessary data such as holidays, seasonality and the campaigns, which were not weekly promotions (3 or 4 days long).

The *preprocessing of data* requires its aggregation because of the vast amount we received so that it becomes as easy as possible to manage and analyze. In addition, we had to decide the appropriate attributes to include in our data frames. Such attributes are *hierarchy level of products* (product level / product family level), *profits*, *incremental sales* and *sales quantities*. We still have to consider whether it will be necessary to normalize the data.

The most interesting and core part of our project is the modeling. Our goal is to find 16 distinct sets of 4 unique products, such as that each set includes at least one product with an attraction rate (AR) higher than the value (1.2) for each 4 customer segments as introduced in part 2. Objectives.

We set to identify the products that attract different segments by using bivariate correspondence analysis. We formed an attraction repulsion matrix using the overall sales as an underlying measure. Furthermore, an attraction rate superior to one denotes that a certain product is more attractive to the customer group it refers to than to other customer groups. In other words, the overall sales of the product are more frequent among this group compared to other customer groups. Accordingly, we are set to solve our multi-objective optimization problem by using the attraction repulsion matrix and by choosing a certain constraint (sigma = 1.2) for the chosen element to be met, which acts as a boundary for the maximization problem.

Furthermore, we try to obtain a *goodness of fit* for one set of 4 products. The chosen *dummy solution* we selected uses the sum square of the attraction rates in a set of 4 products to be promoted each week. In addition, we plan to maximize the incremental profits of those 16 sets of products based on the previously mentioned constraints. After those steps are performed, we will define a certain objective function, which we will then optimize as such:
Profits (€) + 3*Sales (€).

During the last phase of the project, we will establish the profit-maximizing discount percentages for each of the products and add new constraints. For instance, constraints that are more sophisticated may include restrictions on product combination (e.g. products used as ingredients or elements of certain dishes or meals).

For the model prototyping, model validation and verification we will follow an iterative process and this until the completion of the project. As we test out our prototype models, we will have the opportunity to ask for new data from Kesko, data against which we will compare the output of our current model. During the verification phase, we will ask Kesko's experts whether the proposed 16 sets of 4 products and discount percentages seems reasonable and act according to their feedback. We will then deliver the optimization model as well as the final report and presentation.

4. Schedule

January & February	**(1) Research Problematization** (a) Selecting Research question/scoping. (b) Success Criteria. **(2) Exploratory Data analysis** (a) Outliers' identification & analysis. (b) Examination of key explanatory values and creation of plots for insight into the data. **(3) Preprocessing of data** (a) Define how to aggregate the data. (b) Normalization of the data (relative vs absolute values) (c) Decision on the appropriate attributes (e.g. hierarchy level: product/product family level, profits, incremental sales, sales quantities) (d) Filtering out the unnecessary data (consider only 3-4 day campaigns; leave out the holidays, etc.)
1st March	**Project Plan Presentation**
March	**(1) Modeling** (a) Find N distinct sets of 4 unique products so that each set includes at least 1 product with attraction rate (AR) > sigma for each 4 customer segments mentioned in objectives. (b) Identify products that attract different segments using bivariate correspondence analysis (form an attraction rate matrix using overall sales as an underlying measure). (c) Establish a profit structure. **(2) Optimization** (a) Use attraction rate matrix and choose a certain constraint (sigma = 1.2) to be met, which acts as a boundary for maximization problem. (b) Find a goodness of fit for set of products (e.g. sum square of attraction rates in products to be promoted each week). (c) Maximize incremental profits of these N sets of 4 products. (d) Maximize a certain objective function e.g: Profit (€) + 3*sales (€). (e) Choose discount percentage based on objective function. **(3) Model Prototyping** Possibility to ask for new data from Kesko to which compare the output of our model.

April	**Model Validation** (a) Discussion with Kesko's experts. (b) Check for similar entries in the data and then look at the outcome.
12th of April	**Interim Report**
April & May	**Model Verification** (a) Ask "experts" (Kesko): whether e.g. most attractive products and discount % look reasonable. (b) Within the group, strive for a critical assessment of each of the team members' work.
17^{th} of May	**Final Presentation - Final Report**

5. Resources

The team is composed of Markus Wilkman, Master's student from the Department of Mathematics & Systems Analysis (Major: Operations and Systems Research, Minor: Machine Learning and Data Mining), Aino-Nina Saarikoski, PhD student from the Department of Industrial Engineering & Management (Major: Industrial Engineering & Management, Minor: Strategy & Venturing) and Matias Tiainen, Master's student from the Computer Science Department (Major: Complex Systems; Minor Financial Engineering).

The team received in January store-level data on shopping behavior during promotion campaigns for the K-Citymarket grocery Chain (81 stores). More specifically, we have an entry for each of the (store-customer segment-product-campaign) combination. Such entry contains information on the sales (euro), the sales (quantity), the discount percentage and the sales during the same days one week earlier, which can be used as a baseline for normal sales during the period in question.

We also received information about the campaign as well as information about the products. It will be also possible to ask Kesko for other data which might be needed during the project. For instance, fully non-aggregated data such as receipt level data.

As regards to the two main tasks presented in section 1. Objectives, we are confident we will be able to tackle them. Finding attractive product for every segment can be done by grouping our data as (product, customer segments)-pairs and then performing rigorous analysis. Similarly by grouping the data as (product, campaign)-pairs one can gain some information about the increase in sales as a function of discount percentage and price elasticity.

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The team has had first, weekly brainstorming meetings with Kesko’s data analytics team and will continue with regular biweekly meetings.

6. Risks

RISKS	PROBABILITY	EFFECT	IMPACT	MITIGATION STRATEGY
Sub-optimal or inadequate optimization model	(Yellow) Low	No functional end product	High	-Research. -Test prototype -Feedback -Iterate -Validate the model
Model too complex for the scope of the course	(Orange) Medium	Too wide & demanding problem to solve for the allocated time.	High	-Scoping & reformulation of the problem to solve. -Adequate deliverables -Establish success criteria.
End product/solution does not satisfy the client.	(Yellow) Low	Product does not fulfill the expected requirements.	Medium	-Obtain regular feedback from and cooperation with Kesko- -Iteration /test
DATA: data gathering/filtering	(Yellow) Low	Data noise Data bias	Low impact on the model	-Data analysis -Regular Brainstorming with Kesko -Exploratory data analysis - Code reviews
Insufficient communication between team members	(Orange) Medium	-Imbalance in workload between team members -Misunderstanding due to different disciplinary background	Medium	-Weekly team meeting -Regular communication between team members -Scheduling
Team members' other commitments	(Orange) Medium	-Having to postpone to the last minute some tasks before a deadline	Low	-Planning/Scheduling - Weekly team meeting -Regular communication between team members

7. References

[1] D. Kuijpers, V. Simmons, and J, van Wamelen, "*Reviving grocery retail: Six imperatives*", McKinsey's Perspectives on retail and consumer goods, Winter 2018/19.

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[2] P. Kotler, *Marketing Management Analysis, Planning, Implementation, and Control*, Prentice-Hall International, 2016.

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[5] G. Singer and K. Dickman, "*Can smarter pricing and promotion reduce the emphasis on discounting?",* Ernst & Young, 2016.

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Corporate Reports

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