Optimizing the warehouse location and transport routes in retail business

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Background - History

• History of ”logistics” – Moving products from A to B

• Originally logistics was a military system to move troops and machinery

• Nowadays defined as engineering, creating ”people systems”

• Goal to transport products to consumers with as low a cost as possible
Background - Motivation

• Personal working experience in logistics and retail
  – Years in retail as a salesman, warehouse worker
  – Noticed some issues where improvement could be beneficial

• Hands-on understanding of the system and problems
  – Could things be done more efficiently?
  – How the suggested changes would affect the entire system?

• Choosing a warehouse location and optimizing the transport routes to minimize costs (transport time)
Objectives

• To decide a suitable location for a warehouse in a retail business through a facility location problem (Weber problem)

• Having accomplished that, to determine optimal transport routes to fulfill the demand of each store location

• Comparison with an existing system
  – Which one has a lower transport cost?
  – Which one has a lower cost of lost sales?
Facility location problem

- Determining an optimal facility location based on minimizing the weighted sum of distances to each demand location

- In this thesis the problem is a modified Weber problem in which only one facility location is determined
  - First we calculate a weight point for the network
  - Choosing potential facility locations to comparison
  - Determining the optimal location
Optimizing the transport routes

• Routes are determined by assigning transport agents to demand locations through a 0-1 Knapsack problem

• Each location is to be serviced without breaking the transport constraints (e.g. volume, double assignments)

• Initial situation: every store has one exclusive transport vehicle
Specifics

• Objective to minimize costs: alternative cost and transport cost
• Constraints to avoid double-assignments and violations on labour agreements
• Raising the effective driving time to over 10 hours requires two drivers manning the vehicle – raising costs
• Iteratively making the change with highest possible saving
The model

\[ \min z = \sum_{S=1}^{20} S_s T_s + \sum_{k=1}^{K} [\sum_{i=1}^{21} \sum_{j=1}^{21} c_{ij} x_{ij}^k] w^k \]

s.t.

\[ v^k = \sum_{i=1}^{21} x^k d \leq 21, \forall k \]

\[ x_{ij} \in \{0,1\}, \quad i, j \in \{1, \ldots, n\} \]

\[ \vdots \]

\[ \sum_{i=1}^{21} x_{ij}^k = 1, \exists k, j \in \{2, \ldots, 21\} \]
Results

- The optimal warehouse location found in Helsinki (nr 5 on the map)
- Solution to the Weber-problem
- The assignments included 12 vehicles, which all visit at most 2 stores
- All delivery times under 10 hours
- Improvement from the initial situation as high as 12.4%
Results

• The alternative costs and transport costs are 84.7% lower than with the existing practice where the warehouse is located in Sweden.

• Optimization model was built on very narrow source of information. More extensive cooperation needed with the company to reach more conclusive results.

• Results suggest that a more accurate and widened research is needed to make the decision on whether or not to open a warehouse in Finland.
Conclusion

• The obtained results suggest that opening a warehouse in Finland could significantly cut down alternative costs, however:
  – Tradeoff between alternative and warehousing costs
  – More accurate information needed regarding warehousing, sales and transport to obtain more extensive results
  – The model used was very simplified and constrained
  – Different modelling choices could yield different results
  – Closer cooperation with the company to gain access to more useful information from a wider time range needed