Aalto-yliopisto
Perustieteiden korkeakoulu

Optimizing the warehouse location and transport routes in retail business

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28.09.2016

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Systeemianalyysin laboratorio

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

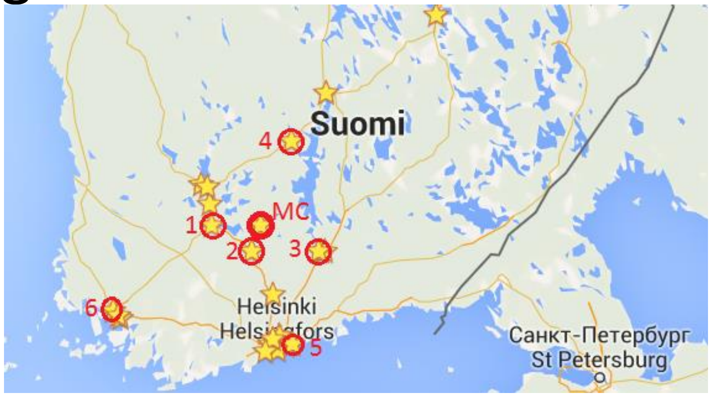
$$x_{ij} \in \{0,1\},\ i,j \in \{1, \dots, n\}$$

$$\vdots$$

$$\sum_{i=1}^{21} x_{ij}^{k} = 1, \exists!\, k, j \in \{2, \dots, 21\}$$

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