

Developing a warehouse optimization model for humanitarian logistics

A master's thesis with the UN Refugee Agency

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This article is based upon the master's thesis "Developing a warehouse optimization model for humanitarian logistics" written at the Division of Engineering Logistics, Faculty of Engineering, Lund University. The idea for the thesis was born after a meeting with Senior Business Analyst Svein Hapnes from UNHCR. He saw a need both in his own organization and in the humanitarian field as a hold for more theoretically based logic concerning warehouse localization. The article will give a short summary of the master's thesis and highlight some of the main findings.

Introduction

In humanitarian logistics there is a gap between the practical and theoretical methods used for facility localization. The consequence is that ad-hoc methods are frequently used, leading to non-optimal localization of facilities which in turn leads to long lead times and costs. The study aims to fill that gap by identifying the factors affecting facility localization in the humanitarian sector and constructing a model thereafter.

Problem statement

Charles (2010) states that humanitarian organizations such as UN agencies and non-governmental organizations (NGOs) all possess the following characteristics to some extent:

- They are under-resourced, have limited skills and high employee turnover.
- The information systems used are relatively basic, some use manual systems without Information Technology.
- They often have several operations done at the same time.
- There is a lack of command and control.

Majewski et al. (2010) advise humanitarian organizations to act more as commercial companies with more focus on cost efficiency, adequate performance measurements and optimal capacity allocations. Van Wassenhove (2006) claims that humanitarian supply chains are about 15 years behind their counterparts in the private sector. Balcik and Beamon (2008) identify that relief organizations might be prone to use ad-hoc methods,

such as basing decisions on experience and intuition, when making facility location decisions.

According to Soltani (2009) there is a need for quantitative support tools for network design in the humanitarian community. He says that one area where such a tool is needed is in facility localization.

An organization within the humanitarian sector which struggles with many of these issues is UNHCR which has been used as a case company for the research.

Purpose

The purpose of the thesis was to develop a model for warehouse network optimization. In order to develop a viable model two research questions were formulated. The questions regarded what factors needed to be incorporated in the model and how it could be adjusted for different circumstances.

Methodology

The thesis process was inspired by Koole's (2010) framework for the modelling process. The thesis has four major activities:

- Problem statement where the project was initiated by analysing prior studies, and holding exploratory interviews in order to define the problem at hand and materialize the purpose of the thesis.
- Data collection, which consisted of the five steps: Field trip to Kenya and UNHCR operations, semi structured interviews, group

discussions, questionnaire and a statistical data request.

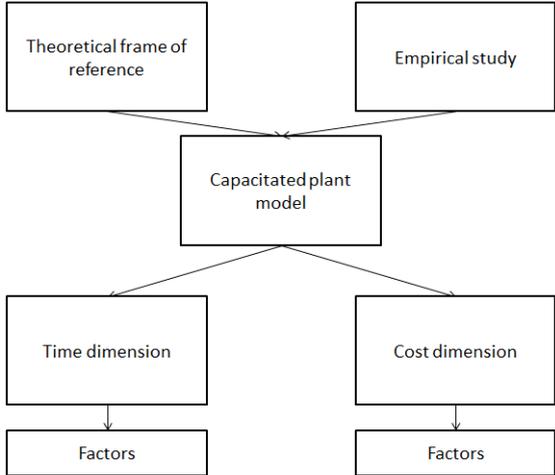
- Analysis where a theoretical framework together with the collected empirical data is analysed in order to draw credible conclusions.
- Model construction is the phase where the Excel-based model is created, tested and validated.

Koole (2010) argues that the process of modelling should get feedback at all of its stages. Facts that might have been obscured in the initial phases of the construction can become visible in later stages meaning that products need to be revised and activities redone. The modelling process therefore needs to be iterative where the model building moves back and forth in the process in order to constantly improve the product.

Results

A basis for the model was chosen when the theoretical frame of reference together with the empirical data was analysed. The capacitated plant model as explained by Chopra and Meindl (2004) was chosen as a starting point for the model. The analysis led to the conclusion that there were two major dimensions that needed to be considered, namely time and cost. These two dimensions were decided to be kept apart because the impact of a humanitarian organisation not reaching its beneficiaries in time is hard to quantify into a cost. It was therefore decided to create two separate models which optimized on the given dimensions separately. Each model would use the

capacitated plant model as basis of logic even though the factors considered would differ. Both models would need a set of both qualitative and quantitative factors in order to be viable. Figure 1 is a representation of what has been mentioned above.



Model

The model itself uses linear programming to optimize the warehouse network. More specifically it uses simplex algorithm in order to find a global optimum. Excel was chosen as a base for the model because it is a standard in offices to have the software and many stakeholders will thereby be able to use it. Many companies also have resources in basic understanding of VBA-programming and can thereby further develop the model if they so choose.

The model is constructed to optimize three layers in the supply chain. What those three tiers are is up to the user to choose. UNHCR for instance would use the model for optimization through supplier-global warehouse- local warehouse or global warehouse-local warehouse-beneficiary.

Conclusions

The purpose to develop a model for warehouse network optimization was met even though it had to be two models in the end. The first research question concerning what factors were needed to be incorporated was answered and a summary can be seen in Figure 2. The second question, regarding how the model could be adjusted to meet different circumstances, was answered by having close contact with future model users to understand their needs and the needs of humanitarian organizations. The model was developed according to the identified needs. The general answer to the research question is that the model needs to be constructed in a way that enables automatic switching of focus and size. It has been done with programming that minimizes the demand on the user. As an example, all the qualitative factors can easily be swapped out in order to fit different scenarios.

Time dimension	Facility capacity Total demand Infrastructure at site Political stability at site Climate at site Security at site
Cost dimension	Facility capacity Total demand Fixed facility cost Variable facility cost Infrastructure at site Political stability at site Climate at site Security at site

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