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**The Influence of Recession and Fuel Prices on Network Design of a Logistics Company in Spain**

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# The Influence of Recession and Fuel Prices on Network Design of a Logistics Company in Spain

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## Summary:

This thesis investigates how demand volumes and fuel prices can affect the performance and configuration of a logistics company's network in Spain. The network is modeled as a minimum cost network flow problem and the optimal network configuration is found by solving a mixed integer programming (MIP) formulation. An in-house developed graphic dashboard allows the user to interact with the simulations' results.



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## KEY INSIGHTS

1. Regardless of the fuel price level, increasing demand results in a smaller proportion of goods being cross docked.
2. Different cross docks can serve the same final destinations. The assignment of cross docks to final destinations should not be static but dynamic.
3. Small trucks are mainly used when demand is low and predominantly for the remaining goods after the subtraction of multiple full large truck loads.

## Introduction

Recession, volatility in fuel prices and globalization exert tremendous pressure on most logistics companies' supply chains. These macroeconomic factors affect not only the performance of such companies but also the way their network is designed and operated. There is on-going interest of logistics companies to identify inefficiencies and areas of improvement that, if addressed, will give them a competitive advantage. This consists of

identifying optimal routes, facility allocation and location, inventory levels and cross-docking usage that will allow them to operate at the efficiency frontier and, why not, even extend it. Strategic decisions necessitate a longer term tracking of fuel prices and demand behavior, than tactical decisions. Managers of logistics companies should be proactive in anticipating exogenous or endogenous parameters affecting the network characteristics, and acknowledge the impact their decisions (or the lack thereof) have on the operation of the network. It is, therefore, of paramount importance to determine the effects of volatility in demand and fuel prices in the supply chain and identify which changes are needed at which values of these macroeconomic factors.

## Current Situation

The company sponsoring this thesis is one of the world's leading providers of express delivery and logistics services, including freight forwarding, transportation management, and warehousing and distribution.

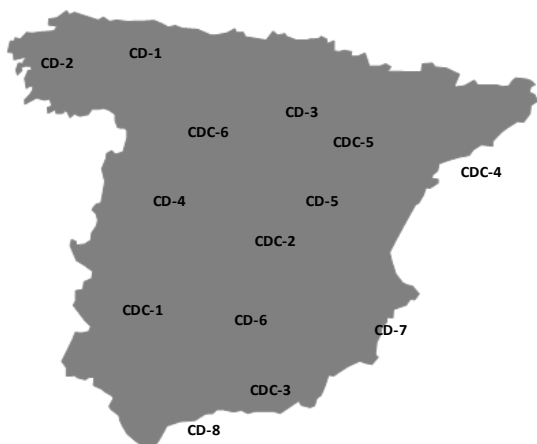
In the company's annual report of 2009, it is mentioned that a threat to its business model is its vulnerability to trading volume declines given its high

level of operational gearing to support its global network. The global economic crisis that decreased trading volumes in 2008 and 2009 has not left the company unscathed. In 2009, the company posted revenues in excess of €20 billion, more than 10% drop compared to revenues in 2008. The cost of fuel, excluding aircraft fuel, exceeded €600 million in 2009, more than the profit in 2009.

The division leading the company's operations in the Iberian Peninsula is seeking to identify the changes needed in its Spanish network in response to changes in fuel prices and demand levels.

### Problem Definition and Approach

The multi-customer network that the company has developed in Spain consists of 6 central distribution centers and 8 cross-docking platforms that serve all delivery orders received on a daily basis with a specified lead time as seen in the following graphic.



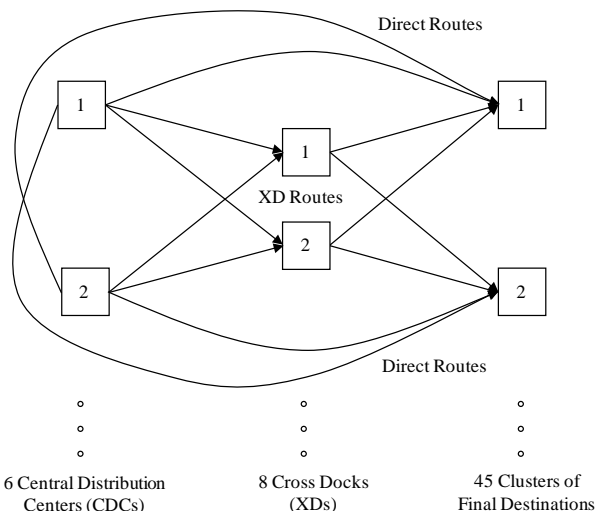
Central Distribution Centers (6 in total)  
Cross-docking platforms (8 in total)

The multi-customer network has thousands of final delivery destinations. The demand pattern was analyzed for all destinations and the 45 clusters that better represent the demand distribution were selected (depicted below).



Destination Clusters (45 in total)

The final mathematical formulation that models the company's network involves 1 product, 6 CDCs, 8 cross dock platforms, 45 demand nodes (as depicted below) and 2 types of trucks.



The costs associated are:

#### Cross Dock Costs

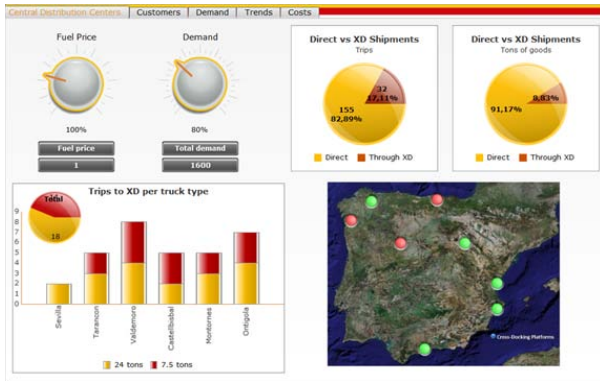
- Fixed costs of operating a cross dock. It includes the building's fixed costs, equipment fixed costs and administrative overheads.
- Throughput cost per unit (aka handling cost) at the cross dock. It includes operations-related labor costs and other costs.

#### Transportation Costs

- Fixed cost per truck (depending on the type of truck). It includes drivers' wages, insurance costs, amortization costs and financial costs.
- Variable cost per truck (depending on the type of truck). It includes fuel consumption, driver's eating allowance, truck's maintenance and repair costs.

The network was modeled as a minimum cost network flow problem and a mixed integer programming (MIP) formulation was solved for 342 different scenarios of fuel price and total demand. The optimal network configuration for all these scenarios was determined. The fuel price varied from €0.20/lit to €3.60/lit and total demand in mainland Spain varied from 400 tons/day to 4,000 tons/day.

This research project is not limited to identifying the effects of varying macroeconomic factors but also includes creating a methodical simulation of the company's network that can be repeated and used in the future for examining the network performance under various conditions by its management. Results of the simulations can be visualized using an in-house developed graphic dashboard as shown in the following figure:



## Results & Recommendations

- *Mix of direct and indirect shipments leaving each central distribution center (CDC)*

Regardless of the fuel price level, increasing demand results in a smaller proportion of goods being cross docked. When demand is higher than 100%, then the proportion of direct shipments varies from 84% to 100%. When demand is lower than 100%, the proportion of goods leaving the CDCs directly for the final destinations varies from 55% to 86% depending on the scenario. The utilization rate of trucks in the XD-final destination route is much smaller than in the other routes. The company can increase the utilization rate by providing service with a longer delivery lead time, using a medium-sized truck and introducing milk-runs.

- *Mix of types of trucks that should be used in each route*

Small trucks are mainly used predominantly when regional demand values are low and for the remaining goods after the subtraction of multiple full large truck loads. This is because the large truck is much larger without being that more expensive than the small truck. For demand values less than 2,000 tons/day 15-20% of trucks used are small (otherwise the proportion is around 5%).

- *Assessment of the performance of the company's Cross Docks*

Currently, the company has all 8 cross docks operating in its network. Simulations indicate that having all 8 cross docks operating is the optimal configuration only for demand values within the range of 2,400-3,000 tons/day (more than 120% of today's demand). The cross docks sorted by throughput volumes in decreasing order are: 1) Valladolid, 2) Zaragoza, 3) Alicante, 4) Valencia, 5) Malaga, 6) Amorebieta, 7) Vigo and 8) Oviedo.

Our findings also suggest that the same region can be served by more than 1 cross dock.

- *Costlier destinations for the company to serve*

Our findings suggest that the three most expensive provinces to serve are: La Rioja, Valencia and Navarra. The three cheapest provinces to serve are: Madrid, Cantabria and Murcia. The aforementioned provinces exhibit a consistency with respect to how expensive or cheap they are relative to the rest of the provinces. The company's network is geared to satisfy demand its biggest market, Madrid, but not its second biggest market, Cataluña, or third, Andalucía. One way to reduce the costs of serving the most "expensive" provinces is the collaboration with competing logistics companies so as to reduce what logistics companies hate most: transporting air. Although that is easier said than done, both (or more) competing companies will benefit. Another option is to increase the delivery lead time to these provinces so that accumulation of demand allows the shipment of full truck loads.

## Cited Sources

Hoover's Database, Hoover's Company Profile, 24.04.2010. MIT Online Libraries.

The Company's Annual Report 2009, Group Management Report