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Research Report: MISI-2014-9
Distribution Network Optimization: A Case Study
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Distribution Network Optimization: A Case Study

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Summary: The present work expands the existing literature on optimizing distribution networks for neighboring countries by using the example of a company looking at redesigning its distribution network in South East Asia region. Proven methodologies including the center of gravity approach and a recent study that enabled a Pharmaceutical major to reduce its annual distribution cost for its U.S. operations by $1.99 million/year have been modified and applied for the purposes of the present work..

The model primarily focuses on determining the optimum number of distribution centers, their locations and the customer locations they serve in order to minimize the distribution costs while maintaining a minimum required service level.

KEY INSIGHTS

1. This methodology can be effectively used to compare network configurations with single distribution center, multiple distribution centers and combination of distribution center(s) and cross-dock facility(ies).

2. Significant cost benefits can be achieved by relocating an existing facility or adding/removing a distribution facility.

3. Demand volumes across the markets served by the network have a very strong impact on the optimality of the network configuration.

Introduction

Distribution network decisions are strategic long-term decisions that have direct impact on customer satisfaction and overall profitability of the firm. These changes in distribution network can have significant impact on the overall profitability of a firm. Thus, evaluating and optimizing the distribution network is very important for any manufacturer in order to be competitive. The GMA (Grocery Manufacturers Association) 2010 Logistics Benchmark Report shows that 92% of the total logistics costs consist of costs related to Distribution centers, outbound customer transportation and intra-company transportation. A modified version of the model proposed by Shang, et al. (2009) is used for the purposes of this study. Shang, et

al. (2009) developed the model for a Pharmaceutical major to re-engineer their distribution network, enabling the firm to successfully reduce its distribution costs by 6% annually and improve customer on-time delivery from 61.41% to 86.2%.

The thesis uses the Singapore-Malaysia distribution network of a multinational company as a case study. This company belongs to the FMCG industry, which is one of the most demanding industries in terms of distribution network configurations as end consumers are very price sensitive and demand high service levels .

Developing and Modeling the Network Configurations

The present distribution network of company AAA was analyzed to determine the present inbound routes to the distribution centers and the possible alternatives to them in addition to mapping the demand volumes across the region. At present AAA has one distribution center in Malaysia and on in Singapore. Both distribution centers are replenished directly from the manufacturing locations. Trans-shipment between the two regions is low. This indicates that whether there is a single distribution center for this region or two separate distribution centers, it will not have significant impact on the product movement between the manufacturing locations and

distribution center(s) as both the facilities have good enough connectivity to all the relevant manufacturing facilities. Also the demand in west Malaysia and Singapore region was consolidated in three groups on the basis of geographic spread, namely, the Kuala Lumpur cluster, the Singapore-Johor cluster and the volume spread over west Malaysia. Singapore-Johor cluster and KL cluster consist of the demand locations within a hundred kilometer range from Johor and Kuala Lumpur respectively. Johor provides significantly lower facility costs as compared to Singapore and is less than 50 kilometers from Singapore, making it a potential distribution facility location to serving Singapore. The center of gravity location for the Singapore-Malaysia consolidated demand was mapped to find another potential distribution facility location and its nearest commercial hub is Kuala Lumpur region. Based on the results of the center gravity results three potential facility locations have been identified; Singapore, Kuala Lumpur and Johor Bahru.

The following hypotheses have been tested:

1) *Malaysia and Singapore should be served using only one distribution center and it should be located at the Center of Gravity location that lies in Malaysia.*

This will allow to consolidate demand and achieve higher economies of scale. In parallel freight costs can decrease for a single facility configuration by minimizing the distance travelled annually between distribution facility and demand locations.

2) *Establish one distribution center in Kuala Lumpur region to serve the demand locations in Malaysia and one distribution center in Singapore or Johor to serve the Singapore-Johor demand area.*

This approach will decrease freight costs by minimizing the distance travelled annually between the distribution facility and demand locations.

The alternative network configurations, which are used to test the two hypotheses, are listed in Table 1.

A deterministic model was developed using optimization software to evaluate the performance of the various potential network configurations that could be used by company AAA to serve the Malaysia-Singapore market. The results for each configuration from the deterministic model were observed over five independent scenarios using "What-If Analysis". Three variables were varied across these scenarios: fuel cost, facility cost and demand volume.

	Configuration Name	Distribution Center	Cross- Dock
1	KL (DC)+ SG(DC)	Kuala Lumpur , Singapore	-
2	KL(DC) + SG (X-Dk)	Kuala Lumpur	Singapore
3	KL (X-Dk)+ Johor(DC)	Johor	Kuala Lumpur
4	KL(DC)+Johor(X-Dk)	Kuala Lumpur	Johor
5	KL(DC)	Kuala Lumpur	-
6	Johor(DC)	Johor	-
7	Multi DC Optimization (KL + Johor)	Decision made by the optimization model. Kuala Lumpur and Johor both have one distribution center each.	-

Table 1: List of Network Configurations evaluated by this study

Results

The results show that the present configuration with one distribution center in Singapore and one in Kula Lumpur is more expensive compared to the proposed configurations (Table 1) by up to two million USD per year. Via the alternative configurations saving of up to 16.5% annually can be achieved.

change in input parameters, the change in their annual distribution costs over a range of variations in input parameters was observed.

The annual distribution costs varied linearly for a uniform rate of increase in fuel cost or facility cost. Also the annual distribution costs increased linearly and did not increase by more than 15% for an increase in fuel cost by 50% and facility cost by 30% in independent
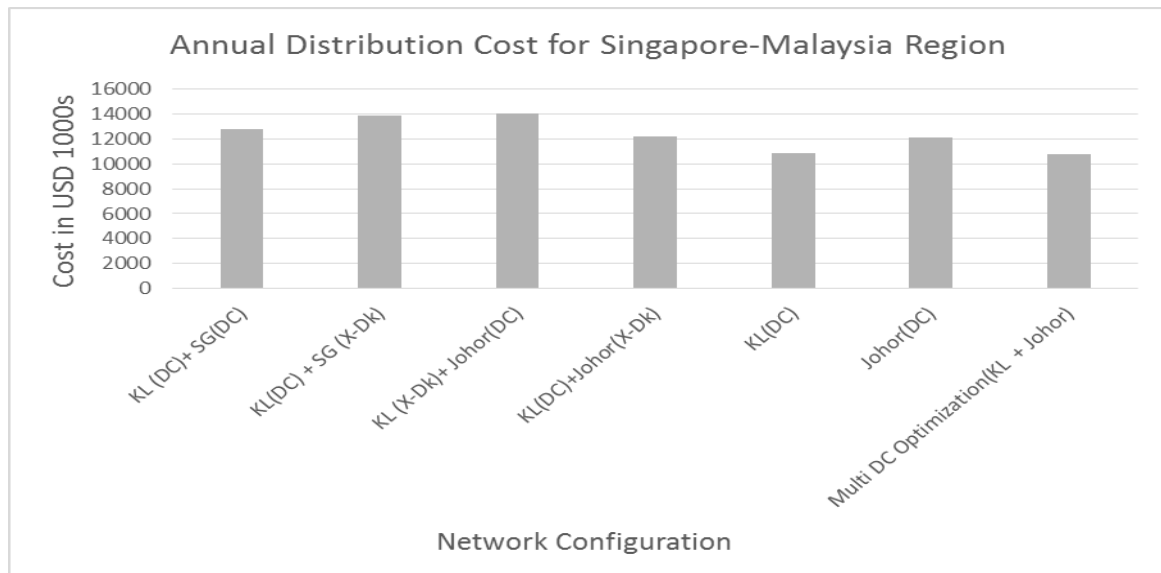

Figure 1: Annual Distribution cost for serving Singapore-Malaysia market for the network configurations in Table 1

Comparing the robustness of the configuration is a suitable approach to compare their performance over a range of possible future states as this allows the decision maker to understand the strengths and weaknesses of each configuration. To evaluate the robustness of the network configurations against the

scenarios. However when the rate for increase in demand volumes varied across the regions, results of annual distribution cost for the configurations became non-linear and a number of intersection points were observed. The results of this study indicate that the rate of increase in demand volumes and its variation across the region has a very strong impact on the optimality of a distribution network configuration.

Conclusion

The results indicate that the hypothesis favoring a network configuration with two distribution centers is appropriate for the Singapore-Malaysia distribution network of company AAA.

Following are the primary reasons for choosing the combination of Kuala Lumpur and Johor DC configuration over a configuration with a single DC in Kuala Lumpur:

1) The annual distribution cost for the Kuala Lumpur and Johor DC configuration is $48,000/year lower than the Kuala Lumpur DC configuration under the present circumstances as well as the various future states analyzed in this study.

2) The Kuala Lumpur DC in the Multi (DC) configuration allows AAA to exploit the center of gravity location of Kuala Lumpur while the Johor DC as well due to lower facility costs at Johor.

3) The freight cost for Kuala Lumpur-Singapore and Johor-Singapore trips were assumed to be the same for this study due to the absence of co-relation between distance and freight for shipments to Singapore. A decrease in the Johor-Singapore freight rate by $50/FEU can result in distribution savings of up to $97,850.

4) The Kuala Lumpur and Johor DC configuration is more robust against supply chain disruptions than Kula Lumpur DC configuration. For instance, if there is a natural disaster in Kuala Lumpur, AAA will still have the Johor DC in operation. Also Kuala Lumpur and Johor DC configuration can leverage from two ports; port Klang and Johor port..

5) The use of Johor DC can assist in responding to Singapore demand variability.

Additionally the results indicate that the companies operating in these markets can generate significant savings by leveraging the difference in currency exchange rates. For instance, company AAA can reduce its annual distribution cost by approximately two million US dollars per annum without compromising on service level by shifting the distribution center from Singapore to Johor Bahru.

Also there are some input parameters that don't change often and cannot be foreseen and thus, decision makers might consider some variables to be constant. Some of those unexpected but abrupt changes in the business environment can be a tax for exporting products from Malaysia to Singapore, which can change the cost structure of the distribution network drastically. For instance if a new tax is levied by Malaysia or Singapore government and it increases the

cost of transporting a shipment to Singapore from Malaysia by 120$/FEU then it will increase the cost of serving Singapore customers via a distribution facility in Malaysia by $400,000 (four hundred thousand US dollars) per year. The impact of such a change will be directly proportional to the future change in the demand from the Singapore market. Also this study assumes that the facility cost for the Johor area will always be less than that of the Kuala Lumpur area. However, if the facility cost per FEU for operating out of Kuala Lumpur is 10% less than that of the Johor area then provided all other parameters remain constant, the annual distribution cost of Kuala Lumpur DC configuration will be $100,000 (one hundred thousand dollars) less in comparison to the Kuala Lumpur and Johor DC configuration.

References

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