MIT SCALE RESEARCH REPORT

The MIT Global Supply Chain and Logistics Excellence (SCALE) Network is an international alliance of leading-edge research and education centers, dedicated to the development and dissemination of global innovation in supply chain and logistics.

The Global SCALE Network allows faculty, researchers, students, and affiliated companies from all six centers around the world to pool their expertise and collaborate on projects that will create supply chain and logistics innovations with global applications.

This reprint is intended to communicate research results of innovative supply chain research completed by faculty, researchers, and students of the Global SCALE Network, thereby contributing to the greater public knowledge about supply chains.

For full thesis version please contact:
Professor Shardul Phadnis
Director of Research
MISI
No. 2A, Persiaran Tebar Layar, Seksyen
U8, Bukit Jelutong, Shah Alam,
40150 Selangor, Malaysia.
Phone: +6 03 7841 4845
Email: sphadnis@misi.edu.my

Regional Distribution Centre Location: Develop and Apply a Framework

By: Abhijeet Prakash and Sumit Goyal
Thesis Advisor(s): Dr. David Marius Gligor

Summary:

By using a world's leading coffee company as a case study, this research has been conducted to develop an easy to use decision making framework to find the optimal location of a regional distribution centre (RDC). The various factors and sub-factors relevant to the location of an RDC have been identified and then using the Analytical Hierarchy Process (AHP), a decision tool has been developed which evaluates the various alternatives by performing cost-benefit analysis to find the optimal regional distribution centre location based on the rankings of various alternatives w.r.t. benefit to cost ratio.

About the author 1:
Abhijeet Prakash received BSc Nautical Sc. Degree from TS Chanakya, India. Prior to the MSCM program at MISI, he worked at K line, Vanoord & Enershell in International Maritime Trade and Manufacturing sector for close to 7 years.

About the author 2:
Sumit Goyal received B.Tech in Production & Industrial Engineering from Indian Institute of Technology (IIT) Roorkee, India in 2010. Prior to the MSCM program at MISI, he worked in Bharat Heavy Electricals Limited (BHEL), an Indian Government owned Engineering and Manufacturing Enterprise for approximately 4 years.

KEY INSIGHTS

1. The proposed decision making framework can be effectively used to find the optimal regional distribution centre (RDC) location while considering all the qualitative as well as quantitative factors relevant to an RDC.

2. As demonstrated by its application to the case company, the proposed framework can be extended to any industry to find the optimal RDC location in any region of the world by modifying associated factors and sub factors.

3. Any high cost impacting decision like location of RDC should not just be based on the quantitative or cost factors. All the qualitative factors like Company Strategy, etc. and quantitative factors should be taken into consideration while making such long term decisions.

4. A good decision framework should consider benefits as well as costs of an RDC in a particular location, then only a sound and comprehensive decision can be made.

Introduction

These distribution centres play a crucial part in the supply network as they act as linkages between the upstream and downstream legs of the chain. Thus extensive planning is required to decide a perfect location for distribution centre of a company. Thousands of internal and external factors

are taken into consideration before the company fruitfully decides one location for its distribution centre.

The company under consideration is a premier roaster, marketer and retailer of specialty coffee around the world. This research primarily concentrates on the company's operations in CAP (China- Asia pacific) zone.

The extensive growth of the concerned company in CAP region has given birth to new parameters which require the company to bring some changes in its distribution strategy to cater effectively to the new stores added to the company's fleet in the CAP region as well as to assist the company's future growth plans which entails doubling the number of stores from its current number in next five years. Thus, this extensive growth coupled with the future plans of growth has put a question mark on the current distribution centre's location and thus led to this research which tries to find out whether the company needs to find another location for the RDC or it holds status-quo.

Thus the new distribution strategy of the company requires development of an easy-to-use, extensive, decision-making mathematical model for identifying the optimal location of Regional Distribution Centre (RDC) in the CAP region by conceptualizing and synthesizing the framework through qualitative insights obtained from an industry analysis of Coffee Retail, Food & Beverage, and CPG companies in CAP region.

Literature Review

The objectives of the literature review are:

1) To identify the purpose of a distribution centre in a company strategy and its supply chain strategy, especially with regards to increasing the customer service level and in turn increasing the end consumer loyalty.

2) To find the various factors one must consider while making a critical cost heavy decision of identifying the location for a distribution centre.

3) To find the methodology which can solve a problem involving multiple decision making criteria of different weightages concerning the distribution centre location.

The distribution centre (DC) is an important component of modern logistics, like a bridge that connects the suppliers and customers, and its location problem has been attached importance very much (Zixia Chen, Yeqing Wang; 2008).

This is a strategic decision involving irreversible allocation of the firm's capital and often has a crucial impact on key measures of the firm's supply chain performance, such as lead time, inventory, responsiveness to demand variability, flexibility, and quality (Rambabu Kodali and Srikanta Routroy; 2006).

The cost and transportation distance have been the major consideration in the international facility location decisions. But over time, many other factors other than cost and transportation distance have gained importance. And this includes both qualitative as well as quantitative factors. A comprehensive list of location factors that have been considered at different periods of time by different researchers has been provided by (Rambabu Kodali and Srikanta Routroy; 2006).

Various methods have been used to decide the optimized location of a distribution centre. The facility's location literature dealing with quantitative modelling is quite extensive. A complete bibliography on the major developments in the literature that have been critical in the application of location-allocation models can be found in the work of (Ghosh and Arche; 1993). But these approaches can only provide a set of systematic steps for problem solving without considering the relationships between the decision factors globally (Rambabu Kodali and Srikanta Routroy; 2006).

Hence an all-encompassing methodology must consider a comprehensive number of qualitative and quantitative factors and their interaction with each other which affects the decision of identifying distribution centre location.

There are many methods used to solve multiple criteria decision making problem. But, the AHP has attracted the interest of many researchers mainly due to the nice mathematical properties of the method and the fact that the required input data are rather easy to obtain (Evangelos Triantaphyllou and Stuart H. Mann; 1995).

AHP shall perform only qualitative analysis of the distribution centre locations from which the benefit index of the locations can be obtained. However, any analysis is not complete if it only evaluates something in terms of benefits. Therefore, a comprehensive, cost – benefit analysis is essential and must be done in order to get the well rounded results.
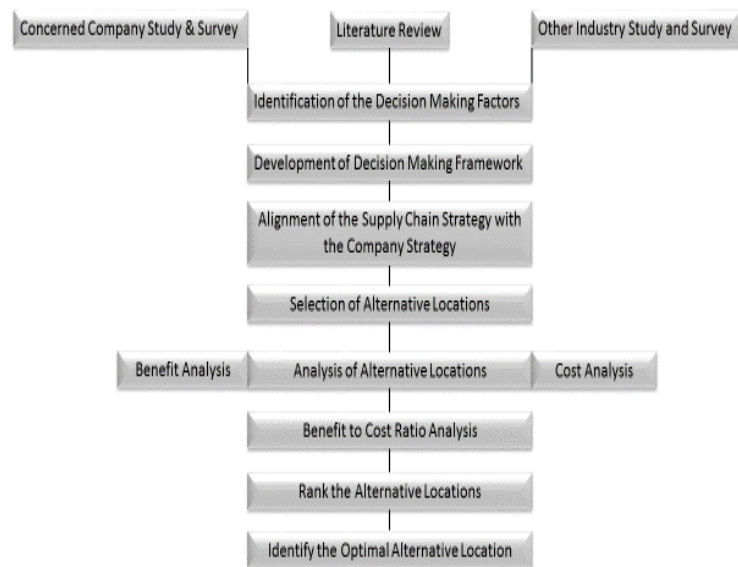
Methodology

The steps to solve the problem are as follows:

1. Identification of decision making factors for identifying the optimal location of regional distribution center (RDC) through literature review, concerned company study & survey and other industry study & survey.
2. Then a comprehensive decision making framework has been developed to solve the problems whose various phases have been explained in the following steps.
3. Then the alignment of the supply chain strategy of the company has been done with the company strategy by incorporating the same and its sub criteria in the comprehensive list of decision making factors.
4. Then the selection of the feasible alternative locations has been done as per the suggestion of the concerned company.

5. Then the analysis of those feasible alternative locations has been done, which consist of the two parts. First is the benefit analysis and the second is cost analysis. The benefit analysis evaluated the benefits of establishing the regional distribution center (RDC) in those feasible alternative locations in the form of decision indexes on the scale of 0 to 1. The cost analysis found out the costs of operating the regional distribution center (RDC) in those selected different alternative locations.
6. Then, the rankings have been assigned to those feasible alternative locations based on the benefit to cost ratio analysis.
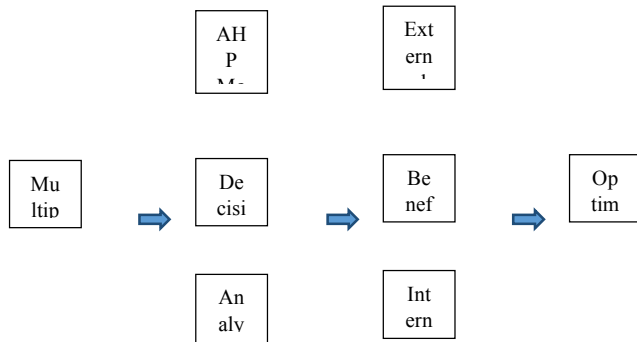7. Then the optimal alternative location has been chosen based on the above ranking results.

The below figure depicts the methodology, which is developed to solve the problem:

Figure 1: Problem – Solving Methodology

Environment		Characteristics
Company Strategy	9	Suppliers

Table 1: Most Relevant Factors

The rankings of the five alternative locations based on the benefit index data as identified from the internal and external surveys are as follows:

Benefit Index Data		
External Data	**Ranking**	**Internal Data**
Malaysia	1	Singapore
Singapore	2	Malaysia
North China	3	Hong Kong
South China	4	North China
Hong Kong	5	South China

Table 2: Benefit Index Data

The rankings of the five alternative locations based on the cost index data as identified from the internal and external surveys are as follows:

Cost Index Data		
External Data	**Ranking**	**Internal Data**
Malaysia	1	Malaysia
North China	2	North China
South China	3	South China
Singapore	4	Singapore
Hong Kong	5	Hong Kong

Table 3: Cost Index Data

The rankings of the five alternative locations based on the benefit to cost ratio as identified from the internal and external surveys are as follows:

Benefit to Cost Ratio		
External Data	**Ranking**	**Internal Data**
Malaysia	1	Malaysia
North China	2	North China
South China	3	South China
Singapore	4	Singapore
Hong Kong	5	Hong Kong

Decision Making Framework

Figure 2: Decision Framework

Results

The final outcomes of the AHP analysis run on the internal and external surveys are discussed and compared. The two AHP results as obtained from the data collected from the survey done on the internal officials of the case company and people from outside the case company belonging to FMCG, CPG, retail, consulting industry have been compared to provide a comparison platform for the final result.

The rankings of main factors as identified from the internal and external surveys are as follows:

Most Relevant Factors		
External Data	**Ranking**	**Internal Data**
Infrastructure	1	Infrastructure
Government Policies	2	Company Strategy
Location Characteristics	3	Cost
Cost	4	Government Policies
Markets & Customers	5	Legal & Tax Structure
Suppliers	6	Business Environment
Legal & Tax Structure	7	Markets & Customers
Business	8	Location

Table 4: Benefit to Cost Ratio Analysis

Conclusions

The key findings of the research are presented as follows:

1) The multiple criteria decisions like the location of regional distribution centre must consider all the relevant qualitative and quantitative factors. The decision should not be based on a few factors like costs, transportation distance, time, etc.

2) The multiple criteria decision making methodology as presented in this research should be used to solve such a problem. Only the factors and sub factors must be modified depending upon the nature of the company, facility location (or region) and the facility (or regional distribution centre) itself.

3) The Analytical Hierarchy Process (AHP) is one of the best practical methods in solving such kinds of problems (multi criteria decision making) due to its proven mathematical capabilities and ease of obtaining the data.

4) A good decision framework should consider benefits as well as costs of a facility location (or RDC) in a particular location, then only a sound and comprehensive decision can be made.

References

Chen Z. & Wang Y. (2008). *Research on distribution centers location problem.* Multimedia and Information Technology International Conference, 438-441.

Kodali R. & Routroy S. (2006). *Decision framework for selection of facilities location in competitive supply chain.* Journal of Advanced Manufacturing Systems, Vol.5, No.1, 89-110.

Ghosh A. & Harche F. (1993). *Location-allocation models in the private sector: progress, problems, and prospects.* Location Science, 81-106.

Triantaphyllou E. & Mann S. (1995). *Using the analytic hierarchy process for decision making in engineering applications: some challenges.* International Journal of Industrial Engineering: Applications and Practice, Vol.2, No.1, 35-44.