Application of Quantitative Techniques for optimization in Logistics

RINOJ P K

FACULTY MEMBER, CENTRE FOR MANAGEMENT STUDIES, KANNUR UNIVERSITY MAIN CAMPUS MANGATTUPARAMBA, KANNUR-KERALA 670567.

ABSTRACT *This paper aims to make an overview of quantitative methods suitable for application in individual areas of logistics management, to show preconditions that have to be met for their application, and particularly to specify the main barriers preventing more effective utilization of these methods in the corporate practice.*

Introduction

The most important for the present well-informed and demanding customers while deciding about purchase are availability, quickness of reaction and the provided services. A significant condition for a business to be successful on the market is thus the supplier's ability to meet the customer's requirements to their full satisfaction. At the same time, the typical features of the present markets are changeability, high rate of change dynamics, difficult predictability, globalization, international migration, progress in the areas of information and communication technologies, transport development, bigger emphasis on the environment and creation of networks. All these factors significantly affect logistics and supply chain management. However, isolated introduction of logistics solutions or a solution to just one area of problems in the logistics chain has only limited effectiveness, and so it is necessary to achieve overall optimization, coordination and synchronization of all the activities within the logistics chain related to the key activities. Changes in area of logistics are important part of restructuring changes in business area .Progressive methods are being developed and applied in logistics using modern information and communication technologies, economic entities are being distinctly interconnected in networks, logistics costs are being thoroughly monitored and optimized through integration of purchase, production and distribution, coordination and cooperation not only with the customers but also with the suppliers are being deepened. All the above activities are aiming to achieve synergic effects. An important role is, without any doubt, played by quantitative methods as a tool supporting the management decision-making

Quantitative methods application in logistics management

Utilization of quantitative methods in management spread significantly after the Second World War in relation to the rapid development of the computing technology and information systems and technologies. In the 60's and 70's, application of quantitative methods and optimization models developed mostly within the so-called Operation Research. The thing that was emphasized from the very beginning was the system approach to problem solving, which enabled getting over the partial and local interests in the company while solving manufacturing, supply, transport, and other operations. A typical problem of that time is the first model of inventory optimization looking for the EOQ (Economic Order Quantity), which is basically compromising countervailing of diverse interests of the production,

storage and finance managers. Further development of application went parallel with development of management from the so called operation management to the process management. The process management aims to steer in the integrated way not only individual operations, but also the entire processes, often going beyond the borders of individual enterprises. The development got as far as the requirements for integrated management of the whole supply chains and networks. This also gave rise to new quantitative methods application requirements in the meaning of optimization of the entire processes and networks.

As an example, we can mention a problem of production planning, where it is possible to apply a number of various methods like prediction of the demand, linear programming, matching algorithms, etc. On the other hand, linear programming as a certain algorithm can be used for solving a number of further factually diverse problems like transport problems, mixing problems, etc. It is possible to give a lot of such examples. Present day logistics management heading more and more obviously from material flow management in separate enterprises towards integrated material flow management in the entire supply chains and networks, places new challenges in front of the quantitative methods applications, too. Basically, it is a shift from partial optimization in separate operations and partial processes towards optimization of the global processes in the entire supply networks.

In fact, production planning and scheduling is closely related to inventory management, which can be, from the point of view of logistics, understood as more or less undesirable interruption in material flow smoothness. And thus we will here in after structure the overview of applicable quantitative methods into four mutually linked areas.

1. Location models

Models dealing with location of cooperating premises (production plants, warehouses, etc.), among which the material flows, half-finished products and products are moved, are an important area of quantitative methods applications in logistics. Location optimization then significantly helps decrease the transport costs, and so it is a part of the managers' strategic decisions. Models can be classified according to the number of located premises, according to the set of available sites, and according to the fact whether the number of premises is given in advance or it is necessary to determine it

2. Transportation models

A large number of applications and models are documented for the area of transportation. Apart from the classic transport problem, which belongs to the oldest optimization models at all, it is possible to state a number of other tasks, as e.g. those concerning optimal connection of the sites, optimal routes within the networks, transport network throughput, etc.. A relatively comprehensive over-view of these methods and models, based largely on the theory of graphs and networks. Travelling Salesman Problem is a specific transport problem. It is a task where more customers should be served in different locations in the way each of the customers is visited just once, and the salesman returns to the point of departure

3. Production models

The list of applications in this area can start with prediction of the demand. It is primarily an area for application of statistical prognostic methods, especially extrapolation of trends on the basis of a time series analysis. Although in this case it is not explicitly the optimizing model, it is necessary to realize that the quality of the demand predictions has strong influence on the dynamics of the distribution systems and on the completeness, timeliness and quality of the services provided to the customers. That implies that good prediction of the demand supports optimization. High quality prediction always requires combination of quantitative method with qualitative assessment of the situation on the basis of the managers' experience and intuition.

In the area of production management, you can meet a number of optimizing models. For instance, for the product range planning you can use, on certain conditions, the classic linear programming model. This model can help determine the optimal production structure and the production quantities of individual products in the given planning period in the way the chosen purpose function (e.g. the sales, the added value, the profits, etc.) reaches the maximum possible value under the given limiting conditions. In the serial productions, it is possible to meet the task to find the optimal size of a series or a production batch. This task has a similar structure to seeking the optimal size of the order in the inventory theory. Another task of production planning is production task scheduling, also known as the Calendar Planning. In some productions, particularly those of the mechanical character, you can meet the need for assigning individual production tasks to individual machines, workplaces, etc. For this purpose, it is possible to use so called assignment models

4. Inventory models

A significant space for optimization is also provided by inventory models. Inventory is a byproduct of the material flow in the whole supply chain. Inventory management aims to choose such a way of replenishment, maintenance and their utilization to ensure their economically effective functions in the whole supply chain. Practically, optimization in this case means balancing the following several types of storage costs: cost of storing individual items for unit quantities and periods, financial costs of maintaining the average inventory in the given period, cost of ordering and takeover of a supply, and potential cost and loss resulting from inventory shortage (business interruption, loss of customers, etc.). Inventory models are usually divided into deterministic and stochastic ones, which count with accidental fluctuations in the demand and delivery time. That is why the stochastic models also include safety inventory, which can be a subject of optimization itself. The

basic variables that are being decided about in the models are the order size and the order terms aka the ordering cycle.

Barriers and problems of Quantitative Methods applications in enterprises

Problems with quantitative methods applications and the reasons for their potential failure can be explained, on the one hand, by the wrong approaches of the managers as their users and, on the other hand, by the frequent shortcomings on the side of IT specialists and model authors.

The above research implies that, as for the company managers, it can be their ignorance of the possibilities being offered by quantitative methods at the present time, or it can be the general aversion to mathematical methods, but we have also met with excessive expectations leading to the corresponding larger disappointment in the case the applications did not bring the expected benefits. What is always important is the standpoint and support of the top management and potential inclusion of the applications into the strategic corporate plans. As for the efficient first line managers who commonly use some quantitative methods in their work, we have also found that they protect their own procedures as their specific "know how", and they are not willing to disclose them to anyone else, and even less willing to disclose the exact algorithmization, which would make it possible to transfer their decision-making process to a computer programm. It is required that the quantity of paper waste is as small as possible while the production plan is met. This task is obviously resoluble by linear programming.

Overview of quantitative methods by application area of logistics activities

Areas of Application
Quantitative Methods and Models

Areas of Application	Quantitative Methods and Models
Location models	Discrete Location Models
	Continuous Location Models
Transportation	Network models (The Shortest Path Model, the minimal Spanning Tree)
	Transportation Problem
	Travelling Salesman Problem
Production and Service	Dynamic Programming for production and inventory planning
	Input-Output Models for Multistep Production Planning
	Production scheduling
	Assignment models for manpower and machine assignment
	Model of the Economic Production Run
	Waiting lines models (queues)
Inventories	Simple EOQ Model
	Models with Variable Demand and Lead Time
	Models of Optimal safety Stocks
	Single-Period Inventory Model

Conclusion

Present day logistics management is heading more and more obviously from material flow management in separate enterprises towards integrated material flow management in the entire supply chains and networks. It thus places new challenges in front of the quantitative methods

applications. Basically, it is a shift from partial optimization in separate operations and partial processes towards optimization of the global processes in the entire supply networks. This is closely linked with development of modern information systems and technologies

General aversion to mathematical methods and resistance to changes in general, excessive expectations leading to the corresponding larger disappointment in the case the applications did not bring the expected benefit, not enough time of managers to analyze the problem and to solve it are main barriers of quantitative methods implementation. It was also found that even existing relatively sophisticated information system is not utilized within the entire company and that the staff is not sufficiently trained and checked. Information sharing in the frame of the entire supply chain encounters the problem of mutual confidence between partners and the possibility of misusing this information in the competitive environment. The quality and effectiveness of the entire process of supply chain management will undoubtedly increase together with support of convenient and well-applied quantitative methods.

REFERENCE Taha A Hamdy Operations research Pearson Publications | Glover F,D "network models and applications, Wiley | Waters .c Inventory control and management, Wiley | Sharma J K," operations research" ,McMillan publications | Adam e, Ebert J production and operations management concepts, model, PHI |