

## A COMPARATIVE REVIEW OF SUPPLY CHAIN OPTIMISATION

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### ABSTRACT

**Purpose:** The paper aims to detail out the element of the supply chain optimisation and compare the elements of supply chain optimisation modelling which is the Mixed Integer Linear Programming (MILP), Knowledge Based Genetic Algorithm (KBGA), Supply Chain Operations References (SCOR) and Agent-Based Model (ABM).

**Design/methodology/approach:** The methodology of this study was carried out by reviewing literature on supply chain optimisation modelling (MILP, KBGA, SCOR and ABM)

**Findings:** Cost, capacity, inventory and time are the elements of supply chain optimisation from the literature review. Meanwhile time and capacity are the most vital elements from four type of optimisation modelling that had been studied.

**Research limitations:** This study only limits to four type of supply chain optimization modeling (MILP, KBGA, SCOR and ABM) and did not present the overall elements of optimisation modeling.

**Originality/value:** This paper differentiated four type of supply chain optimization modeling (MILP, KBGA, SCOR and ABM) in term of parameters and the purposed of the modeling to help researchers decide which of the modeling will be useful and more suitable.

**Keywords:** supply chain, optimisation, supply chain optimisation

**Paper Type:** Conceptual Paper

### Introduction

Economic globalisation around the world especially Europe experienced rapid growth of freight transportation until 30% during the last decade (Arnold, Peeters and Thomas, 2004). Logistics play the vital role in supply chain industry for keeping the physical movement of goods with the main objective to deliver goods in exact quantity and condition to the right place just in time. Logistics cannot bring full role without an efficient transportation system. It is very important to manage the activities to be operated efficiently to guarantee the seamless journey of the chain (Nazery, 2006). In Malaysia, the mechanisms on movement of goods through the supply chains industries involved the mode of sea, land and air transportation. The allocation for transportation in this country has risen from RM6.5 billion in the Fifth Malaysia Plan (1986-1990) to RM32.51 billion in the Ninth Malaysia Plan (2006-2007). Currently, competitive industry around the world force companies to produce and deliver goods quicker to the end user by managing integrated logistics systems and supply chain efficiently (Rondinelli and Berry, 2000). Optimisation techniques are employed to aid decision in making the supply chain to determine the time point (period of interest) and its capacity for procurement, manufacturing and delivery activities (Chen and Kim, 2007). Even though there is a lot of supply chain optimisation modeling currently, but only the most suitable type of modelling will optimize the result.

### Objective of the study

Many supply chains still operate traditionally by doing production orders and replenishes stock without considering the situation at either up or downstream tiers of the supply chain. Thus, it is not efficient to implement conventional supply chain to cope with the current competitive industry nowadays. This paper detailed out the element of the supply chain optimisation and compares the previous element supply chain optimisation modelling.

### Scope of study

The study focused on four type of supply chain optimisation modeling (MILP, KBGA, SCOR and ABM) and only differentiated parameters and the purposed of the modeling.

### Overview of the study

#### Supply Chain Characteristics

Supply chain is a system in moving products from supplier to customer after going through three stages of process which are the purchasing, production and distribution. Supply chain can be categorised as centralised control and decentralised control as below (Vonderembse, Uppal, Huang and Dismukes, 2006):

- a) Centralised control - A system manager needs to know the mechanism for the entire supply chain for the purpose of optimisation and the performance for the whole.
- b) Decentralised Control – Each player must know on how to move in order to maximising individual profit.

However, in reality no single agent has the totally power of control for the whole supply chain because every player in supply chain has their own incentives, information and own benefits. Figure 1 shows the basic supply chain process which divided into two segments which are the production planning and inventory control and the other segment is distribution and logistics. From this figure it shows that transportation play the important role in the supply chain as to deliver goods to distribution centre and to retailer.

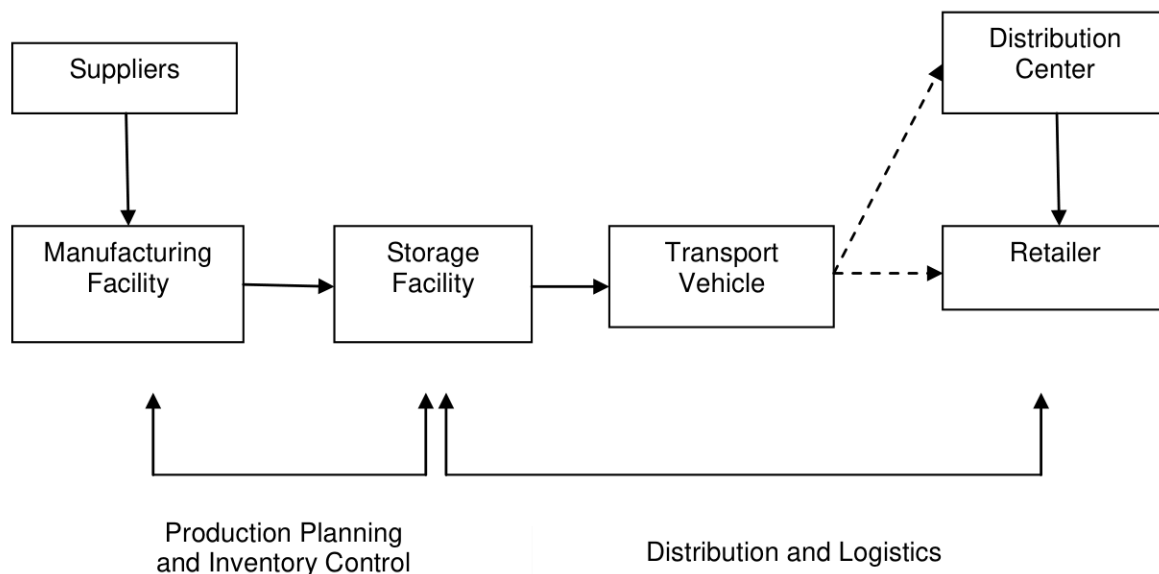


Figure 1.0: The Supply Chain Process (Beamon, 1998)

The characteristics of demand affected the capacity and inventory and in the supply chain (Holweg, Disney, Holmström and Småros, 2005). It means that the demand influenced the supply chain's characteristics to be designed differently for every sector. The seasonal products benefitted the synchronised ordering and common inventory control. The shelf life of the products determined the pace of supply chain operations. For example fresh foods have only shelf life for few days, so the collaboration on inventory levels are not available but the main benefits can be from the aspects of sharing the information and forecasting collaboration. The efficiency in the supply chain in electrical and electronics appliances derived from low inventory levels and high capacity utilisation make the synchronised very interesting. Electrical/ electronic industrial sector are more knowledgeable to be efficient and effectively and could be greener than any other industrial (Zhu, Sarkis and Lai, 2008). Meanwhile in automotive sector, the characteristics are slightly different as it started with the development, design, marketing, extracting raw materials, fabrication and assembly and ends with fit and finish in retailer's show room (Vonderembse, et. al., 2006).

### *Theories Relating to Supply Chain Optimisation*

Supply chains nowadays are complicated networks that extend to longer distances which make them vulnerable to a variety of risks (Vilko and Hallikas, 2000). Disruptions affecting one entity or process will interrupt the operations of other members of the chain. Optimisation techniques will be employed to support decision making for the processes in supply chain (Chen, et. al.,2007). This decide the delivery process, procurement capacity, manufacturing and time of interest. Supply chain efficiency and effectiveness depends to the delivery promptness, leadtime performance and waste elimination (Li and O'Brien,1999). Optimised supply chain operations could be done by minimising the operation cost of supply chains under lead time performance. Lead time performance means required maximum delivery delay and expected delivery delay. Meanwhile delivery promptness are the gap between required delivery delay and expected delivery delay. The wholesalers and retailers should integrate with the logistics functions so the transportation providers will be more efficiently managed the transportation and distribution functions (Tan, 2001). It means that the integrated logistics and smart partnership with supply chains could give benefits in term of, provided visibility, reduced demand uncertainty, consolidated distribution centre, reduced transportation costs and replace inventory with information. Since 1990's researchers tried to collaborated supply chain to create a flawless supply chain to increase responsiveness and reduced inventory cost. Supply chain collaborations has strongly been advocated by academicians and consultant in the concept of Collaborative Forecasting Planning and Replenishments (CPFR), Continuous Replenishment (CR) and Vendor Managed Inventory (VMI), From all the system previously, it is obvious that they created and established one part or one entity of the supply chain instead of the whole supply chains (Holweg, et. al., 2005).

### *Element in supply chain optimisation from literature*

The main element to be determined in the supply chain optimisation will be the time point allocation and the demand and supply activities (Chen, et. al., 2007). Logistics cost formed a main part of supply chain's cost as distribution planning and inventory control and will affected the overall costs of the supply chain (Prakash, Chan, Liao and Deshmukh, 2012). This statement means that the selection of mode of transportation will affect the the supply chain as a whole. This supported by Tan (2001) that the integrated logistics and the supply chain will give benefits such as reduced demand uncertainty, visibility, consolidate distribution centre, reduced transportation costs and substitute inventory with information. Currently, extremely aggressive environment improved decisions at strategic and management level for efficient supply chain approach. Supply chain optimisation not only depends to operational level but from the strategic planning as well (Papergeorgiou, 2009).

### **Methodology approach**

The methodology approach in this study was through reviewing from previous literature meanwhile and analysed four type of optimisation modelling (MILP, KBGA, SCOR and ABM). Table 1.0 below shows four different type of optimisation modelling by purposed and parameters involved.

Tools/ Models Criteria	Mixed Integer Linear Programming (MILP)	Knowledge Based Genetic Algorithm (KBGA)	Supply Chain Operations References (SCOR)	Agent-Based Model (ABM)
Sources/ authors	Chen, et. al., (2007) Perea-López, Ydstie, and Grossmann, (2003).	Prakash, et. al., (2012)	Stefanovic, Stefanovic and Radenkovic, (2009).	Akanle and Zhang, (2008). Barbati, Bruno and Genovese, (2012).
Purpose of Modelling	High flexibility and effectiveness in supply chain	Network optimisation	Integrates of business process engineering, benchmarking and process measurement	Optimising supply chain configuration to cope with customer demand over a period of time
Variables/ Parameters involved	-Time -Capacity (manufacturing, delivery)	-Time -Cost -Inventory -Transportation -Capacity	-Time -Cost -Transportation -Capacity	Dimension depends to the purpose of modelling: -time -capacity - inventory -location -transportation
Type of modelling	Computational	Mathematical	Simulation	Computational

Table 1: Supply Chain Optimisation Modelling

### Findings

This section discusses on the findings from the literature mention in the previous section.

#### *Element in supply chain optimisation from literature*

The main elements in supply chain optimisation are as below:

- a) Capacity – Capacity consist of supply and demand that should be manufactured or delivered to meet the supply and demand (Chen, et. al., 2007).
- b) Inventory - Inventory control and distribution planning should be well organised because it will affected the total cost of the supply chain (Prakash, et. al., 2012)
- c) Time – It considers at the time point allocation on when the activities whether manufacturing or delivering will be organised (Chen, et. al., 2007).
- d) Cost - Cost is the vital part in supply chain optimisation as it will affect the entire process in supply chain itself (Beamon, 1998).

#### *Element in supply chain optimisation from Table 1*

From the Table 1, it shows that there are many types of supply chain modelling for research and industrial used. Mixed Integer Linear Programming (MILP) and Agent-based Model (ABM) are computational modeling, Knowledge Based Genetic Algorithm (KBGA) is mathematical modelling meanwhile supply Chain References (SCOR) is simulation modelling There are many purpose of supply chain optimisation modelling for example to optimise the entire supply chain network, subproblem of the supply chain or optimise within certain period of time or certain constant parameters. The practical usage of the supply chain modelling depends to the complexity of the supply chain modelling itself whether to be used by academicians or industry practitioners. KBGA had implemented mode of transportation in the model. Papageorgiou, (2009) stated that simulation models can be used to study the detailed dynamic operation of a fixed configuration under operational uncertainty, and can be used to evaluate expected performance measures for the fixed configuration to a high level of accuracy. Meanwhile mathematical models are used to optimise high-level decisions involving unknown configurations, taking an aggregate view of the dynamics and detail of operation. Computational modelling limits to the complexity of the modelling system and ease of use.

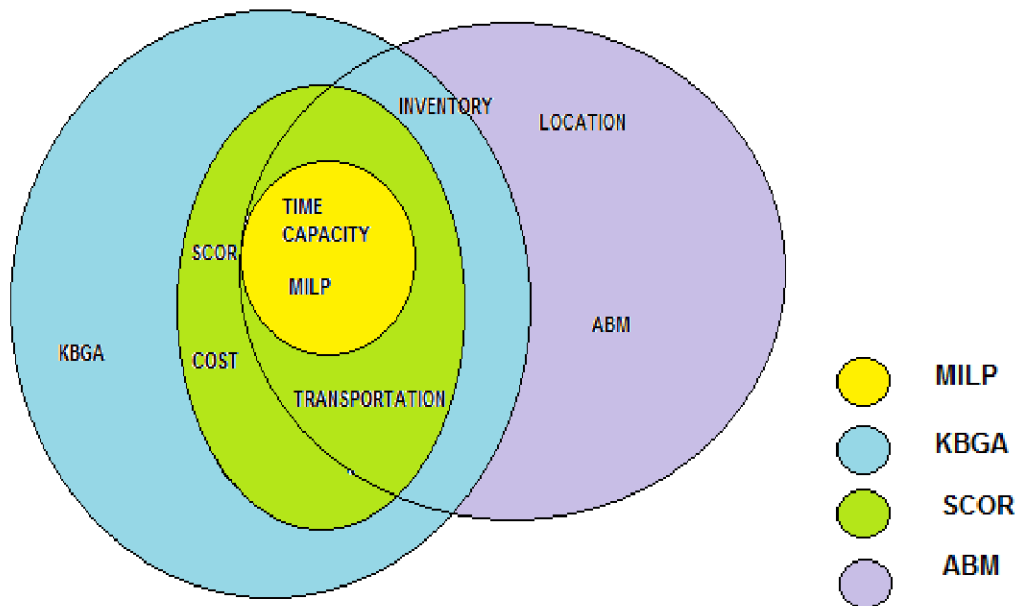


Figure 1: Parameters in Supply Chain Optimisation Modelling

### Discussion and conclusions

Optimisation is compulsory in supply chain because it will provide accurate information for all members in the system, well planned manufacturing and delivery process, timing information, efficiency and the capacity to meet the supply and demand in the system. From the discussion in previous chapter, it is obviously that the optimisation is important to guarantee the seamless journey in supply chain. Optimisation in supply chain depends to the four main elements in supply chains which are the capacity, inventory, time and cost. When all the main elements in the supply chain are efficient, the optimisation will be utilised. Optimisation is the basic needs in supply chain as industries nowadays are moving ahead of very competitive environment every single day. Optimisation is crucial especially to decentralised control supply chain which no system have been controlling the entire supply chain which makes it vulnerable to risks and inefficiency process. Furthermore, this finding will also help the researchers to develop or improving the current supply chain optimisation modelling. From the figure 1 above, it shows that five supply chain optimisation modelling sharing the same parameters of time and capacity (supply and demand). It means that these two parameters are the most vital in supply chain optimisation. Apart from these two parameters, cost also represents the important parameters for KBGA, and SCOR for commercialised reason and thus gives implement cost efficiency element in the modelling. It concludes that time and capacity along with the cost for suitability for industrialised used. This is because efficiency also implies total benefits divided among the players and this means cost plays a major part in determine the effectiveness (Guardiola, Meca and Timmer, 2007). As in a nutshell, the findings of this study will help future researcher to determine the type of supply chain optimisation modelling to be use with the suitable parameters.

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