The effect of location decision on a business success

2. 1 Introduction

Todays competitive market demands companies to deliver their products and services as effectively and efficiently as possible. The distribution strategy is the key to the success. One of the key components of a distribution network is warehouse location. Location decision is considered as a long-term business strategic decision. The correct location decision can resulted in significant improvement in business processes and performance, and bring competitive advantages (i. e. cost saving, service quality, etc.) over its competitors. On the other hand, if a poor location decision was made, it could equally cost the company time, money and opportunity. The location decision’s environment is dynamic and normally described as a multi-criteria decision.

Furthermore, the globalisation and the rapid evolution of information technology have changed the characteristics of location problems. There are two major trends in facility location selection accordingly to Yang and Lee (1997). First, there has been an increased interest to gain potential competitive edge in the global marketplace. Second, small to medium-sizes communities has become more attractive to many businesses as new facility location. These two trends are influenced by the more advanced communication technology, better transportation infrastructure system, liberalised trade between countries, and so on. This allows company to select their facilities where they think has the most advantages (i. e. in land cost, labour cost, skilled labour availability, etc.).

This chapter will start by identifying why a company needs to improve its logistics system, then defining the linkage between the organisation's strategy and the logistics strategy, followed by the general roles of warehouse in distribution strategy. Then it will present the influencing location factors companies normally consider when they make location decisions. And finally in the latter section of this chapter, it will present literature reviews of decision aid techniques and model used in location decisions.

2. 2 Logistics system and the changing business environment

Why do we need to change our logistics operations and strategy? The main reason why we need to change is because the environment we live in is constantly and rapidly changing. In order to survive in this unforgiving environment businesses are forced need to change. There are many factors given by Rushton, et al. (2006) including increasing customer demand, reducing product life cycle, changing technologies, increasing pressures from competitors, and so on. The pressures for change given by Rushton, et al. (2006) are illustrated by the figure 1.

Figure 1 Pressure influencing logistics systems

2. 3 Logistics strategy

Logistics strategy should aim to establish the most appropriate blend of storage and transport at a given customer service level. Efficient logistics and distribution strategies should reduce the total logistics costs and must take into account the interactions of various the various replenishment activities in the distribution chain (Rushton, et al., 2006; Teo & Shu, 2004).

Chopra and Meindl (2004) suggest there are four drivers to a successful distribution system: (1) Facilities – location, capacity, operations methodology, and warehousing methodology; (2) Inventory – cycle inventory, safety inventory, seasonal inventory, and sourcing; (3) Transportation – mode of transportation, route and network design, and in-house or outsource decision; and (4) Information – push or pull, coordination and information sharing, forecasting and aggregate planning, and enabling technologies. Bowersox and Closs (1996) suggest similar points but they also add another driver which is ‘ network design’. They also claim that classical economics often neglected the importance of facility location and overall network design. Similarly but in more details, Alling and Tyndall (1994) identify ten principles that make logistics operations successful. They are: (1) to link logistics to corporate strategy; (2) to organise logistics comprehensively; (3) to use the power of information technology; (4) to emphasize human resources – recognising the importance of quality human resources; (5) to form strategic alliances; (6) to focus on financial performance; (7) to target optimum service levels; (8) to manage the details – pay attention to details as it can be significant savings; (9) to leveraging logistics volume – through consolidating shipment volumes, inventories and the like; and (10) to measure and react to performance.

Furthermore, when considering a distribution strategy, warehousing strategy is an important part and typically the decision makers or logistics planners has to answer these questions (1) should warehousing facilities be owned, leased or rented, (2) what is the optimal size and number of warehouses, (3) what are the optimal locations for warehouses, (4) what product line should

be stocked at each warehouse location, and what market areas should be serviced from each warehouse location. (Stock & Lambert, 2001; Bowersox & Closs, 1996; Simchi-Levi, et al., 2003; Bowersox & Closs, 1996; Geoffrion & Powers, 1995; Bender, 1994; Stock & Lambert, 2001; Greasley, 2009)

Matching logistics strategy to business strategy

The important key to achieving the strategic fit is the ability of the company to find a balance between responsiveness and efficiency that best matches the business strategy. Whatever strategies chose to implement by the company, there will be impacts. And the impact of the selected logistics and distribution strategy has to be assessed against the business strategy. Often these may involve undertaking some qualitative analysis where it is impossible to derive good quantitative measures. The main areas of where this will impact, they are (Rushton, et al., 2006): a) Capital costs – this is the costs of new facilities, new equipments, and so on. In certain situations capital constraints can exclude otherwise attractive options; b) Operating costs – the minimum operating cost is often the main criterion for selection between options. In some cases increased operating costs can be accepted in the light of future flexibility; c) Customer service – Although options should have been developed against customer service targets, the selected short list must be examined for the customer service level achieved. The balance of the mix might have changed in an effort to reduce costs. Stock held close to the customer might need to be increased to improve service reliability.

2. 5 Obstacles to achieving strategic Fit

As many as there are many factors and influences to achieving the strategic fit in the supply chain, there are also many obstacles to achieving the same

goal as Chopra and Meindl (2004) and few other writers mention. Few examples of the obstacles to strategic fit are: a) the variety of products – the increasing variety of products tends to raise uncertainty and uncertainty tends to raise costs and reduce responsiveness within the system; b) the product lifecycles – the decreasing product lifecycles also tends to raise uncertainty and reduce the window of opportunity to achieving strategic fit; c) the increasingly demanding customer – customers demand for faster fulfilment, better quality, and better value for money for the product they buy, companies must be able to provide these just to maintain their businesses; d) the fragmentation of supply chain ownership – less vertically integrated structure can result in difficult coordination to achieving strategic fit; e) the effect of globalization – difficulties raised by the invasion of foreign players. It is noticed that these factors are the same factors which drives the need to improve logistics system as determined in section 2. 2.

2. 6 The logistics and distribution planning framework

Many authors agree on the first and the most important step, when planning the logistics and distribution, which is to identify the objective and strategies of the organization. Then it follows by the second step which is to gain a detailed understanding of the present position of the system. The rests of the procedures are identifying the options, analysing the options, comparing and evaluating the results, and developing a planning and implementation. A diagram illustrating the approach to distribution planning by Rushton, et al. (2006) is shown in the figure 3 below.

Figure 2: An approach to logistics and distribution planning (Rushton, et al., 2006)

2. 7 Optimal number of warehouses

The optimal number of warehouses can be found by using a costing model, a model which takes into account of variable costs, particularly the transport and operating costs. Few facilities give low cost for inward transport, but high cost for outward transport, as they are, on average, further away from customers. On the other hand, more number of facilities can give higher cost for inward transport, but the cost for outward transport is lower, as they are, on average, closer to customers. Another cost that varies with the number of facility is the operating costs. Higher number of facilities means the company has to bear more expensive cost to operating these facilities. Operating costs also vary with facility size. Generally, larger facilities give the economies of scale; however, this is not always the case. Higher cost from operating larger facilities may come from the cost of supervision, communication, inefficiency and so on (Attwood & Attwood, 1992; Bowersox & Closs, 1996; Waters, 2003; Chopra & Meindl, 2004; Rushton, et al., 2006). Figure 4 graphically illustrates the relationships between number of facilities and costs incurred.

Figure 3 Relationship between costs and numbers of facilities.

The need to hold inventories

Prior to planning and designing logistics and distribution system, it is very important to be aware of the reason why a company need to hold stock. The most common objective of a supply chain is to efficiently balancing demand and supply. As most people understand that it is impossible to precisely synchronise or balance the requirements of demand with the fluctuations of supply. Therefore stocks are there to provide buffer between supply and

demand. Rushton, et al. (2006) reviews the important reasons to stock, as follows: a) to keep down production costs – keeping production to run as long as possible, as the costs of setting up machine is often expensive; b) to accommodate variation in demand – to avoid stock-outs by holding some level of safety stock; c) to take account of variable supply (lead) times – to cover any delays of supplies from producers and suppliers; d) to reduce buying costs – often there are administrative cost of placing an order, holding additional inventory can reduce these costs; e) to take advantage of quantity discounts – often goods are offered at a cheaper cost per unit if they are ordered in large quantity; f) to account for seasonal fluctuations – certain products are popular in a certain time of the year, retailer normally pile-up inventory during low demand season to cater the demand in high season; g) to allow for price fluctuations/speculation – the price of certain products, steel for instance, fluctuate due to variety of reasons. Some companies buy in large quantity to cater this; h) to help the production and distribution operations run more smoothly – stock is held to ‘ decouple’ two different activities; i) to provide customers with immediate service – stocks enables companies to provide goods and service as soon as they are required to maximise the sales opportunity. This is essential in highly competitive markets; j) to minimise production delays caused by lack of spare parts – Breakdowns of machineries required to produce goods or services can be very costly to business. Having spare parts to fix the machineries as soon as it breakdowns is an advantage; k) to facilitate the production process by providing semi-finished stocks between different processes (Work-in-Progress).

2. 9 Roles of warehouse

Why businesses need warehouse? There are many reasons why business needs warehouses. Warehouse has many roles apart from providing storage and supplying the materials or finished goods to producers or retailers as reviewed in the previous section. In fact warehouse has many other roles and functionalities which can be classified on the basis of economics and service accordingly to Bowersox and Closs (1996). On the basis of economics, a warehouse is economically justified when the total logistical costs are reduced by providing the facility. On the basis of service, a warehouse is justified when the overall logistical system can provide a better service, in terms of time and place capability.

Here are some common roles of a warehouse (Bowersox & Closs, 1996; Higginson & Bookbinder, 2005; Rushton, et al., 2006):

Role as a make-bulk/break-bulk consolidation centre – making bulk and breaking bulk are traditional functions of a warehouse/DC. In a break-bulk facility, large incoming loads are aggregated, often for product mixing and to create consolidated out- bound shipments. A make-bulk facility, or consolidation centre, com- bines small quantities of several products in fewer, larger assortments.

Role as a cross-docking station – Cross-docking is a process where the product is received, occasionally combined with different products going out to the same destination, and then shipped at their earliest opportunity without being stored. Cross-docking has many benefits, including: faster

product flow, no inventory pile-up, reduced product handling, and reduce cost due to elimination of those activities.

Role as a transhipment facility – transhipment refers to a process of taking a shipment out of one vehicle and loading it onto another. It only occurs when there is a good reason to change transportation modes or vehicle types.

Role as an assembly facility – Hewlett Packard’s distribution centre is a good example of the role as an assemble facility. It also benefits from the idea of postponement which allows product differentiation until later stages. Products are designed to use generic parts and assemble at the warehouse.

Role as a product-fulfilment centre – the major function is to find the products that are ordered and directly deliver them to the final customer. Amazon. com warehouse is a good example.

Role as depot for returned goods – the major functions are to inspect and separate the returned good into those that can be repaired, repackaged, resale, or recycled.

2. 10 Transportation

Accordingly to Chopra and Meindl (2004), the target level of service the company sets determines the role of transportation in a company competitive strategy. If the company is targeting customers whose main criterion is price, then the company can use transportation to lower the cost of the product at the expense of reponsiveness. But more often companies tries to achieve the right balance between efficiency and responsiveness using both inventory and transportation.

Often in logistics plannings, decision to make to make any changes based on the costs of transportation. Accordingly to Rushton, et al. (2006), the transportation costs can be broken into three main types. The first one is the fixed costs – these costs must be borne whether the vehicles run for 10 or 100 kilometres and might include the depreciations of the vehicles, the licence fees, the insurance, etc. And these may vary from one vehicle to another depending on various reasons. The second type is the variable costs – these costs vary in relation to the activity of the vehicles, i. e. how far the vehicle travelled. The most obvious example of a variable of cost is the fuel cost. And the last type is the overhead costs – these costs are indirect costs that are borne by the whole fleet of vehicles. They may be the usual business overheads that are required to run the vehicles, i. e. staff salaries, telephone, internet, and other administrative expenses.

2. 11 Location decision objectives

Warehouse site selection is a complex process involving multiple, both qualitative and quantitative, criteria. And often location decisions have more than one objective depending on the organisation’s objectives and strategies. Current, et al., (1990) classified the objectives for facility location problems into four general categories namely: (1) Cost minimisation; (2) Demand Oriented; (3) Profit maximisation; (4) Environment concern, and often these objectives are found to overlap each other. For retailing business, cost minimisation and profit maximisation are often the main objectives.

2. 12 The influences of warehouse site location selection

It is important to effectively identify potential locations for the new warehouses. Typically, these locations must satisfy a variety of conditions and the potential locations should meet all the requirements. The potential locations should take into account the future demand and that the decision should have an impact on the firm for at least the next three to five years (Simchi-Levi, et al., 2003).

Many authors (Chase, et al., 2004; Barnes, 2008) suggested that the choice of facilities location is influenced by two principles. The first one is the need to locate close to customer due to time-based competition, trade agreement, and transportation cost. And the second one is the need to locate close to the access to resources such as labour, raw material, and specialist skills and capabilities. Often the two principles are taken into account when an organization makes a decision on the choice of location. The characteristics of operations of business (i. e. Manufacturer or service provider) will govern the weight of factors should be taken into account.

Barnes (2008) looked at the location decision on the international perspective where the influential facility location factors are more in numbers and level of complexity. However, these factors can be adapted and used for domestic facility location. Here is the list of major factors which in themselves comprises of several sub-factors given by Barnes (2008): Costs; Labour characteristics; Infrastructure; Proximity to suppliers; Proximity to market/customers; Proximity to parent company facilities; Proximity to competition; Quality of life; Legal and regulatory framework; Economic

factors; Government and political factors; Social and cultural factors; and Characteristic of a specific location.

Bowersox and Closs (1996) concentrated on the warehouse location analysis in the context of logistical network strategy. He discusses about three warehouse location patterns namely Market-Positioned Warehouse, Manufacturing-Positional Warehouse, and Intermediately Positioned Warehouse. They imply the similar idea of the two principles suggested by Chase, et al. (2004) and Barnes (2008). They also discussed the warehouse location from the viewpoint of transportation economies and from the viewpoint of inventory economies. Furthermore they incorporate the concept of Least-Total-Cost system where the sum of total inventory cost and transportation cost is minimal to design the warehouse network.

The conditions or attributes of potential warehouse locations reviewed from many literatures are summarised as follows:

Site-related factors

Regional factors

Land cost/size/soil characteristics/ drainage

Proximity to market

Construction costs/leasing cost/renting costs

Proximity to suppliers

Transportation facilities/cost

Proximity to competitors

Zoning restrictions

Proximity to industry

Community factors

Geographical characteristics

Quality of life/cost of living

weather characteristics

Public facility accessibility

Labour cost/availability/skill

Taxes

Energy availability/cost

Environment regulation

Telecommunication facility

Local government support/incentives

Political matters and regulation

Sustainability

Transportation infrastructure

2. 13 Methods and techniques in facility location problems

In this section, we will review the methods, techniques, and approaches found in a number of literatures.

Bowersox and Closs (1996) claim that a sophisticated modelling and analysis techniques are required in location decision because the location analysis is very complex and data-intense. The complexity is created because of the number of locations multiplied by the alternative location sites multiplied by the stocking strategies for each location. Meanwhile, the data intensity is caused by the requirement of detailed demand and transportation information. Furthermore, the facility site selection process is complicated by the impact of environment legislation and related political issues (Bowersox & Closs, 1996).

Thai and Grewal (2005) suggest the conceptual framework of location selection for distribution centre that consists of three main stages. The first stage is a general geographical area for distribution centre is identified based on the Centre-of-Gravity principle. The second stage is the identification of location alternatives of distribution centre and associate gateway airports/seaports. At this stage a qualitative approach should be applied. The third and final stage concentrates on the specific site selection based on the quantitative approach, i. e. The distribution centre should be place where the integration of volumes transported and distance involved is minimum and also the total distribution cost is minimum.

2. 13. 1 Decision-aid Techniques and Models

Several operations management books (Stevenson, 2007; Barnes, 2008; Greasley, 2009) have their sections on facility location selection techniques and some common influencing factors as reviewed in the previous section. Accordingly to works of Simchi-Levi, et al. (2003), Rushton, et al. (2006), and Bowersox and Closs (1996), there are three categories for tools used to support location analysis. The first type is the analytic techniques. The second type techniques are the mathematical optimisation techniques which can be subdivided into two types: the exact algorithms that find least-cost solution; and the heuristics algorithms that find good solution. And the third type of techniques is simulation models that provide a mechanism to evaluate specific design alternatives created by designer. The simulation models will not, however, be included in the discussion.

Accordingly to Randhawa and West (1995), the facility location problem can be approached by considering the location search space as continuous or discrete. Continuous space allows facilities to be located anywhere in the two-dimensional space; it normally assumes that the transportation costs are proportional to some distance measure between the facilities. Though easy to solve, the continuous approach may yield impractical results. The discrete space approach limits the number of possible locations to a finite set of predetermined sites, and the transportation costs are not necessarily function of distances.

Four common types of techniques found on these books namely: (1) the Centre of Gravity Method – i. e. finding a location that minimises the distribution costs; (2) the Locational Cost-Volume analysis – i. e. comparing

the total costs between location alternatives by graph plotting; (3) the Factor Scoring – i. e. finding the location alternative with highest composite score; and (4) the Transportation model – i. e. a linear programming model that shows location alternative with the most optimal solution (the lowest costs).

2. 13. 2 The Centre of Gravity Method

The Centre of Gravity Method (CoG) is a method for locating a distribution centre that minimises the distribution costs. The main assumption of this method is the distribution cost is a linear function of the distance and the quantity transported, and that the quantity transported is fixed for the duration of the journey (Stevenson, 2007 & Greasley, 2009). The locations of destinations are presented on the map with coordinate X and Y in an accurate scale. The location of the distribution point should be located at the centre of gravity of the coordination calculated by these following equations:

Where

= Quantity to be transported to destination i

= x coordination of destination i

= y coordination of destination i

= x coordinate of centre of gravity

= y coordinate of centre of gravity

This technique is commonly used to solve location problems at a macro level. The method is applied to solve location problems in many fields other

than location of a distribution centre such as school, fire centres, community centres, and such, taking into consideration location of hospitals, population density, highways, airports, and businesses (Stevenson, 2007).

Bender (1994) argues that the CoG approach had became obsolete because of the replacement of other computerised approach including linear programming. He also discusses the limitation of the approach which ignores all constraints, such as capacity, financial, operational, legal, and all cost other than transportation. It is also assume that all the transportation costs are directly proportional to distance, and independent of the direction of traffic.

2. 13. 3 Locational Cost-Volume Analysis

This method is an economic comparison of location alternatives which involves determining the fixed and variable costs for each location alternative. The method indicates which location is suitable for a particular volume level by analysing the mix of fixed and variable costs. The fixed cost plus variable costs line is plotted for each location alternative on the graph and the location with the lowest total cost line at the expected volume level is chosen. A total revenue line can also be plotted on the same graph to compare which location alternative has the earliest breakeven point if the objective is to consider the quickest breakeven location (Stevenson, 2007). The equation for expressing the cost is:

Where

TC = Total distribution cost

VC = Variable cost per unit

X = Number of units produced

FC = Fixed costs

This type of economic analysis is very common tool to compare which options have the highest rate of return and is not only limited to location problems. However, Stevenson (2007) suggests that, in most situations, it is very important that other factors other than costs must also be considered. The Locational cost-volume analysis alone is not sufficient to make decision.

2. 13. 4 Factor Rating Method

The Factor Scoring method is sometimes known as weighted scoring or point rating, which attempts to take a range of considerations into account when choosing a location. Then technique starts by indentifying the relevant factors, then assign a weight to each factor that indicate the importance compared with other factors, given that all the weight sum up to one. Scores then have to be given by decision makers to each factor for all location alternatives. The total weighted scores for each location alternative are then calculated by multiplying the factor weight by the score for each factor, and sum the results for each location alternative. The alternative with highest score is chosen unless it fails to meet the minimum threshold, if there is one (Stevenson, 2007).

The drawback of this method is identifying and determining the appropriate factors and weighting for each factor. Factors like quality of living and labour attitude are intangible factors and hard to quantify. Greasley (2009)

suggested an approach to compare the tangible and intangible factors by conducting an ‘ intangible factors only assessment’ by the method, and then determine if the difference between the intangible scores is worth the cost of the difference in tangible costs between the location alternatives.

Data collection, statistical estimates, optimization and simulation models, and economic analysis are some of the methods used to assess quantitative attributes. Qualitative attributes represent subjective factors for which it is generally difficult to define a natural measurement scale. Descriptive classes or interval scales (for example, 0 to 10) can be established to enable a numerical value to be assigned to represent how a site scores with respect to a particular attribute (Randhawa & West, 1995).

Linear Programming and location problems

Linear Programming is one of the most widely used strategic and tactical logistics planning tools. The transportation model helps decision maker to decide the facility location based on the transportation costs. The model is very useful as it can compare the resulting total costs for each location alternative. Other costs like production costs can also be included in the model by determining the cost on a per-unit basis for each location. There are three major pieces of information needed to use the model as following (Stevenson, 2007; Balakrishman, et al., 2007): a) list of origins and each one’s supply quantity per period; b) list of the destinations and each ones’ demand per period; and c) the unit cost of transporting items from each origin to each destination. The method can be used to solve for optimal or near-optimal locations. Even though the optimisation models are designed to provide an optimal solution, they can be used to analyze a problem under

different scenarios (different combinations of constraints and cost parameters). The result would be a set of location alternatives that are the preferred choices under different operating conditions. Furthermore, examination of a solution will generally result in the identification of more than one specific site. Such sites may then be further analyzed and compared using a multi-criteria model (Randhawa & West, 1995).

There are many types of mathematical programming models and they can be classified accordingly a variety of conditions. Aikens (1985) classified distribution location models accordingly to: a) whether the underlying distribution network (arcs and/or modes) is capacitated or incapacitated; b) the number of warehouse echelons, or levels (zero, single, or multiple); c) the number of commodities (single or multiple); d) the underlying cost structure for arcs and/or nodes (linear or nonlinear); e) whether planning horizon is static or dynamic; f) the patterns of demand (e. g. deterministic or stochastic, influence of location, etc.); g) The ability to accommodate side constraints (e. g. single-sourcing, choice of only one from candidate subset, etc.).

Aiken (1985) gives some examples of types of distribution location mathematical programming models: a) Simple incapacitated facility location model; b) Simple incapacitated multi-echelon facility location model; c) Multi-commodity incapacitated facility location model; d) Dynamic incapacitated facility location model; e) Capacitated facility location models; f) Generalised capacitated facility location model; g) Stochastic capacitated facility location model; and h) Multi-commodity capacitated single-echelon facility location model.

Diabat, et al. (2009) also show that the techniques can be applied to solve location-inventory problems which finds the number of warehouses to establish , their locations, the customers that are assigned to each warehouse, and the size and time of orders for each warehouse so as to minimise the sum of inventory. Melo, et al. (2009) review many literatures related to facility location problem that show that linear prog