**Topic 9: Location of Production Facility**

Overview

Productive capacity can be expanded by adding a new facility. The problem is where to locate it. This problem is encountered by service and goods. Businesses are concerned with selecting locational sites that will best enable them to meet their long-term goals. Facility location is clearly an important part of operations planning.

Learning Outcomes

By the end of this topic, you will be able to:

1. consider the factors for the selection of a location of the production facility to enable the

 firm to attain competitive advantage..

2. explain the location effects on the costs and revenues of the firm

3. analyse the reasons for locational changes.

4. follow the general procedures for facility location planning for products and services in

 relation to resources, local conditions, revenue focus and cost focus. and clustering

 situation

5. apply methods of evaluating location alternatives

6. evaluate the behavioural impact in facility location.

Introduction

9.1 Consider the factors that can affect location decisions

9.2 The strategic importance of location in terms of revenues and costs.

9.3 Other reasons for relocating or locating new facilities

9.4 General procedures for facility location planning - main resources and local factors for

 both products and services

9.5 Methods for evaluating alternatives of location

9.6 The behavioural impact in facility location such as cultural differences; job satisfaction

 of employees; customer consideration.

**Lecture Notes**

**9. Facility Location Planning**

Adding a new facility is one of the most common ways of expanding productive capacity. The problem is where to locate it. This problem is encountered by service and goods producing organisations in both the public and private sectors. Businesses are concerned with selecting locational sites that will best enable them to meet their long-term goals. Facility location is clearly an important part of operations planning.

\*Factors that affect Location Decisions

1. Market economies
2. Better international communications
3. More rapid, reliable travel and shipping
4. Ease of capital flow between countries
5. High differences in labour costs.

The consequences of all these developments have let to the location of facilities of firms in other countries in order to achieve *competitive advantage*.

\*The Strategic Importance of Location

1. Location greatly affects both fixed and variable costs.
2. Location has a major impact on the overall risk and profit of the company. The further away from the supply of the material inputs and from the available market can increase the cost of transportation and this increases the production cost. Other costs may be affected by location. It is estimated after taking all costs into consideration, location may alter total operating expenses as much as 50%.
3. Location becomes important when the demand exceeds the existing capacity of the plant or there are changes in the labour productivity, exchange rates, cost or local attitudes or because of demographic shift or customer demand.

**\*Location Effect on Costs and Revenues**

1. Revenues

In some industries, revenues depend on having the facilities near potential customers. For manufacturing firm that supply customers (who are often themselves manufacturers and assemblers), delivery time can be a crucial component of the strategic mission.

In service industries, the situation is somewhat different. For stored services, those not directly consumed, location is not so important. They do not need to located at sites to be near their customers. But for firms that offer directly consumed services, location can be critical. E.g. movie theatres, restaurants, banks, apartments, dry cleaning stores and even public recreation areas must be located at sites that are convenient to the public; if they do not customers will go somewhere else,

2. Fixed costs

New or additional facilities incurred fixed initial costs, usually incurred only once, which must be recovered out of revenues if the investment is to be profitable. Acquisition of new and additional facilities involved costs for new construction, addition to existing facilities, purchase and renovation of other existing plants or rental. And once they are acquired, more money must be spent on equipment and fixtures. The magnitude of these costs may well depend on the site that is selected. Costs vary greatly from one place to another.

3. Variable costs

 Once built, the new facility must be staffed and operated, and these costs depend on

 location. For labour-intensive conversion process, labour availability and local wage

 structures are major concerns. Management must also concern proximity to raw material

 sources and to finished goods, either of which can cause transportation and shipping costs

 to go up or down.

It is difficult for an organisation to find a single site that is best in terms of all revenues and cost variables. The location offering the highest revenue potential may also incur higher variable costs of operation. Tradeoffs must be made among fixed costs, variable costs and revenue potential; the final locational choice should be the one that offers the best overall balance toward achieving the organisation’s mission.

In evaluating any potential site, it involves considering the principal revenue and cost factors and using the breakeven analysis. E.g. for location, ‘A’ fixed costs are low, variable operating costs are high and expected revenue per unit is low because of locational inconvenience to the customers. However, the higher fixed cost of location ‘B’ is offset by low variable and the greater revenue per unit that can be commanded for locational convenience. In spite of high fixed costs, then, the breakeven volume is substantially lower for location “B” than it is for “A”.

 Breakeven analysis for overall comparison of two alternative sites

 Location “A” Location “B”

 Revenues Revenues

 Total costs

 Total costs

 Fixed costs

 Fixed costs

 Units of output Units of output

 Breakeven point Breakeven point

**\*Reasons for Locational Changes**

In addition to the need for greater capacity, there are other reasons for relocating or locating new facilities:

1. Changes in input resources may occur. The cost or location of labour, raw materials and supporting resources (such as subcontractors) may change.
2. Shifts in geographical demand may occur. As product markets change, it may be desirable to change facility locations to provide better services to customers.
3. Mergers of companies may result in redundant facilities, some of which must be phased out.
4. The introduction of new products may necessitate locational changes, so that new input resources and product markets can be reached more economically.

**General Procedures for Facility Location Planning**

The preliminary study

A screening study is initially done early in the planning process to identify feasible sites. For some facility, particular environmental or labour considerations are crucial. E.g. breweries require an adequate supply of clean water; aircraft manufacturers must be located near a variety of types of subcontractors and primary aluminium producers need substantial amounts of electricity power.

Some main resources and local factors that must be considered are listed below:

|  |  |
| --- | --- |
| Resources | Local conditions |
| Labour skills and productivityLand availability and cost Raw materialsSubcontractorsTransportation facilities (highways, rail, air, water)Utility availability and rates | Community receptivity to businessConstruction costsOrganised industrial complexesQuality of life: climate, housing, recreation, schoolsTaxesExchange rates and currency risk |

Sources of Information – after identifying several key factors, management undertakes a search to find alternative geographic locations that seem consistent with general requirements. Sources of the information: Local authorities provide literature promoting expansion possibilities and local communities, the Ministry of Trade and Industry, The Development Bank and other local business associations.

Outcome of preliminary screening - it usually narrows serious alternative sites to just a few. At this stage a more detailed analysis takes place. At each potential site a labour survey may be considered to assess the availability of local skills. Where community reaction remains a serious uncertainty, or where the strength of local consumer response is questionable, pilot studies or systematic surveys may be undertaken. Community response is important, for example, in deciding where to locate a nuclear reactor, a recreation area, a commercial bank, a state prison or a restaurant. For assessing existing attitudes and for developing strategies to gain favourable acceptance in the community, survey research techniques become useful.

When the few remaining location alternatives are about equally attractive, for many industries the final decision hinges on transportation costs. A facility located far from its raw materials or product markets will have to invest in truck fleets and/or will incur higher daily operating costs for transportation. Analysis of transportation costs has been the main area in which models have been applied to the location problem.

Service Location Strategy

While the focus in industrial sector location analysis is on minimizing cost, the focus on service sector is on maximising revenue. The reason is the manufacturing firms find that costs tend to vary substantially among locations, while service find that location often has more impact on revenues than cost.

For a service firm the selection of a specific location is based on the volume of business and revenue. For determining these two aspects, the information can come from 8 possible sources:

1. Purchasing power of the customer drawing area.
2. Service and image compatibility with demographics of the customer-drawing area.
3. Competition in the area.
4. Quality of the competition
5. Uniqueness of the firm’s and competitors’ locations
6. Physical qualities of facilities and neighbouring businesses
7. Operating politics of the firm
8. Quality of management

The analysis of these factors provides a reasonable picture of the revenue expectation.

The techniques used in the service sector include correlation analysis, traffic counts, demographic analysis, purchasing power analysis, the factor-rating method, the centre-of-gravity method and geographic information systems.

A summary of location strategies for both service and goods-producing organisations is shown below:

|  |  |
| --- | --- |
| Service/Retail/Professional | Goods-producing |
| **Revenue Focus****Volume/revenue**Drawing area; purchasing power Competition; advertising/pricing**Physical quality**Parking/access; security/lighting;  appearance/image**Cost determinants**RentManagement calibreOperation policies (hours, wage rates) | **Cost Focus****Tangible costs** Transportation cost of raw material Shipment cost of finished goods Energy and utility cost; labour, raw material.  taxes and so on.**Intangible and future costs**Attitude toward union Quality of life Education expenditures by state Quality of state and local government |
|  **Techniques**Regression models to determine importance  of various factorsFactor-rating methodTraffic countsDemographic analysis of drawing areaPurchasing power analysis of areaCentre-of-gravity methodGeographic information systems |  **Technique**Transportation methodFactor-rating methodLocational break-even analysisCrossover charts |
| **Assumptions**Location is a major determinant of revenueHigh customer-contact issues are criticalCosts are relatively constant for a given area;  Therefore, the revenue function is critical | **Assumptions**Location is a major determinant of costMost major costs can be identified explicitly for  each siteLow customer contact allows focus on the  identifiable costsIntangible costs can be evaluated |

***Clustering***

It is defined as the location of competing companies near each other, often because of a critical mass of information, talent, venture capital or natural resources.

This happens to both the manufacturing and service organisations. This tendency occurs because of the existence of a major resource in that particular area/region.

Nine examples of industries that exhibit clustering and the reasons why are given in the table below.

Clustering of Companies

|  |  |  |
| --- | --- | --- |
| Industry | Locations | Reason for clustering |
| 1. Wine making | Napa Valley (US), Bordeaux region (France) | Natural resources of land and climate |
| 2. Software firms | Silicon Valley, Boston, Bangalore (India) | Talent resources of bright graduate in scientific/technical areas, venture capitalists nearby |
| 3. Race car building | Huntington/North Hampton region (England) | Critical mass of talent and information |
| 4. Theme parks (including Disney  World, Universal Studios and  Sea World) | Orlando, Florida | A hot spot for entertainment, warm lweather, tourists, and inexpensive labour |
| 5. Electronics firms (such as  Sony, IBM, HP, Motorola and  Panasonic) | Northern Mexico | NAFTA, duty free export to US (24% of all TVs are built here) |
| 6. Computer hardware  manufacturing | Singapore, Taiwan | High technological penetration rates and per capita GDP, skilled/educated |
| 7. Fast-food chains (such as  Wendy’s, McDonald’s, Burger  King and Pizza Hut) | Sites within 1 mile of one another | Stimulate food sales, high traffic flows |
| 8. General aviation aircraft  (including Cessna, Learjet,  Boeing and Raytheon) | Wichita, Kansas | Mass of aviation skills (60-70% of world’s small planes/jets built here |
| 9. Orthopaedic device  manufacturing | Warsaw, Indiana | Ready supply of skilled workers, strong US market |

***Methods of Evaluating Location Alternatives***

Four major methods are used for solving location problems:

1. The factor-rating method - involves 6 steps:

1. Develop a list of relevant factors called key success factors
2. Assign a weight to each factor to reflect its relative importance in the company’s objectives.
3. Develop a scale for each factor (e.g. 1 to 10 or 1 to 100 points).
4. Have management score each location for each factor, using the scale in step 3.
5. Multiply the score by the weights for each factor and total the score for each location.
6. Make a recommendation based on the maximum point score, considering the results of other quantitative approaches as well.

2. Locational break-even analysis

3. The centre-of-gravity method - a mathematical technique for finding the location of a

 distribution centre that will minimize distribution costs. The method takes into account

 the location of markets, the volume of goods shipped to those markets and shipping costs

 in finding the best location for a distribution centre.

 (For the mathematical formula and calculation see pp 354-355 in Heizer, 10th edn, 2011.)

4. The transportation model - determines the best pattern of shipments from several points of supply (sources) to several points of demand (destinations) so as to minimize total production and transportation costs. Every firm with a network of supply-and-demand points faces such a problem.

**Behavioural Impact in Facility Location**

Location decisions are difficult and complex, because they can involve many different consequences.

Costs are not the whole story, and models must be interpreted with caution because model results are deceptively precise. No matter how exact, models are inadequate; they simply do not consider any aspects of a problem that are non-quantifiable.

New locations require that organisations establish relationships with new environments and employees and adding or deleting facilities requires adjustments in the overall management system. The organisation structure and modes of making operating decisions must be modified to accommodate the change. These hidden “system costs” are usually excluded from quantitative models, and yet they are very real aspects of the location decision.

We examine three qualitative aspects of location planning:

1. Cultural differences in the location - when a facility is located in a new location, it means that employees will be hired from within the new locale and the organisation must establish appropriate community relations to ‘fit into’ the locale as a good neighbour and citizen. At the heart of environmental influences are 4 social institutions: ***the family, religion, the school and the state***. A person’s disposition toward accepting responsibility, exercising independence of thought and initiative, style of interpersonal interaction with others and lifelong goals and aspirations are tempered by environmental elements.

Family structures and role relationships can mould a person’s views on the ‘proper’ roles of men and women. These views are carried over into the workplace and affect employees’ attitudes toward men or women occupying certain occupational roles. Employee acceptance of superior-subordinate relationships and varying degrees of authoritarianism may vary with subcultures in which family relationships are male-dominant, female-dominant or egalitarian.

At the international level there are greater cultural differences. For example the Japanese culture is very much communal-oriented, while the Western culture is more individual-oriented. Between USA and Europe, the US practised a participative/decentralised managerial style than the authoritarian/centralised managerial style. By recognising cultural differences, we can anticipate special problems if we decide to locate in another society (country). It is not simply a matter of duplicating a highly refined manufacturing process from the US to somewhere else. It is recognised that “the developed country’s class structure, behaviour and attitude are often implicitly built into the technology” (Richard N. Farmer, 1966). The productive tools and techniques that are workable and appropriate at home may be unworkable in another place.

Therefore merely transferring tools and equipment is not adequate. To operate the physical facility, managerial techniques and skills, in proper mixture, must be borrowed from the culture and so must the cultural assumptions that are needed to make them work. The economic, political and cultural makeup of a society has far-reaching effects on the technological and economic success of multinational locational decisions.

1. Job satisfaction of employees - managers have been very concerned about employee job satisfaction because it has an impact on how well the organisation operates. Research has found that the work role most conducive to job satisfaction has participative supervision, an opportunity to interact with peers, varied duties, high pay, promotional opportunities and finally, control over work methods and pace. However, no consistent overall relationship between job satisfaction and productivity seems to exist, other important relationships have been found. High job satisfaction exhibits the following characteristics:
* lower labour turnover
* less absenteeism
* less tardiness and
* fewer grievances

 These 4 factors can have substantial impact on both costs and disruptions of operations.

 But how is job satisfaction related to facility location?

 (1) Found that workers in prosperous community think of more job opportunities available

 and therefore they tend to be somewhat dissatisfied with their existing work.

 (2) Higher employee satisfaction occurs in small town settings and where there is a lower

 degree of unionization than in large industrialised metropolitan locations.

 (3) Employees who are alienated from the middle-class value systems, showed higher job

 satisfaction in jobs required low levels of responsibility. However, employees who are

 not alienated from middle-class values, they have high job satisfaction in jobs that

 require greater responsibility.

1. Consumer consideration - location planning must take into consideration consumer behaviour and proximity to customers. If the primary product is to provide a service to the public, locational convenience for the customer may be the prime consideration. Theatres, banks, supermarkets and restaurants heavily emphasize customer convenience when choosing a location. In fact, convenience of location itself is often considered to be the product offered by some firms. For these reasons the location decision may be regarded as a marketing function instead of a production/operations responsibility, especially as it affects revenues rather than costs.