THE THEORIES ON INDUSTRIAL LOCATION

A location theory is the systematic and rational analysis of spatial distribution of industries to find out the relative merits and demerits of any particular space over the others, for the construction of manufacturing unit or units.

The distribution of industries of the world markedly varies from each other on the basis of raw materials, the process of manufacturing, the resultant product and even the markets. Therefore, it is quite natural that the locational preference will also differ. So, this spatial difference of locations need careful study. The studies primarily concerned about the spatial variation of industrial locations are known as 'industrial location theory'.

Any manufacturing process involves in the transformation of inputs, in one way or the other. Of course, the inputs like raw materials, energy, labour force are spatially distributed over different places. To mobilize all the inputs in a single place, we need excellent transport facilities. Other than production process, selling of the 'output' to the consumers in the market also requires transportation of finished products. So, input mobilization, transformation process of inputs for the manufacturing of output or finished products and selling of the product to the consumers are the major processes of manufacturing.

The manufacturing units get comparative advantage over one another, if the 'scale', 'technique' and the 'location' varies. The selection of industrial location is always controlled by the magnitude and cost of production. Beside these, the technologies adopted also controls the wage rate of labours and quality of products.

11.1 THE FACTORS OF INDUSTRIAL LOCATION

The relative advantage of one area over other, and the combined production cost difference between the places, is the essence of any locational study. The availability of raw material, cheap labour, transport cost and proximity to market makes the manufacturing cost differential between the places. If 'profit maximization' is the chief objective of the entrepreneur, automatically 'least cost' location will be preferred for industrial location. The different locations have distinct geo-economic character. If one region has the advantage of the presence of raw material, the others have marketing facilities. One industrial region specializes on the production of a single item, the others may produce varieties of products. Some industries grow rapidly, while the old ones may show the sign of decline. Some of the manufacturing units produce basic products like pig iron, the others may concentrate on consumer goods, like automobiles. But whatever be the product, there must be some value addition to the raw materials. The utility of the product, after processing, has to be increased.

The basic factor that determines the location of any manufacturing unit is the positive cost-benefit ratio. The preference and relative advantage of a particular place over the others is also guided by minimum production cost.

The factors governing the location of a industry fall into two broad groups. These are :

(1) Geographical factors. (2) Socio-economic factors.

It is indeed very difficult to discern the factors distinctly on which category they belong to, but broadly the subdivisions are as follows :

1. **Geographical factors :**
   - (a) Land.
   - (b) Raw material.
   - (c) Climate.
   - (d) Water resources.
   - (e) Fuel
2. **Socio-economic factors :**
   - (a) Capital.
   - (b) Labour.
   - (c) Transport facilities and charges.
   - (d) Demand.
   - (e) Market.
   - (f) Government patronage and policies etc.
   - (g) Tax structure.
   - (h) Management.
   - (i) Other factors.

I. GEOGRAPHICAL FACTORS

Availability of land – Needless to say that land is a prime requisite for any industrial establishment, whatever may be the process, technique or volume of the raw material or the product. Apart from the mere availability, quality of the land-form—undulating, even or steep slope—influences the localization of the industry.

The cost of the land abruptly changes with the change of economic development of the area. It has been observed that extensive plain lands are generally inhabited by dense population. The urban centres generally develop on riverine plains, which on the other hand is also preferable for industrial location. Due to this conflict, cost of the land escalates rapidly.

Due to increasing cost of the land, the industrial establishments have to migrate from populous regions to sparsely populated regions. Though, the other advantages of urban areas exert *centripetal* force to industries. This *stress* and *strain* on the site selection is an important attribute in the locational analysis.

Raw material – It is universally true that the transformation of raw material and total value added to that primary material is the fundamental objective of any manufacturing. The quantum of profit is based on the nature, quality and availability of

that raw material at a desired price. The enhancement of the utility of the raw material is, thus, a significant aspect in any manufacturing activity.

The influence of raw material on industrial location depends on several factors like total weight of raw material, ease of loading and unloading, perishable goods or not. The differential cost of raw material transportation from its source to the plant and finished product to the market governs the degree of importance of the raw material. In some cases, the transport cost of raw material is insignificant to the total production cost, so raw material locations cannot exert considerable influence on locational pattern. Of course, basic industries like iron and steel, alumina reduction plants, copper smelting plants always prefer raw material location, because of the weight-losing character of the raw materials. On the other hand, consumer industries like electronics and automobiles prefer non-raw material locations as these never use unprocessed raw materials.

The development of high-technology reduced the importance of raw material. Lesser amount of raw materials are used in basic industries. Even, in some industries, re-use of waste materials, e.g. scrap in iron & steel industry, reduces the dependence of raw material source.

The nature of the raw material also sometimes controls the location of industry. In sugar cane industry in India, sugar industries are concentrated near sugar cane fields, because away from the field, due to delay, sucrose content of the cane diminishes rapidly. In fish processing units, for example, after the catch, fish needs instant preservation. So, industries are located near the harbours.

Ports, cities or *break of bulk points*, where loading and unloading takes place, are sometimes regarded as ideal location.

Moreover, despite the decreasing importance of raw material in the present era, the more weight losing, bulky raw materials still attract industrial establishment at its vicinity.

Climate – Even today, role of climate in the development of any industry has not been properly ascertained. The effect of climate on the growth of some particular industries cannot be ignored. In some instances, climate plays vital role in the development of the industry. The effect of climate was, perhaps, greatest in cotton textile industries in last centuries. The mild, humid climate of some places yielded comparative advantage over their competitors. Apart from textile, precision industries like electronics, watch, electrical, aviation aparatus and telecom instruments have also preference on particular climate. Besides this, in general, mild climate increases productivity. After the introduction of artificial cooling system, however, effect of climate has been reduced.

Water resources – Availability of water near industrial plants are pre-requisite for some particular industries like iron and steel, textile, paper, card-board, copper smelting and alumina reduction plant etc. Besides manufacturing industries, thermal power stations and, of course, hydel power plants require large amount of water. The recent trend of industrial location indicates strong influence of the proximity of water source.

Apart from direct use of water to the plant, for drinking, drainage of industrial effluent, cooling purpose, water is regarded as one of the major ingredients for industrial growth.

Fuel – Fuel is one of the pre-requisites in manufacturing units. The conversion of fuel, either solid, liquid or gaseous, to kinetic energy is the basis for the transformation of

raw material to the finished product. About two-thirds of the fuels (coal, petroleum, natural gas and radio-active minerals) used in the industries are not used in its direct form. It is generally used as electricity, after conversion.

The fuel resources, specially coal, is very bulky and weight-losing material. The presence or non-presence of coal in any region is a determining factor for industrial location. In past centuries, when most of the power was harnessed from fossil-fuels, location of coal and location of iron and steel plant became synonymous. At that stage, due to poor state of technology, 5 to 6 times more coal was required. Therefore, availability of coal was one of major determinants in the early location of iron-steel plants.

In subsequent periods, introduction of petroleum and natural gas as the substitute of coal to some of the industries reduced the overwhelming dominance of coal. The case of transportation through pipe-lines, less weight loss during energy production, low degree of pollution and less impurities in petroleum curbed the necessity to set-up manufacturing units to the fuel source.

The introduction of nuclear power in some industries further reduced the dependence on energy locations. As the efficiency of exploitation capacity increased through ages, the effect of energy sources further decreased. It has been estimated that same amount of coal is now producing 10 times more energy than 150 years ago. The fuel efficient machinery of the present era are now capable to produce 3 times more output, from same amount of fuels.

More and more, industries are trying to reduce fuel consumption. Some countries, like Japan, are dependent entirely on imported fuel. The less variation of global price of major fuels, like petroleum and coal, are also liable for low dependence on fuels for industrial location.

II. ECONOMIC FACTORS

Capital – The capital or investment is the basic requirement for the establishment of a manufacturing unit. The amount of financial investment discerns the magnitude or scale of the unit. In modern manufacturing world, not only the product but its marketing also need tremendous capital investment. The role of financial institutions like bank and insurance are increasing day by day. The large industrial establishments require such a huge amount of money that capital accumulation from financial agencies, state governments and even from people is a regular practise.

To keep pace with the changing nature of manufacturing process, large sums are required for modernization. Advertisement of the product, purchase of equipments, land and payment of remuneration to the workers, in all kind of processes, require sufficient capital. So, role of capital in industrial establishment is immense, and perhaps most important.

Labour – Unlike fixed raw materials, labour is very dynamic and spatially unevently distributed. The human aspect of this input poses problem to measure its contribution. Over space and time, quality, and skill, wage and availability of labour varies greatly.

The availability of labour is an essential pre-requisite for industrial location. This condition is more applicable particularly in labour intensive industries.

The cost of labour also constitutes a vital share to the total industrial expenditure. The organised labour force and Trade Union activities sometimes bring stress and strains in the industry.

The skill and ability of labour also varies considerably from place to place. Cheap and skilled labour location pulls some of the manufacturing units like cotton textile.

Due to high expenditure on labour, multinational companies are trying to reduce dependence on labour, by adoptation of mechanization and automation.

Transport – Though the influence of transport and communication has been reduced considerably in last centuries, still the role of transport in the location of manufacturing units cannot be under-estimated. Some of the noted geographers suggest that, if other conditions remain equal, transport cost difference between the places will be major determinant in plant location. The hauling of raw material from the source to plant and finished goods from plant to consuming market involves huge amount of charge, if the raw material is bulky and weight-losing. In the case of non-weight losing or pure material, transport cost is unable to exert the same degree of influence on locational pattern.

In sophisticated industries like electronics, the components are so light that total transport charge of either raw material or finished product is very low to total expenditure.

Some of the regions are, however, ideally located in terms of transport. River or sea-side locations enjoy cheap water transportation routes. The *break of bulk* points, where loading-unloading takes place, enjoy relative advantage. The place situated in the midst of return journey of raw materials also avails raw materials at a much cheaper rate. The railway freight rates are cheaper than roadways. Thus, places situated near rail lines are getting advantages. Some raw materials like petroleum and natural gas is now transported through pipe lines. So, initial construction cost is high but recurring cost of transportation is minimum.

It will be erroneous to consider that transport cost increases uniformly in ali directions. Long distance haulages are comparatively cheaper per tonne/km.

The advancement of transportation methods reduced the expenditure of haulage. Ttransport cost still exerts considerable influence on the industrial location.

Demand – Demand cannot directly influence the location of the industry. In fact, demand of a particular commodity determines the very existence or survival of the industry. But in macro-level, demand of a region or a country attracts industries. Demand is, in reality, the reflection of market condition. Demand of a commodity determines the price and the increasing price due to high demand brings higher rate of profit. Dut to high profit rate, industries naturally migrate to the region, if the commodity is perishable or market-based.

Demand, on the other hand, determines the magnitude of production. If production increased, in that place industries also expand. New industries also venture to establish their plant.

Market – It is quite natural that in the contemporary world, consumer centre or market influences maximum the location of the industries. The changing mood of consumer and keen competition with several other similar industries force the industries to make greater access to the consumers.

The sprawling urban market centres possess all the economic, civic and recreational amenities. As a large cross-section of people are always present in urban market centres, regarding labour and transportation, it is the best location for any kind of industries.

The declining importance of raw material and fuel in the industrial laocation have given a distinct weightage to market centres. The technology-oriented industries prefer market as location because of the easy availability of technocrats and easy access to latest technology.

To keep pace with variation of demand and supply and changing price level of the commodity, of course, market location will be the best possible location. This sensitive price index exerts maximum pull towards market location.

The marketing of the product in the consumer centre requires maximum attention in perfect competition. For information on latest developments of sales and advertisement for sales promotion some industries may be forced to select markets as location.

Some industries, which produce perishable goods, have no other alternative but to establish plants in the periphery of the market. The industries that use scrap (i.e. iron & steel) or waste material, also concentrate on urban centres. Another type of industry, so often developed near market, produces brittle products like glass or ceramics. Unless it is located near the market centre, probability of loss due to damage will be higher.

Government patronage and policies – The government of the countries are more and more paying increasing attention to the industrial growth and selection of locations. Broadly, government interference is of two types. One is on the military purpose or strategic reasons and other, to avoid regional imbalances of economic growth. Of course, socialist governments are more aware about the location and distribution of industries in remote and underdeveloped areas than their capitalist counterparts, where profit maximisation is the only objective. On the other hand, in Third World underdeveloped or developing countries, the government plays a the pivotal role in the location of a industry.

The emphasis on decentralised planning in socialist and underdeveloped countries ignores the general principle of location. The mounting unemployment problem and stagnant state of the economy inspire the governments to erect industrial establishments, specially in underdeveloped areas, to boost the economy. In capitalist states, however, to avoid congestion, government pays subsidies to any dispersion move. In some states, for the upliftment of backward areas, special subsidies are generally declared to encourage industrial location.

For ecological reasons, some regions are prohibited for industrial establishment by the governments.

Tax and Subsidies – Tax structure and its rate influences greatly the industrial location. High rate of taxes discourage the location of industries in some regions while concessions and subsidies in tax rates favours the location of industries. Even in some states, to bring homogeneity within entire nation, equal tax structure and freight rates were introduced, which nullifies the natural advantage of some region, while giving advantage to other areas. The old *'Pittsburg plus and multiple basing point policy'* in U.S. iron and steel industry and *freight equalization policy* in India are typical examples of the protective policy.

In a federal state, like India, each state government has its own tax policy. Sometimes, for the urge of industrialization, taxes are exempted to attract industrialists for fresh investment in the state. Low tax rate attracts entrepreneurs to settle in the area. The classical example of low tax region is Monte Carlo in Europe, Singapore and Hong Kong in Asia, where a large number of industrial establishments have grown up.

In capitalist economy, tax rate is lower but in socialistic or mixed economic pattern, the government collects revenue through taxes for the development of other backward areas. So, tax rates are higher in industrially developed regions.

It has been observed that metropolitan city areas charge heavy taxes, compared to rural areas.

Management – The spectacular development and specialization of particular products in a single area naturally develops a traditional skill and managerial ability to the local people. It has been observed that in some industries, like fish-product, wine manufacturing, cigarette, textile, silk, rayon etc., production is well managed by the people of the regions where these industries are traditionally famous. So locational pattern of these industries are indirectly controlled by this factor.

Other factors – There are several other factors which influence the locational pattern of the industry. The high degree of industrial development of a region as its necessary corollary exerts certain amount of influence on the setting up of other industries. This agglomeration, as it is popularly known, gives certain advantages to the new industries. Among these advantages are latest information, contemporary technology, sound administrative set up, easy access with sister organisations and day-to-day direct contact with consumers are very important.

The sound infrastructure within the region, in the form of communication (roadways, airport, port, telecom, network, newspaper, laboratory etc.), sound administration, efficiency of financial institutions, greater civic amenities in the metropolitan or industrial areas, attracts industries.

Though industrial location in private sectors is ultimately determined by the entrepreneur himself, it is always influenced by the trends of the contemporary locational pattern. The prime objective of *'profit maximization'* may not always influence his decision entirely. In Third World countries, political decisions may offset any locational consideration.

The industries, either private or government owned, always show the tendency to grow in the region where sustained development is possible. This is a prime requisite for the ultimate existence of any kind of industrial establishment.

11.2 THE LOCATION THEORY

From the later part of the 18th century, the Western world had witnessed an unprecedental industrial growth. Numerous industries of various kind, scale and technique took birth. The spatial concentration of the industries in urban centres and mining towns posed tremendous problems both to the entrepreneurs and the people. To earn maximum profit by reducing cost, growing urge surfaced to find out the least cost location of the industries.

The pioneer effort in this regard was made by Johan Von Thunen in the early part of the 19th century. The major objective of his theory was, however, to delineate the agricultural zones of different crops and demarcation of its limit and distance from the city core. In this theory, he attempted to discern the probable profit of cultivation of different crops according to the distance from the consumer. Though the theory primarily discussed agricultural activities, it had certain influence on the industrial theories devised in the subsequent periods.

The first composite and self-explanatory theory that revolutionized the concept of industrial location was promulgated by Alfred Weber, in his book *'Uber den Standort der Industrien'* in 1909.

After the publication of Weber's theory, several theories came into being. Locational analysis soon became a very important subject. The subsequent theories, formulated after Weber, were as follows :

I. *The Theory of Tard Padandar*, published in 1935.
II. *The Theory of Edgar Hoover*, published in 1937.
III. *The Theory of August Lösch*, published in 1954.
IV. *The Theory of Melvin Greenhut*, published in 1956.
V. *The Theory of Walter Isard*, published in 1956.
VI. *The Theory of Fetter.*

Among the different locational theories, because of simplicity, scientific approach and originality, the Theory of Alfred Weber and August Lösch are more relevant than the others.

11.3 THE LEAST-COST LOCATION THEORY OF ALFRED WEBER

In tune with the suggestion made by *Wilhelm Launhardt* in 1885, Professor Alfred Weber first introduced his famous theory of industrial location in 1909, through the book *Uber den Standort der Industrien*. Since then, tremendous controversy has taken place on the relevant points of the theory. Whatever may be the merits and demerits of the theory, it is true that his theory cannot be ignored even today.

Objectives of the Theory

The basic objective of Weber's theory is to find out the minimum cost location of a industry. In this theory, he tried to establish that transport cost plays a pivotal role in the selection of industrial location. Irrespective of socio-economic and political climate of the country, the general trend of the location is universal. He denied the importance of factors other than transport cost, labour cost and agglomerating factors.

Assumptions

The Weberian concept is not universally applicable. This hypothesis is only applicable where certain optimum conditions are available. These general conditions are as follows :

1. The area under consideration is having a self-supporting economy where uniformity prevails regarding land-form, weather, labour and even ability or performance of the people.

2. The perfect competition prevails in market. The demand of the product is unending.

3. The labours are static within the region. A uniformity of wage rate is a necessary pre-condition of the theory.

4. Uniformity of socio-economic and political environment within the region.

5. Raw materials vary according to the weight. Some raw materials, available everywhere, were classified as ubiquitous; the others, confined in particular places, were known as fixed raw materials.

6. Transport cost increases uniformly and proportionately according to weight in all directions.

Postulations

The presence of all required conditions favours the implementation of Weber's theory. The location of the industry, as stated by Weber, will be controlled by these factors of separate nature. These factors are :

I. Influence of transport cost.

II. Influence of labour cost.

III. Influence of industrial agglomeration or deglomeration.

The first two factors are classified as *general regional factors* and the third one is *local factor.*

I. INFLUENCE OF TRANSPORT COST

In the least cost model of Alfred Weber on industrial location, transport cost was considered the most powerful determinant of plant location. The total transport, as stated by Weber, is determined by the total distance of haulage and weight of the transported material.

Regarding the transport cost between the points, generally from raw material to plant and market, distance is the sole determinant.

The weight, however, influences most the total transport cost. If other conditions remain same, the relative advantage of transport cost determines the plant locations. The advantage on transport cost, is, however, largely dependent on the nature of raw material.

On the basis of availability of raw material, it was divided by Weber as : (A) Ubiquitous. (B) Localised.

The ubiquitous raw materials are found everywhere. This raw material is freely bestowed on earth, e.g., water, air, soil etc.

The localised raw materials are confined only in some selected places on earth, e.g. iron ore, coal, bauxite etc. The localized raw materials are not uniform in nature and their distribution is also not uniform.

The localised or fixed raw materials are again subdivided into two :

(a) Pure raw material.

(b) Impure or weight-losing raw material.

The basis of the above divisions is the net weight loss during manufacturing process. If the weight of the raw material remains same even after manufacturing process, raw material is termed as pure or non weight losing raw material. On the other hand, if after manufacturing, weight of the raw material becomes reduced it is impure or weight-losing raw material.

To find out the nature of raw material, whether it is pure or impure, Weber introduced his famous *'Material Index'*. Material Index is the ratio of raw materials and finished product. When the Material Index (M.I.) is one, raw materials may be classified as pure. But when the weight of raw material is greater than the finished product, the material index become greater than unity (>1), raw material is then classified as impure or weight losing. Raw cotton as raw material is a pure raw material. Because, to produce one tonne of finished cloth, same amount (1 tonne) of raw cotton is required. On the other side, iron ore is a impure or weight-losing material. Because, to produce 1 tonne of pig iron, more than 2 tonnes of iron ore is required now.

Depending upon the nature and type of raw materials, according to Weber, industry selects its location. Not only raw material nature, the number of raw materials used for a particular industry also discerns the location. The industry may be dependent on single item of raw material. So, in that case, push and pull factor will exert influence on a straight line joining the raw material and market. But if the industry uses more than one raw material source, then each raw material source will exert push or pull on the location. Then the situation will be very complicated when the weight loss ratio in each raw material is varied. In this case, complicated pattern will evolve and selection of location for the plant will be a difficult task.

If only one raw material is involved in the manufacturing process, the location of the industry will certainly vary within a line. That is called linear location. If multiple raw materials are involved, the location pattern may attain different geometric shapes. When two raw materials are used, the pattern will be triangular. If more than two raw materials are involved, patterns may emerge in different geametric forms, like rectangle, pentagon, hexagon etc. So locational pattern, according to Weber, are of two types :

A. Linear—when industry is situated between market and one raw material.

B. Non-linear—when industry is situated between market and more than one raw material.

A. **Linear location of the industry** : In this situation, one raw material is used for the manufacturing of finished product. Therefore, three options are left to the entrepreneurs to select the location :

1. At the market.
2. At the raw material source.
3. At any intermediate point between raw material source and finished product.

The selection of the location, in this case, is entirely dependent upon the nature of raw material and the degree of weight loss during manufacturing. Depending upon the material index of the raw material, several preferences may occur. These are as follows :

(a) In the case of manufacturing process, where no localised materials are used, rather all the raw materials are ubiquitous, naturally raw material location cannot exert any influence on location of the industry. In that situation, industry will develop only in the market as distributional cost is minimum on that point.

(b) If some of the necessary raw materials are localised and the remaining are ubiquitous, in that case it may happen that final product will be greater than the weight of localised raw material. In that peculiar situation, Material Index will be less than one. Obviously, market will be the least cost location.

(c) A situation may arise when the raw material is pur and localised. In that case the Material Index will be one (MI = 1). As total transport cost in this situation remains unchanged everywhere, industry may develop either in market or raw material source or even in the intermediate location between the two.

(d) In the situation where Material Index is greater than one (MI = >1) i.e., raw material used are weight-losing or impure, the industry should develop within the raw material source region.

B. **Non-Linear location of the industry** : In this case, as more than one raw material is involved in the production process, due to the push-pull factor between more than two points (market and at least two raw material source), the locational pattern will

vary in a non-linear fashion. When two raw materials are used, the 'influence area' will be a triangle.

Depending upon the nature and type of raw materials (weight loss, M.I., etc.) the location of the industry varies. Weber illustrated this concept in the situation of two raw materials and the market. As three points are involved in the manufacturing process, the influence area for the location should be triangular shaped.

If two raw materials (R_1 & R_2) are used in the manufacture, there will be four probable locations for the industry. These are :

(1) At the market [M], (2) At first raw material source or at R_1 (3) At second raw material source or at R_2, (4) At any intermediate region between the three [R_1, R_2 & M] within the triangle.

The industrial location in triangular area is controlled by the nature of raw material (whether pure or impure); and if the raw material is impure (weight losing), how much reduction of weight takes place in each raw material. The material index of each raw material and distance of market from the raw material sources decides the least cost location.

In this triangular area, promulgated by Alfred Weber, a least cost location may emerge through transport cost analysis. The probable situations are as follows :

(a) In the production process, two raw materials may be of ubiquitous nature. It is a rare occurrence but if it happens, as there will be no transport cost difference, the industry should concentrate on market, due to lowest distribution cost.

(b) If one of the raw materials (R_1) is ubiquitous and other (R_2) localised and impure, the industry will certainly develop at the localised raw material source.

(c) In the case of two raw materials, the least cost location will be on market.

(d) A complex situation may arise, if both the required raw materials are localised and impure or weight losing (M.I. = >1), there may be several possibilities. The amount of weight loss (M.I.) of raw materials will determine the location of the industry.

In this case there also may be two possibilities :

(i) If the weight loss is same to both the raw materials, or same material index of the raw materials.

(ii) If the amount of weight loss or material index is different in each raw material.

(i) If the weight loss ratio is same in both the raw materials, I or an intermediate location will be least cost location. This can be proved by following steps :

Let M,R_1L and R_2L be an equilateral triangle with each arm 100 km. long. A perpendicular MI was dropped over R_1L and R_2L with 86·6 km. long (MI = $\sqrt{(R_1L.M)^2 - (R_1L.1)^2} = 86{\cdot}6$). Now suppose, R_1L and R_2L are two raw material locations and M is the market.

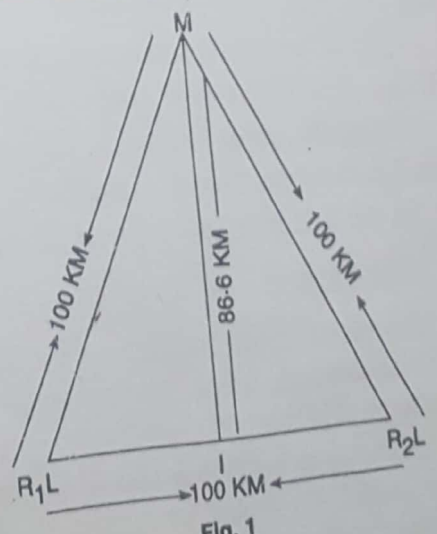

Fig. 1

Transport cost per ton/km. is one rupee. According to Weberian premises, it is uniform in all direction and increases proportionally. Both the raw materials reduce half of their weight during manufacture.

Now, if to produce per ton of finished product, the raw material requirement from each source is 2 tonnes, the cost structure at four places will be as follows :

If the industry be situated at R_1L, total transport cost will be – $(2 \times 100) + 100$ = 300/-

If the industry be situated at R_2L, total transport cost of the product to the market will be – $(2 \times 100) + 100 = 300$/-

If the industry be situated at M_1, total transport cost of the product to market will be – $(2 \times 100) + (2 \times 100) = 400$/-

If the industry be situated at I or intermediate point, total transport cost of product to the market will be –$(50 \times 2) + (50 \times 2) + (86{\cdot}6 \times 1) = 286$/-.

So, I or intermediate location will be the least cost location.

(ii) The locational pattern will change, if the raw materials involved in the production process are localised, impure or weight-losing and proportion of weight loss is unequal, the location of the industry would take place near maximum weight-losing raw material. The location, in this case, can be ascertained by following steps :

In the triangle (Fig. 1), let R_1L and R_2L be two weight-losing materials and M is the market. Now, according to the given figure, production of 1 tonne of finished product requires 3 tonnes of raw material from R_1L and 5 tonnes of raw material from R_2L.

If the other conditions remains same to case (i), then the industry will tend to location near R_2L, as raw material loses maximum weight in R_2L (5 tonnes to 1 tonne). This can be illustrated by following steps : —If the industry is situated at Market (M), the total transport cost will be – $(3 \times 100) + (5 \times 100) = 800$/-

[Transport cost of 3 tonnes raw material from R_1L is 300/- and transport cost of 5 tonnes raw material from R_2L is 500/-]

—If the industry is situated at raw material source or R_1L, the total transport cost will be – $(5 \times 100) + (1 \times 100) = 600$/-

[Transport cost of 5 tonnes of raw material from R_2L will cost 500/- (5×100) and transport cost of 1 tonne of finished product from R_1L to market will cost 100/- (1×100)]

—-If the industry is situated at other raw material source R_2L, the total transport cost will be – $(3 \times 100) + (1 \times 100) = 400$/-

[Transport cost of 3 tonnes of raw material from R_1L would cost 300/- (3×100) and from R_2L to market 1 tonne of finished product would cost 100 (1×100)]

So, the R_2L or more weight losing material location will be the least cost location.

II. INFLUENCE OF LABOUR COST

The role of labour cost in the location of any industry was not clearly pointed out in Weberian concept. It has been observed that Weber was rather hesitant to define the importance of labour cost.

According to his labour cost factor, some regions may have the advantage of cheap labour availability than other regions. If the total savings of the area due to cheap labour cost exceeds the savings of another region due to transport cost advantage, then only first

region gets distinct advantage over the other. So, in that case, industrial location will shift from least transport cost location to least labour cost location.

Apart from wages of labours, productivity of the labour also changes from one place to another. So, it may also happen that a place with equal wage rate with another region get advantages in terms of high productivity of the labour. In that case, in second region, total labour cost per unit of product is quite lower than the first region. In this case, if other conditions remain same, industry will certainly move to second region. Even if savings in labour cost is higher than saving in transport cost, same thing will happen. Weber, in his model, explained satisfactorily how cheap labour cost may offset the advantage derived from transport cost. To calculate the effect of labour cost on the location of a manufacturing unit, Weber introduced the concept of *Isotime*, the lines joining points of equal transport cost.

All along the lines or isotimes, have same transport charge. O is situated on 12th isotime. Here value of each isotime from another is Rs. 10. So, from R_2L, transport charge at O is $12 \times 10 = 120$/-. We know from our Fig. 1 calculations that R_2L is the least transport cost location, where total transport cost is Rs. 400. Suppose, the total labour cost in this region is Rs. 500. So, the aggregate cost of transport and labour at R_2L is Rs. 900.

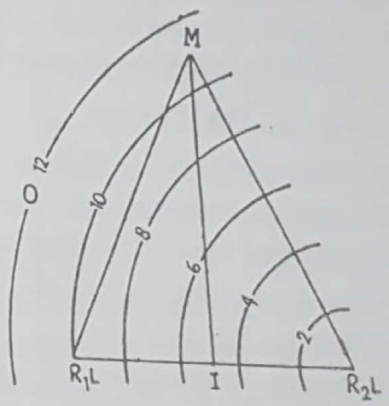

Fig. 2

Now isotimes are drawn around R_2L. A place situated outside the triangle is O. In O, total extra transport charge will be Rs. 120, but total labour cost is half to that of R_2L, i.e. Rs. 250. So, combined transport and labour cost at O, a place situated outside the triangle, is only (400 + 120) + 250 = Rs. 770.

So, it is evident that total transport charge and labour cost at O is far less than the combined labour-transport charge at R_2L. So, naturally, industry will shift from R_2L to O and O will be the least cost location.

Weber, in this regard, introduced his famous concept of *Isodapanes*, or the lines that connects equal additional transport cost around the least transport cost locations or, in other words, *Isodapane* is the line that connects several points having equal total costs.

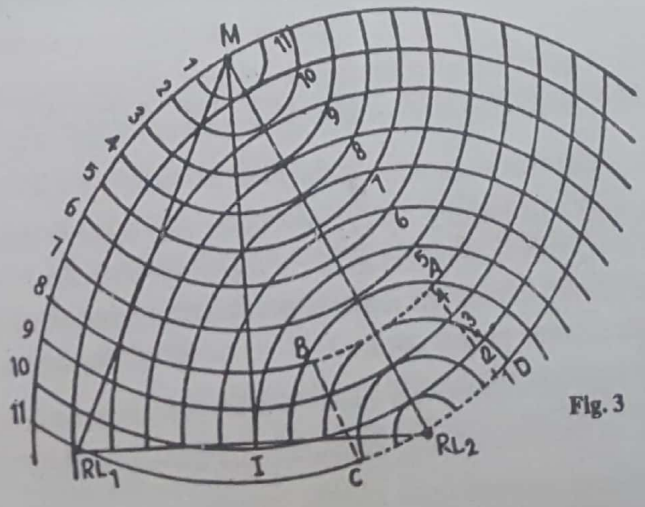

Fig. 3

The area bounded by the line, is isodapane. In all the four points A, B, C, D total transport charge is same. It has been considered that the raw materials of RI_2 is used 1·5 units to manufacture 1 unit of finished product. At A, 1·5 units of raw materials are transported (1·5 × 4 = 6 unit) and after production 1 unit is transported to 8 unit distance. So, total transport charge is (6 + 8) = 14 unit. In B, C, D also, if a industry is established, transport charge will be 14 units.

So, the area bounded is known as *isodapane*. If labour cost differs between the places, the region will be advantageous than other centres.

III. INFLUENCE OF AGGLOMERATION

Weber also emphasized much on agglomeration of the industries. According to his theory, if number of factories concentrate within a region, due to mutual co-operation, the total transport cost may be less than a single area. All the industries concentrated in the region should be dependent on each other.

Criticism of the Theory

(1) Weber's theory is a model hypothesis based on several premises. But in the complex manufacturing process, presence of all the desired conditions is not possible. Only in the exceptional cases all the premises may occur in a place.

So, the theory is an exception rather than rule.

(2) The difference of different economic systems has been ignored by Weber. The difference between the capitalistic and socialistic economy, institutional factors and entrepreneurial decisions were not taken seriously.

(3) Weber over-emphasised on the role of transport cost. He considered transport cost is proportional with weight and distance. But, in reality, transport cost of raw materials are cheaper than finished product. Transport rate is also not proportional with the distance. It has been estimated that with increasing distance transport cost reduces substantially. The advantage of the 'break of bulk' location was ignored.

(4) In his agglomeration concept, Weber tried to establish that if industries concentrate in a region, it would get distinct advantages. But he failed to consider the space problem, energy crisis and problems of civic amenities.

(5) The assumption of perfect competition in the concept of Weber is an ideal condition. In the long run it is very difficult to sustain perfect competition in the region.

(6) Competition and price fluctuation in the economy is a natural phenomena. Weber failed to recognise that.

11.4 PROFIT MAXIMISATION THEORY OF AUGUST LÖSCH

August Lösch, a German economist, published his theory of 'Profit Maximisation' in the year 1954. The least cost location theory of Weber was wholly discarded by Lösch. In fact, he suggested that, 'profit maximisation' is the only objective of the entrepreneur, whether it is state or an individual. The major objective of the industry is, therefore, to find out the place where maximum profits occur.

Unlike Weber, who postulated his entire theory in an economic state of perfect competition, Lösch, on the other hand, explained his theory within the environment of monopolistic competition. According to Lösch, industry will not necessarily be located

within the least cost (transport cost and labour cost) location, rather it would locate in areas where maximum profit will occur. So, ignoring transport cost, labour cost and agglomeration cost, he emphasised more on the total production cost.

To get the maximum profit, as stated by Lösch, total consumption is important. Higher the consupmtion rate, greater will be the profit. In this case, he emphasised most on the price reduction of the commodity. Any decrease of price would automatically stimulate the volume of consumption. This can be illustrated by the following diagram.

In this simple model, it is evident that when price of the commodity drops from R to P, the consumption increases from M to N.

The theory of August Lösch considered demand as a most important variable. The fundamental objective behind the theory was to find out the most profitable location for industrial establishment.

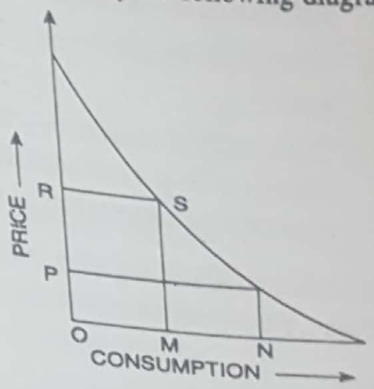

Fig. 4

To determine the location of maximum profit, Lösch said, *"The complexity stems from the fact that, there is more than one geographical point where the total demand of a surrounding district is at a maximum, ... We are thus reduced to determine separately for every one of a number of virtual factory location the total attainable demand, and for similar reasons the best volume of production as a function of factory price (Market and Cost analysis). The greatest profit attainable at each of these points can be determined from the cost and demand curves, and from this place of greatest money profits, the optimum location can be found."*

Lösch argued that most of the existing theories are all simplified and generalizations of the complex problem of industrial location. Like Weber, he also considered certain assumptions for the success of his theory.

Assumptions

Like Weber's theory, 'profit maximisation' theory of Lösch is not universally applicable. In the presence of certain optimum conditions the maximum profit location may occur :

(1) The area under consideration should be an extensive homogenous plane where raw materials are distributed evenly.

(2) The 'transport cost' is uniform and directly proportional in all the directions.

(3) The people inhabiting the region have a general homogeneity either in taste, knowledge and technical skill.

(4) There is no economic discriminations among the people. The economic and career building opportunities are open and uniform to all individuals.

(5) The population distribution is very even and the area is self-sufficient in agricultural production.

In the case of excess production of agriculture, the status quo of economy will be distored. To achieve homogeneity of economy within the region, the theory required some more conditions. These are as follows :

(1) The entire area should be equally served by the factories. No area should be exempted from the supply, therefore, no new firm would dare to venture in the area.

(2) There must be conformity in the range and quantum of profit. In case of abnormal profit, new firms may try to establish their own plant.

(3) The location must satisfy both producer and consumer. The profit of the firm and satisfaction of the consumer must be optimum through the location.

(4) There must be provisions for consumers to get the products from other adjacent areas.

(5) The number of consumers, producers and areas should be well defined and not very extensive. Only a limited number of producers within a small area will be able to overcome the complexities and satisfy completely the handful of consumers.

According to Lösch, to get the desired result from the location and sustained growth of the industry, these conditions are pre-requisites.

Theory

The major objective of the location theory is to attain equilibrium in the producing area and the product and the ability of the producer. If a single entrepreneur enters in the production process, within a vast area, the distribution cost will be very high. But when several small producers are engaged in the production process in separate regions, the distribution cost will come down and due to increasing competition, efficiency of the product and cost of production will be lower. The profit will increase substantially.

Due to increasing competition, the area served by individual manufacturing units will be reduced. In the reduced area, several producing units will remain adjacent with each other, without leaving any area unserved. So, in this particular situation, a hexagonal area would serve the purpose.

To establish his theoretical model of the theory, August Lösch proposed three distinct phase of development. The phases are as follows :

I. In this first phase Lösch observed that if sufficient and symmetrical demand of a product prevails in the market, the market conditions may be explained by a demand cone. The following diagram illustrates that the effective demand of the particular product will be exactly same to the volume of the cone.

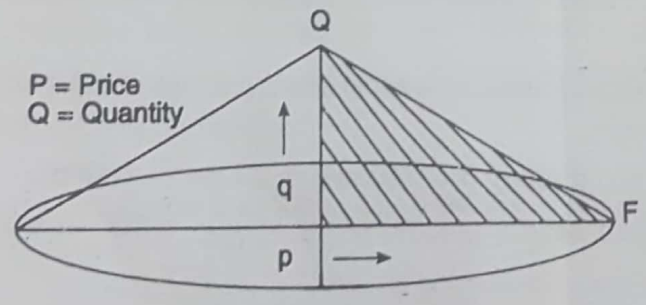

Fig. 5

In Fig.5, P is a producer, and demand curve is lying on QF. P or price line, controlled jointly by transport cost and distance. The price increased from P to F. Along the Y axis or PQ, demand of quantity is measured between PF and QF.

When PF is taken as a measure of distance and is rotated about P, the circular market area is formed, bounded by the locus of points F, where the price becomes too high. Total sales are given by the volume of the cone produced by the rotation of PQF.[1]

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1 August Lösch , 1954, P–10 and David M. Smith, "Industrial location" (P–87) —John Wiley & Sons.

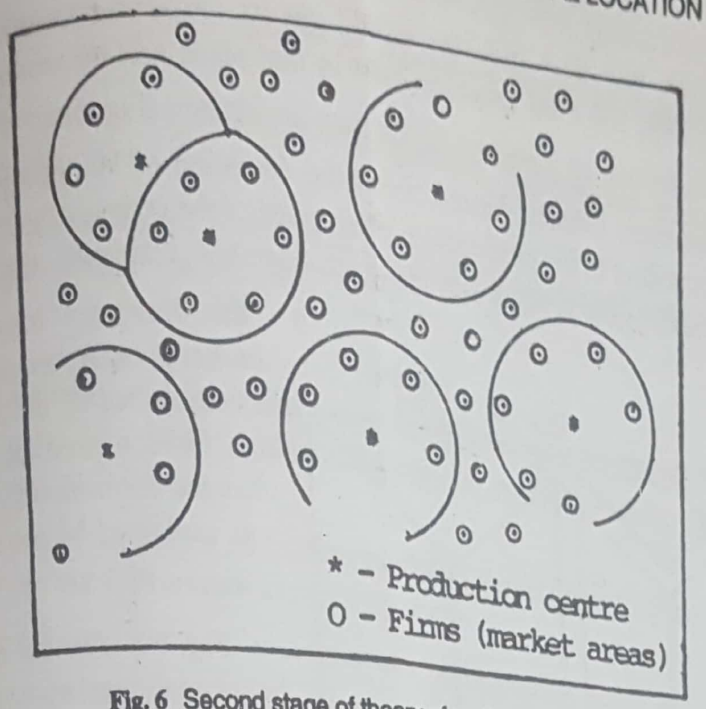

Fig. 6 Second stage of theory of profit maximization.

In Fig. 5, it is clear that, away from centre, with increasing distance, demand of the quantity drops drastically.

II. In the second phase, within the vast rounded area, several factories will concentrate. The virgin, extensive market area will automatically give a lucrative operational area.. But despite the growing competition among the firms to capture larger share of consumer and larger market areas, there should be some void in the boundary zones. Like intra-molecular space, a certain amount of region will remain unserved or poorly served. Though the mal-distribution of firms may result in shrinkage of areas in some instances, some other regions will be devoid of any industry. The circular pattern of industrial hinterland in phase two will ultimately decide the future of the industry in that region.

In Fig. 6, the space situated outside the circular areas are still lying vacant. It is quite natural for the other industries to capture this potential market areas, hitherto unexploited. The influx of new industries in the region will result in shrinkage of the market areas (denoted in Fig. 6 by circle) of different production centres. The intrusion of one market area to other will distort the circular market areas and the market areas of different production units will further reduce. This situation will lead to the initiation of the third phase.

III. In the third phase of industrial location witness the narrowing of the intermediate space between two market areas. The areas fall vacant between the different market areas become the target of new enterprises. As new firms set up within the vacuum, the hinterlands of earlier industries become reduced. The reduction of the market area results in rapid disruption of the early circular pattern. Gradually the market area of the industries attain a hexagonal shape.

According to Lösch, when any area possesses several hexagons, lying upon each other and surrounding a particular centre, a metropolitan city will grow. In other words, it may be said that around the nucleus of a city, numerous hexagons or market areas of different commodity will grow.

So, in this fashion, industries would concentrate within a region, each having different products. So, almost all types of materials including raw materials should be available on

that point. Hence, any new industry would get its required raw material within near distance. Obviously, the total transport cost in that place will be minimum. In this way, 'equilibrium conditions' as stated by Lösch may be attained (Fig. 6).

Lösch, however, himself hinted about the deviation of his theory in some special conditions. According to his conception, when price of the commodity of a particular firm increases, demand of the product decreases considerably. Naturally, due to higher price, the company loses some of its market area. Automatically, that area is encroached by the adjacent firm. In this fashion, market area of a unit changes continuously. This incident was explained by the figure given by Lösch in Fig. 7.

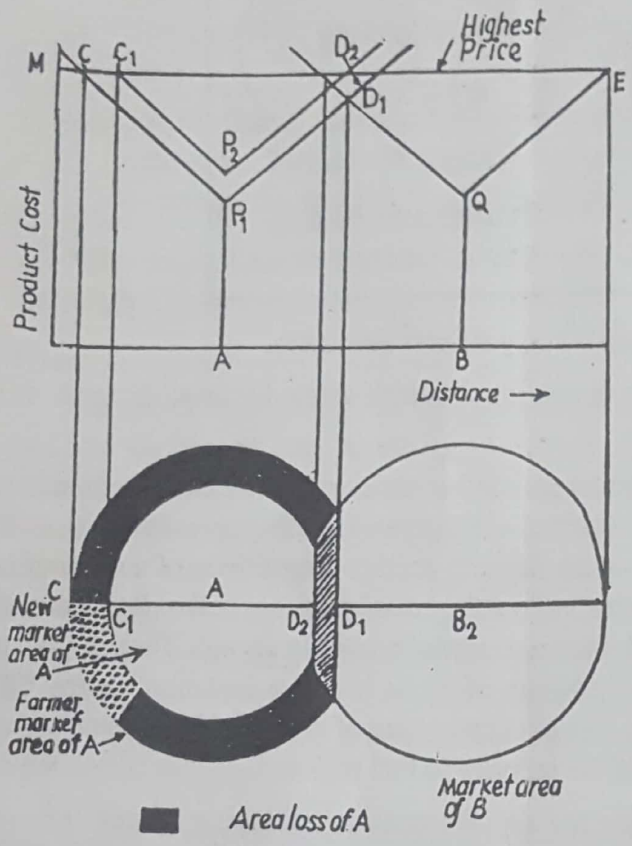

Fig. 7

Fig. 6 shows the development of hexagonal market area in the third stage. The dotted lines represent market boundaries of respective production centres. The crossed area is the production centre.

In Fig. 7, as stated by Lösch, A and B are two producing centres, with total production cost of P and Q. Their respective market boundaries are CPD_1 and EQD_1. At the product cost of M, their production touches the optimum level and equilibrium is attained.

But when production cost at A increase from P_1 to P_2, the equilibrium condition is disrupted. The product of A becomes less attractive than before, so market boundaries also reduces from CP_1D to $C_1P_2D_2$.

Following the reduction of market of A, automatically market area of B advances in that void region. The previous area of EQD_1 increases to EQD_2. This D_1D_2 areal increase is well reflected in the circular diagram of Lösch. The BD_1 radius increases to BD_2 and former AC radius reduces to AC_1.

Merits of the Theory

1. Lösch tried to restore a order in the former chaotic classifications of industrial location.

2. He was the first person to consider the influence of the *magnitude of demand* on industrial location.

3. Lösch rightly emphasises upon the *role of competition* as an important determinant of location analysis.

4. The calculations adopted by Lösch were simple and easily applicable to any place.

5. The theory has also a *philosophical contribution* on the motive of entrepreneurs' role.

6. His *equilibrium* concept is perhaps the greatest contribution among the location theories developed later on.

7. The least cost concept of Weber was nullified by Lösch and instead more precise 'profit maximisation' concept was adopted.

Demerits

Of course, the theory of Lösch was not entirely flawless. Numerous criticism from different quarters were put forward against the theory on various grounds. The major points against the theory are as follows :

1. This theory is essentially a simplified model or theorizing of an ideal condition. In reality, only in a rare occasion, these events may occur.

2. The assumed conditions of homogeneous plain region, equal distribution of raw materials and uniform transport rates never occur in the real world. Therefore, Lösch's theory, as said by some critics, is nothing but only intellectual exercise.

3. Lösch even assumed the cultural homogeneity and uniform taste of the people within the region. This is nothing but absurdity.

4. He ignored the variation of technological development of different regions. The difference of technical know-how may offset the theoretical model.

5. Political decisions play an important role in the industrial location. Lösch ignored it.

6. The variation of the cost of raw materials and labour wage rates were not given proper weightage in the theory.

7. Lösch categorically separated the role and effect of agriculture and industry. But this difference is somehow arbitrary in nature.

8. The abstract and optimum situation demanded by the theory may be available in agriculture but not in the complex production process of modern manufacturing industries. Thus, Lösch theory is more practical in agriculture, rather than in industry.

Other Theories

Among the other noted theories of industrial location, Edgar M. Hoover's transport cost theory contributed a lot to location analysis. Through the development of 'isotimes', he tried to analyse the nature of demand and supply of a product and role of government in industrial location. He argued that four costs influence the location, namely : procurement, production, distribution and transport cost. This theory is the extension of Weber's theory.

The other group of theorists, specially behavioural school, led by Allan Pred, however, recognise individual behaviour or decisions of entrepreneur as the ultimate determinant of plant location. Not only profit maximization but taste, desire and inclination of the entrepreneur ultimately selects the industrial location. The mood, taste, experience and aim of the investor, as suggested by Pred, discerns the location of an industry.

The market areas school, lead by Frank Fetter, emphasizes more on the competition with others. The technique adopted to force to raise the price of others' product, brings