

FACILITY LOCATION DECISIONS IN THE AUTOMOBILE INDUSTRY

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Abstract - Decisions on location of a factory play a crucial role for many private and public firms. The location decisions taken now will have a major impact on the company's long term sustainability. A decision on location of a firm is a long term investment as it requires large amount of capital for property acquisition and construction of the company. Therefore, in order to make these sorts of decisions profitable, the decision makers must select sites that will not simply perform well according to the current system state, but that will continue to be profitable for the facility's lifetime, even as environmental factors change, populations shift, and market trends evolve. This is basic for all endeavors, however especially transitional ones like the auto territory. An automotive sector needs to recognize imminent destinations, as well as painstakingly dissect their appropriateness for their particular needs. One plainly needs to takes a gander at different viewpoints like site advancement; transportation foundation; defenselessness to catastrophic events; vicinity to contenders and merchants; work economic situations; and natural effect ponders. Areas must be analyzed for their present esteem and future effect to the organization's operations.

Key Words: Automotive sector, Market trends, Population shift.

1. INTRODUCTION

Facility location considered as a vital choice, since it is worried about the entire condition in which the firm works and it includes every one of the assets and the general population who frame the organization. A Facility area choice has long haul impact on organization's operation; in this manner, a great deal of research should be done keeping in mind the end goal to gather enough information to settle on an educated choice. Automobile industry across the world is undergoing some rapid structural changes and is currently one of the most significant topics of today in terms of restructuring and enhancing its production structure in the present scenario. The automobile industry has its roots deep into the various segments of our society and moreover it also has large employment potential, therefore, changes in this sector largely affects the industrial development of a country.

There was no sign of automobile industry in India before Independence. India was only the center of assembly work from the imported parts. General Motors (India) Ltd. has begun amassing trucks and autos in 1928 in their industrial facility at Mumbai. Ford Motor Co. (India) Ltd. has begun amassing of autos and trucks at Chennai in 1930 and at Mumbai in 1931. The initiation of the car business in India began with the Premier Automobiles Ltd. at Kurla (Mumbai)

in 1947 and the Hindustan Motors Ltd. at Uttarpara (Kolkata) in 1948. Vehicle industry in India has gained significant ground amid the most recent three decades. Today, it is a standout amongst the most energetic divisions of economy. With unfaltering progression of the car business since 1991, an ever increasing number of players have set up assembling offices in India. At current, there are 15 producers of traveler autos and multi - utility vehicles, 9 makers of business vehicles, 14 of two/three wheelers and 14 of tractors other than 5 makers of motors. The business has a speculation of more than Rs. 50,000 crore.

Amid the year 2003-04 the turnover of the car division surpassed Rs. 1, 00,000 crores. The business additionally offers considerable work potential. As of now it gives 4.5 lakh coordinate work and around one crore roundabout business. The commitment of Auto Industry to GDP has ascended from 2.77 for every penny in 1992-93 to 4.7 for every penny in 2002-03.

The automobile industry in India is a standout amongst the most essential enterprises. This industry has grown over the years leading to India being ranked at 7th place in the world for production of automobiles. It is estimated that India produces a total of 17.5 million vehicles every year, 2.3 million of which are exported to other markets. This figure is expected to double with certain government interventions as according to a recent study, a survey by global consulting major, Capgemini, late last year suggested that India could challenge China and emerge as the next big manufacturing destination over the next three-to-five years.

2. IDENTIFY, RESEARCH & COLLECT DATA

Factors influencing facility location decision of automobile industry in India

Facility location is the way toward deciding a geographic site for an association's operations. There are many factors contributing to the facility location decision of a private or a public firm. The manufacturing organizations must weigh many components while surveying the allure of a specific site, including vicinity to clients and providers, work expenses, and transportation costs.

The automobile industry has a tendency to be situated close iron and steel delivering focuses on the grounds that steel is the essential crude material utilized as a part of this industry. The closeness of spots delivering tires, tubes, stockpiling batteries, paints and other auxiliary enterprises is thought to be an additional favorable position as it spares extra transportation cost of social occasion parts and supplies from different areas. Port urban communities additionally discover

support with this industry due to the import and fare offices offered by such places. Additionally, automobile industry has moved toward becoming business sector arranged and inclines toward those areas which offer prepared market for the made vehicles as prepared markets implies less stock as an ever increasing number of items can be sold and accordingly decreases the stock conveying cost. There are many factors which influence the facility location decision of automobile industry in India.

The Specific location factors can be divided into two categories:

- **2.1 Dominant factors:** these are derived from competitive priorities, these include:
 - **Favorable labor climate:** An extraordinary work air may be the most basic factor in region decisions for work raised firms. Work climate consolidates wage rates, getting ready requirements, and perspectives toward work, worker productivity, and union quality. Climatic condition drives a laborer capacity to buckle down, controls his conduct and disposition.
 - **Proximity to customers:** Location is a key factor in choosing how profitably customers can hold up under on business with a firm. For example, couple of people should need to go to remotely discovered cleaner or market if another is more useful. More consolidated the territory of the customers, more profitable it is for the creator to win a regularly expanding number of advantages by diminishing the diverse costs related with the thing.
 - **Quality of life:** Great schools, recreational offices, social occasions, and an alluring way of life add to personal satisfaction. This factor is moderately irrelevant all alone, yet it can have the effect in area choices. These elements do assume a specific imperative part for the representatives of the association, as these components are basic for survival and driving an agreeable and solid way of life.
 - **Proximity to suppliers and markets:** In many organizations, plants supply parts to different offices deliberate on different offices for administration and staff bolster. These require visit coordination and correspondence, which can turn out to be more troublesome as separation increments. The closeness to market would guarantee the familiarity with most recent market patterns and buyer purchasing conduct, which is essential from the organization's perspective.
 - **Utilities, Taxes and real estate costs:**

Other essential factors that may develop incorporate utility costs (phone, vitality, and water), nearby and state charges, financing motivating forces offered by neighborhood or state governments, migration expenses, and land costs. Assessment rates, land costs,

fundamental courtesies cost significantly impact the office area choice of an assembling association.

- **Secondary factors:** these factors are mostly ignored by the management team as other factors are more important.
 - Room for expansion
 - Construction cost
 - Accessibility to multiple modes of transportation
 - The cost of shuffling people & material between plants.
 - Competition from other firms for the workforce.
 - Community attitudes.
- **2.2 The General location factors, which include:**
 - **Controllable Factors:**
 - **Proximity to markets:** Each organization is relied upon to serve its clients by giving merchandise and ventures at the time required and at sensible value associations may find offices near the market or far from the market contingent on the item. Finding closer to the market is favored if the items are fragile and powerless to decay. After deals administrations are quickly required frequently. Transportation cost is high and increment the cost fundamentally. Time span of usability of the item is low. Closeness to the market guarantees a steady supply of merchandise to clients and lessens the cost of transportation. India's vehicle industry has developed to a great extent in view of its expansive market estimate. The business has had what's coming to it's of both nearby and outside buyers prompting higher generation levels.
 - **Supply of materials:** It is fundamental for the association to get crude material in right qualities and time keeping in mind the end goal to have a continuous generation. This factor turns out to be imperative if the materials are perishable and cost of transportation is high. At the point when a solitary crude material is utilized without loss of weight, find the plant at the crude material source, at the market or anytime in the middle. At the point when weight loosing, crude material is requested, find the plant at the crude material source. At the point when crude material is all around accessible, find near the market zone. In the event that the crude materials are handled from assortment of areas, the plant might be arranged to limit add up to transportation costs. An assembling office would need to consider the accessibility and expenses of crude material segment parts, and additionally the subsequent cost of transporting these materials to the potential office area. Dissemination focuses need to decide how

the potential office areas will agree to the geographic areas of vital provider offices.

- **Transportation facilities:** Quick transport offices guarantee opportune supply of crude materials to the organization and completed products to the clients. The vehicle office is an essential for the area of the plant. There are five essential methods of physical transportation, air, street, rail, water and pipeline. Products that are mostly expected for trades request an area close to the port or extensive airplane terminal. The decision of transport strategy and subsequently the area will rely upon relative costs, accommodation, and appropriateness. In this manner, transportation cost to esteem included is one of the criteria for plant area. Many organizations require high caliber, proficient transportation administrations. This factor is of significant significance in numerous area determination choices. A proper site may require at least one of the accompanying highlights relying upon the item write and industry to be served: openness to major expressways, accessibility of nearby rail offices, simple entry to a noteworthy air terminal office, closeness to inland or sea port offices, and so forth.
- **Infrastructure availability:** Framework accessibility assumes a pivotal part in office area basic leadership. The essential framework offices like power, water and waste transfer, and so forth, turn into the noticeable factors in choosing the area. Certain sorts of ventures are control hungry e.g., aluminum and steel and they ought to be found near the power station or area where continuous power supply is guaranteed consistently. Process ventures like paper, synthetic, bond, and so on, require persistent supply of water in extensive sum and great quality, and mineral substance of water turns into an imperative factor.
- **Labor and Wages:** The issue of securing satisfactory number of work and with abilities particular is a factor to be viewed as both at regional and at group level amid plant area. Bringing in labor is normally expensive and include regulatory issue. Work Productivity is additionally a critical factor to be considered. Work and wage rate can enable an association to increase beneficial favorable position over its rivals. Winning pay design, average cost for basic items and modern connection and dealing energy of the unions' structures in essential contemplations.
- **External economies of scale:** External economies of scale can be depicted as urbanization and locational economies of scale. It alludes to points of interest of an organization by setting up operations in an extensive city while the second one alludes to the "settling down" among different organizations of related Industries. Thusly, the vast majority of the assembling organizations wants to open their separate plant in the expansive urban communities which prompts the

development of bunch of such organizations together in a specific area. On account of urbanization economies, firms get from situating in bigger urban communities instead of in littler ones out of a pursuit of approaching a huge pool of work, transport offices, and too to build their business sectors for offering their items and approach a considerably more extensive scope of business administrations.

- **Capital:** By taking a gander at capital as an area condition, it is critical to recognize the physiology of settled capital in structures and hardware from money related capital. Settled capital expenses as building and development costs shift from area to district. Be that as it may, then again, structures can likewise be leased and existing plants can be extended. The capital structure of an area assumes a significant part in getting the consideration of the maker.
- **Uncontrollable Factors:**
 - **Government policies:** The arrangements of the state governments and nearby bodies concerning work laws, construction laws, wellbeing, and so on., are the components that request consideration. Business charges (income or pay charges), stock expenses and property charges affect essentially on the cost of running an organization at the area under thought. The appeal of a district or neighborhood by individual expenses which incorporate charges on wage and property and additionally suitable deals charges, extract charges, and so on.
 - **Climate conditions:** The topography of the territory should be viewed as together with climatic conditions (mugginess, temperature). Atmospheres enormously impact human proficiency and conduct. The atmosphere changes to a great extent drive the conduct and working example of the specialists, which is in this manner a vital territory of concern.
 - **Supporting industries:** With the new forthcoming development, an ever increasing number of organizations are going for outsourcing of different parts of their particular items instead of having their own particular assembling line of generation of the separate item. Presently a day the assembling association won't make every one of the segments and parts independent from anyone else and it subcontracts the work to merchants. Along these lines, the wellspring of supply of segment parts will be the one of the elements that impacts the area
 - **Community and labor attitudes:** Group mentality towards their work and towards the forthcoming ventures can make or blemish the business. Group states of mind towards supporting exchange union exercises are critical criteria. Office area in particular area isn't alluring despite the fact that all elements are favoring a

direct result of work state of mind towards administration, which brings all the time the strikes and lockouts. These worker's organizations, strikes and outlandish requests of work are significant territories of worry of an assembling association in taking an office area choice.

- **Community infrastructure:** All manufacturing activities expect access to a group framework, most prominently financial overhead capital, for example, streets, railroads, port offices, electrical cables and administration offices and social overhead capital like schools, colleges and doctor's facilities. All these essential offices frame the foundation of office area choice of any assembling association.

3. STUDIES

Cluster analysis or clustering is the task of grouping a set of objects in such a way that objects in the same group (called a cluster) are more similar (in some sense or another) to each other than to those in other groups (clusters). Cluster analysis groups data objects based only on information found in the data that describe the objects and their relationships. The goal is that the objects within a group be similar (or related) to one another and different from the objects in other groups. The greater the similarity (or homogeneity) within a group and the greater the difference between groups, the better or more distinct the clustering. There are various methods to perform clustering. It can be done through various algorithms. The output of different algorithms is same as they all perform the similar task of assigning each entity to a group, the difference lies in the way the assignment is done. The various algorithms to perform clustering are:

Similarity coefficient based clustering

Similarity coefficient bas clustering was first discovered by McAuley (1972) and Carrie (1973).

In similarity coefficient based clustering each pair of entities is calculated as the number of attributes that get the value of 1 for both of them with respect to the number of attributes that are for either of them. Similarity coefficient bas clustering has many advantages, some of them are:

- It is simple to understand and easy to use.
- It has a wider scope in computer application.
- It has greater flexibility in accommodating manufacturing data into machine cell formation process.
- The threshold value of the similarity to which the groups of entities are allowed to form is determined essentially by the algorithm for each iteration for a given set of data of the problem.

- This method generates a set of alternative solutions, thus one can add more constraints for the final selection of the solution.

There are various methods of clustering, some of them are:

A. Single Linkage Clustering (SLINK):

It was first developed by Sneath in 1972. Among all the clustering techniques, Single Linkage Clustering is the simplest and has minimal computations. This algorithm calculates the similarity coefficients for each pair of entities and then forms the similarity matrix. The threshold value of the similarity coefficient is decided by the decision maker through which two entities can be considered similar, and finally all the entities with similarity coefficient greater than the threshold similarity value are grouped together.

The first similarity coefficient was developed by Jaccard and is known as the Jaccard Similarity Coefficient or JSC. In this method, all the attributes are considered as binary and therefore has four possible combinations for each pair of Object i :: 1-1, 1-0, 0-1, 0-0

	Object j	
	1	0
1	a	b
0	c	d

Table1. Different possibilities for the attributes

Where,

a = No. of attributes common in both location

b = No. of attributes common in i nut not j

c = No. of attributes common in j but not i

d = No. of attributes neither common in i nor j

By definition, Jaccard coefficient is calculated as follows:

$$S_{ij} = a / (a+b+c)$$

Jaccard similarity coefficient takes a value of 0 or 1. The maximum value is 1 i.e., when both the attributes are common in both location (b=c=0) and the similarity coefficient has the minimum value when none of the attributes are common in either location i.e., when a = 0.

The algorithm for Single Linkage Clustering is as follows:

1. Draw the similarity matrix by computing the similarity coefficient for every pair of attributes

2. Find the groups that have maximum similarity coefficient and group them together.
3. Remove the rows that indicate the attributes grouped together.
4. Add a new row to the matrix for the new attribute and calculate similarity coefficient using the formula:

$$Stv = \text{Max} \{S_{mn}\}_{m \in t \ \& \ n \in v}$$

- 5 Stop the iteration if the desired objective is achieved or else go to step 2

B. Complete Linkage Clustering (CLINK):

Complete Linkage Clustering is very much similar to Single Linkage Clustering except for the fact that for the computation of similarity coefficients between the attributes CLINK uses the minimum similarity level. The similarity coefficient for CLINK is calculated as follows:

$$Stv = \text{Min} \{S_{mn}\}_{m \in t \ \& \ n \in v}$$

The only advantage CLINK has over SLINK is that it prevents the merger of two clusters because of the high level of similarity between the two entities.

C. Average Linkage Clustering (ALC):

It was developed by Sokal in 1968. Sokal's algorithm is known as Average Linking Clustering and it involves all the attributes in calculating the similarity coefficient. The formula for calculating similarity coefficient is:

$$Stv = (\sum_{m \in t} \sum_{n \in v} S_{ij}) / N_t * N_v$$

This formula takes the average of pairwise coefficient between all the attributes in the group. The algorithm for Average Linkage Clustering is as follows:

1. Draw the similarity matrix by computing the similarity coefficient for every pair of attributes
2. Find the groups that have maximum similarity coefficient and group them together.
3. Remove the rows that indicate the attributes grouped together.
4. Add a new row to the matrix for the new attribute and calculate similarity coefficient using the formula:

$$Stv = (\sum_{m \in t} \sum_{n \in v} S_{ij}) / N_t * N_v$$

Where,

t = new attribute

v = other entity group

5. Stop the iteration if the desired objective is achieved or else go to step 2

4. FINDINGS

Automobile industry requires large variety of raw materials from other industrial sources viz. steel, nonferrous metals, window-glass, plastic, rubber, wood, paint, textile, electronic cables, seat cushions etc. For continue mass production on the assembly line, you need continuous supply of those spare parts, raw material. Therefore, best location for automobile industry established industrial region that has tradition of manufacturing such components.

There are various reasons why an automobile manufacturing plant is located in a particular region in India. For example, let us study the Tata Nano factory in Sanand, Ahmedabad. The various factors contributing to the profitable establishment of Tata Nano plant in Sanand, Ahmedabad are:

- **Raw Material:** Ahmedabad-Vadodara industrial region has many factories for spare parts, car-accessories, tires, circuit, glasses etc. from which they can easily outsource their parts of the automobile.

Moreover, as Tata Nano is a small car, therefore does not requires as much steel as most of SUVs or trucks do.

And lastly it is located near a port, which makes it further easier for the imports and exports business to be operational.

- **Transport:** Located in Delhi-Mumbai Industrial corridor (DMIC), which makes it easier for the transport of spare parts, raw materials and finished cars.

The nearest port is the Mundra port which is roughly 180 kms away from the plant and the next port is Kandla port which is also 250 kms away from the plant.

- **Labor:** Training of local youths from Ahmedabad has helped Tata Nano to keep up to its labor requirements.

Ahmedabad is also a very large state, which indicates huge urban amenities and which also means that there is no need to establish a town or a locality for the workers and their families.

- **Market:** The entire Ahmedabad to Mumbai region is well established and is fully developed with lakhs of middle class families residing.

- **Energy:** Tata Nano is also working on 4000 MW Ultra Mega Power Plant in Mundra, which solves the issue related to energy requirement.

- **Land:** Most of the land belongs to the state government; hence there was no issue of land acquisition.

Another example is of the Yamaha, New Holland Tractors and Honda Siel Cars India being located in Greater Noida, Uttar Pradesh, the reasons being the following:

- Greater Noida has also emerged as an auto industry hub.

- Its proximity to Delhi, smooth road connectivity, continuous water supply and easy access to three important markets (northern, eastern and central) makes Greater Noida attractive to many large companies.

Similar is the case with Maruti Suzuki, Honda Motorcycle & Scooter India, being located in Manesar, Haryana, the reasons for which are:

- Manesar has all the ingredients—good infrastructural facilities and proximity to the national capital
- The Haryana government has focused on building local infrastructure, and also gives incentives like tax holidays, and a 10 per cent refund of land cost on timely completion of projects.

And there are many more to follow, like:

- ABB, Bosch India, Mahindra & Mahindra, L&T, Thyssen Krupp, CEAT and Siemens, located in Nashik, Maharashtra.
- Bajaj Auto and Tata Motors, located in Pune belt (Chakan – Ranjangaon-Talegaon), Maharashtra.
- Hyundai Motor India, located in Sriperumbudur, Tamil Nadu. Etc.

5. CONCLUSION

In this paper, the facility location problem is solved through a clustering technique. The model uses a set of decisions making factors that are gathered from previous research papers, and the model creates a classification of alternative locations from which we can make a profitable decision.

There are many algorithms to solve the facility location problem, and the reason behind choosing this algorithm is that it gives the decision maker a wider classification of available alternatives, rather than suggesting a single solution. This algorithm gives more flexibility to the decision maker by providing a wider range of options to choose from. Another added advantage of this method is that it is less sensitive to errors or mistakes in the data, as our output is a set of possible alternatives; therefore, the risk of ignoring a good alternative is much lower.

Also, as previously mentioned, the data used in this method is generated randomly and no real data has been utilized. However, the real data can be employed for the analysis of various factors such as:

- Identifying the most important decision making factors.
- Finding the trends in the global market
- Anticipating the future changes in the market

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BIOGRAPHIES



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