International Journal of Recent Engineering Research and Development (IJRERD)
ISSN: 2455-8761
www.ijrerd.com || Volume 02 – Issue 08 || August 2017 || PP. 67-72

Planning Optimizing the Traveling Time (Distance) in Manufacturing Industry with the help of Single Facility Location

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Abstract: A facility planning is a typical and broad subject that covers several disciplines. It involves civil, electrical, industrial and mechanical engineers, as well as architects, consultants, managers and urban planners. Facilities planning can be divided into two components: facilities location and facilities design. Facilities location is about placement of the facility on a specific plot of land with respect to customers, suppliers and other facilities. Facilities design consists of the facility systems design, the layout design and the handling systems design. The facility systems consist of the structural systems, the environmental systems, the lighting/electrical systems and safety systems. The layout consists of all equipment, machinery and furnishings within the building structure. The handling system consists of the mechanisms needed to satisfy the required facility interactions. For a manufacturing plant, the facilities layout, also called plant layout, consists of the production areas, production related or support areas and personal areas within the building. This paper proposes a Euclidean distance based approach (WEDBA) as a multiple attribute decision making method to deal with the complex plant or facility layout design problems of the industrial environment.

Keyword: Facility location, optimization, traveling distance, minimum location method

Introduction

The physical arrangement of organization of a manufacturing industry system is defined to be the facility location layout problem. This well-studied combind optimization problem arises m a variety of production service and communication settings, but here the focus is on manufacturing plant facility layout. The manufacturing plant or industry system is the critical component m such production systems, and thus, it must be considered when determining the layout.

The design of the facility layout has generally has been recognized as an important issue in modern manufacturing Industry systems. This fact was emphasized by Sule (1994), he pointed out that the facility layout problem is a longterm, costly proposition, and any modifications or rearrangements of the existing layout represent a large expense and cannot be easily accomplished. Hence, a efficient facility planning can reduce these costs, and thus increase productivity

The facility layout problem deals with the physical array of a given number of departments and machines within a given pattern and ideas In the context of manufacturing industry the objective is to minimize the total maintenance time. Material handling cost. An Organization of even modest sizes optimizes their operations to minimize costs and improve efficiency. One of the many aspects of operations is cost effective and efficient accessing of a set of services or infrastructural facilities by a group of demand points or clients. Typically, many service centers locations are set up, each of which serves the demands of a subset of demand points. Some examples of such an exercise are setting up of a supply chain of a business, locating Essential services such as Rectilinear and Education Distance method, and construction of transportation networks [5]. Facility location applications are concerned with the location of one or more facilities in such a way that optimizes a certain objective such as minimizing transportation time and Cost.

Litrature Survey

A few important papers relevant to Facility Location Planning are described below- M.T. Melo, S.Nichel, F.Saldanha-da-gama [5] studied almost 120 article and papers published in last decades including few from year 2008. According to his survey he found that most of the researchers used deterministic models in comparison to the stochastic model. With the help of these charts we can easily conclude that most researchers has given stress on Capacity, Inventory and production area only no one is used facility location planning in maintenance area. This paper helps out to find out which field is untouchable from researchers or in which field we can put our efforts.

Hongzhong Jia, Fernando Ordonez, and Maged Dessouky. [6] -This research does not typically address the particular condition that arise when locating facilities to service large scale emergencies like earthquakes, terrorist attacks etc. in this work he first survey general facility location problems and identify models used to address common emergency situation, such as house fire and regular health care needs. Author classified the emergency according to there severity on consideration of that he proposed optimum locations of facility from where max no of peoples can be attended. Then analyze the characteristic of large scale emergencies, has covered P-median and P-center model, dealing with multiple locations of facility centers.

Phuong Nga Thanh, Nathalie Bostel, Oliver Peton [7] has proposed a program for the design and planning of a production-distribution system. This study helps out to make strategic decisions like opening, closing or enlargement of facilities supplier selection etc. These decisions are dynamic, i.e. the value of the decision variables may change within the planning horizon. Authors has done some related work which is been done by Dashkin et al (2005) propose an extensive review of location problem [10], Beamon (1998) distinguishes models with deterministic data from those with stochastic data [11], owen and Dashkin (1998) clearly seperates the static and dynamic models [12].

Masashi Miyagawa[13], deals to find the best configuration of facilities that minimizes the average rectilinear distance from residents to their nearest open facility when some existing facilities are closed. Assuming that facilities are closed independently and at random, we show that the diamond lattice is the best if at least 73% of facilities are open. For this purpose the author calculate the kth nearest rectilinear distance of two regular point patterns: square and diamond lattices. The probability density functions of the kth nearest rectilinear distance are theoretically derived for $k = 1, 2, \ldots, 8$. Upper and lower bounds of the kth nearest distance are also derived. As an application of the kth nearest distance, we consider a facility location problem with closing of facilities.
Sergei Bespamyatnikh and David Kirkpatrick [14]. Have investigated three rectilinear 2-center problems, the continuous and two constrained versions when facility locations are restricted to a set of points or a set of axis-parallel poly topes. Author presents a simple linear-time algorithm for the continuous version and an efficient algorithm with poly log running time for the restricted versions.

Pranab K Dan[15]. Discussed a solution methodology for determining optimal travel path to and from existing facilities and corresponding location of a new facility having physical flow interaction between them in different degrees translated into associated weights. The proposed methodology considers all types of quadrilateral barriers or forbidden region configurations to generalize, to bypass these obstacles, and adopts a scheme of searching through the vertices of these quadrilaterals to determine the alternative shortest flow-path for optimal location of facilities based on weighted-distance computation algorithm with minimum summation or mini-sum objective. Congruence testing has been carried out for reconfiguring complex obstacle geometry as an equivalent quadrilateral. This procedure of obstacle avoidance is completely new. Software, DANSORK, has been developed to facilitate computations for the new search algorithm and test results have been presented based on computations using this software.

Daoqin Tong, Alan T. Murray[16]. In this paper other representations, such as lines and polygons, are investigated in covering location problems. The evaluation of warning siren siting in the city of Dublin, Ohio is used to discuss nuances of point representation and other geometric shapes in location modeling. how geometric sophistication and reality can be addressed in location coverage modeling through the use of Geographical information science.. Authors included the weightage for the factor of geographical information.

Zhiqiang Lu, Nathalie Bostel[17]. Produced a facility location model which including the reverse flow. To make a logistic decision for a new facility the basic question involves the location and size of the main facilities for a system. Reverse flow or back flow can be considered remanufacturing, recycling etc., most of the researchers only concerned one sided flow of a material but nobody concerns about reverse flow of material this research help to optimize the cost and time during remanufacturing or back flow of facilities.

P.M. Dearing and R. Segars Jr. [18]. Author planned a single facility location for rectilinear distance. A modification of the barriers is developed based on properties of the rectilinear distance. Where the Objective function is any convex, non decreasing function of distance. Such problems have a non-convex Feasible region and a non-convex objective function according to author very few researchers have concerned about barriers.

Katz and Cooper [19], considered a total cost problem with Euclidean distance and one barrier consisting of a circle. They develop a heuristic solution procedure based on non-linear optimization

Methodology

The minimum problem consists of locating a single facility in the plane with the aim of minimizing the sum of the weighted distances (the maximum weighted distance) to m given points. We present two solution methods for generalized versions of these problems in which.

(i) Location is restricted to the union of a finite number of convex polygons; (ii) distances are approximated by norms that may differ with the given points; and (iii) transportation costs are increasing and continuous functions of distance. Computational experience is described

The Euclidean distance between point's p and q is the length of the line segment. In Cartesian coordinates, if p = ($p1$, $p2$,..., pn) and q = ($q1$, $q2$,..., an) are two points in Euclidean distance n space, then the distance from p to q is given by

The Euclidean norm measures the distance of a point to the origin of Euclidean space:

Where the last equation involves the dot product. This is the length of p, when regarded as a Euclidean vector from the origin.

$$f(x,y)=\sum_{i=1}^{m} w_i[(x-a_i)^2+(y-b_i)^2]^{1/2}$$

We use the following notation:

X= (x, y) location of the new facility

P=(a_{it} bi) location of existing machines, i=1,2,3 ………..m

W_i "weight" associated with maintenance hours and distance

Between Existing facility & machine i=1, 2, 3

Since above Equation is written in such a way that terms involving x are separate from terms involving y, the optimum values of x and y can be obtained independently.

The minimum location problem is formulated as follows:

$$\text{minimize f(x)} = \sum_{i=1}^{m} W_i|x-a_i| + \sum_{i=1}^{m} W_i|y-b_i|$$

Since above Equation is written in such a way that terms involving x are separate from terms involving y, the optimum values of x and y can be obtained independently.

In order to find the optimum value of x, two mathematical properties of such a solution are employed. Namely, the x-coordinate of the new facility will be the same as the x-coordinate of some existing facility; and the optimum coordinate will be such that no more than half the total weight is to the left of x and no more than half the total weight is to the right of x The latter condition is referred to as the median condition. Both properties also apply in determining the optimum value of Y

$$d(X, P_i) = |x - a_i| + |y - b_i|$$

Euclidean (or straight line) where distances are measured along the straight line path between two points.

A straight conveyor segment linking two workstations illustrates Euclidean distance for the case where distance are Euclidean, the string and weight model can also be used to gain a "convex hull" insight placing a peg in each hole representing an existing facility location, stretching a giant rubber band around all the pegs, and releasing the rubber band.

The region that the rubber band encloses is known as the convex hull of the existing facility locations. Any optimal solution to the location problem will be inside the convex hull, as the knot representing the optimal new facility location would never go into equilibrium outside the convex hull.

COLLECTED DATA FROM MANUFACTUREING INDUSTERY

List Of Critical Machine			
Machine no	Machine code	Machine name	Location of machine(bay wise)
1	SAL S1	Shearing machine	2
2	SAL AC1	Air compressor	1
3	SAL M1	Milling machine	3
4	SAL L1	Lathe machine	5
5	SAL L2	Lathe machine	4

6	SAL D1	Drill machine	1
7	SAL SF1	Surface grinder	4
8	SAL SF2	Surface grinder	3
9	SAL HP1	Hydraulic Press m/c 100 ton	2
10	SAL TH1	Threading m/c	6
11	SAL PT1	Parting m/c	2
12	SAL PP1	Press m/c 63 ton	3
13	SAL PP2	Press m/c 75 ton	4
14	SAL PP3	Press m/c 50 ton	5
15	SAL PP4	Press m/c 30 ton	6
16	SAL PP5	Press m/c 10 ton	3
17	SAL PP6	Press m/c 250 ton	2
18	SAL PP7	Press m/c 63 ton	4
19	SAL PP8	Press m/c 100 ton	3
20	SAL MW1	MIG welding m/c	7
21	SAL PH1	Power hexa m/c	8
22	SAL L3	Lathe machine	2
23	SAL TG1	TIG welding m/c	5
24	SAL PR1	Press Roller m/c	6
25	SAL PC1	Pipe cutting m/c]	4
26	SAL D2	Drill m/c	1
27	SAL D3	Drill m/c	2
28	SAL L4	Lathe machine	3
29	SAL MW2	MIG welding m/c	2
30	SAL MW3	MIG welding m/c	7
31	SAL MW4	MIG welding m/c	4
32	SAL MW5	MIG welding m/c	3
33	SAL M1	SIM welding m/c	2

Result

- Analysis of optimum facility location of Maintenance shop by using Euclidean model. Comparison between existing and new location is carried out. With the help of distance method.
- The facilitation of common facilities has also contributed in enhancement of availability of plant equipments.
- I have finally proposed the location that gives us the optimum maintenance travel time for maintenance work.
- With the help of Facility Location Planning Tool (Euclidean with minisum location method) we find out the optimum location for new Facility center of co-ordinates From new location Net savings in distance traveled (in meters)

Existing facility center distance-Proposed facility centre distance(m)	Net savings in distance traveled (in meters)
96234 – 74230 (meter)	22004(meter)

- Saving Maintenance Traveling Time (Distance) in percentage %=

$$\frac{\text{Total Maintenance time required in hours} \times 100}{\text{Total Maintenance time}}$$

If man a travel in 1 meter (0.93) are 136 hours in breakdown time and Total Maintenance time required are from calculation table 3

(Distance comparison table) = 6698 hours

$$\frac{136 \times 100}{6698} = 2.03\%$$

- Net Saving Travelling Distance in percentage % =

$$\frac{\text{Net saving Distance in meter} \times 100}{\text{Total Distance from Proposed facility center}} =$$

$$\frac{22004 \times 100}{74234} = 29.6\%$$

Result in Table;

Saving Maintenance Traveling Time (Distance) in percentage %=	2.03%
Net Saving Travelling Distance in percentage % =	29.6%

Future Scope of Work

Although the Facility Location Planning (Euclidean Distance with minimum location Method) is used in the present thesis work. However, there is always a scope of improvement. The following future work may be possible.

- The maintenance time can be further being optimized through considering other aspects like human behavior and considering obstacles in path.
- We can use Deterministic models which can give more accurate results with changing weight age.
- This project can be a basic tool for problems of same nature in similar type of industries.

Conclusion

- Meet the economic demand: minimize investment in equipment and material handling cost.
- Meet the requirement of product design and volume.
- Meet the requirement of process equipment and capacity: minimize overall production time; maintain flexibility of arrangement and operation; minimize variation in types of material handling equipment; facilitate the manufacturing process.
- Meet the requirement of quality of work life: provide for employee convenience, safety and comfort; facilitate the organizational structure.
- Facility Location Planning is having a wide application in product, service and process industry but very few researchers has concerned about Maintenance department. In this thesis work, with, implementation of Facility Location Planning (FLP) tool we optimized maintenance time.
- Reduction of the travelling time during maintenance by optimizing the location of the facility center with the help facility location planning tool (Euclidean distance method), The Total maintenance time for all machines is reduced by using Euclidean distance method.

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