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Comparative Evaluation of Facility Layout Alternatives Based on Material Handling Cost

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Abstract - **This paper addresses the evaluation method for facility layout problem based on material handling cost (MHC). Evaluation is very important part of any problem solution tool. This is also important to decide that, on what bases the evaluation should make for any problem, not only in engineering but also in other sectors. Facility layout plays an important role in any kind of industry. While designing the facility layout for a new industry, the evaluation of the alternative layouts should handle carefully with appropriate method. Material handling cost is very crucial factor in layout design. In this paper a method of evaluation based on material handling cost is taken with practical examples of industry. The results indicate the effectiveness of the proposed method.**

Keywords - Evaluation, facility layout, material handling cost, new industry.

1. INTRODUCTION

Facility layout planning seriously impacts on a company's profitability. According to Grassie [1] the selected layout establishes the physical relationship between facility activities. According to Tompkins and White [2], since material handling activities account for 20-50 percent of a manufacturing company's total operating budgets. If the facilities are arranged optimally, the manufacturer can reduce total product cost. Salvendy [3] stated that an effective layout may minimize the material flows and distances between the department locations which lead to the reduction of material handling costs and improvement in cycle time. Facility layout planning effect the scheduling and process planning of manufacturing shops [4-13].

Shayan and Chittilappilly [14] in 2004 defined the facility layout problem as an optimization problem that tries to make the layouts more efficient by taking into account various interactions between facilities and material handling systems while designing layouts. According to Stephens and Meyers [15] manufacturing facilities design is the organization of company's physical assets to promote the efficient use of resources such as people, material, equipment, and energy. In this paper evaluation based on material handling cost is discussed.

Zandin [16] stated that, a facility layout planning was about arranging the physical departments or machines within a facility to help the facility work in a productive way. A poor layout can lead to accumulation of work in process inventory, overloading of material handling system, inefficient setups and longer queues. Jannat, et al., [17] said ,whether facilities layout of manufacturing system is reasonable or not, it not only directly affects the production efficiency and production cost, but also affects production cycle.

Facility layout is an important decision as it represents a long-term commitment. Every Industry wants to design a layout, which should provide the optimum relationship between output, floor area and manufacturing process. Chary [18] stated, it intends to facilitate the production process, minimizes material handling time and cost, and allows flexibility of operations, easy production flow, makes economic use of the building, promotes effective utilization of manpower, and provides employee's safety, comfort at work, maximum exposure to natural light and ventilation [19-22, 25-29].

2. MATERIAL HANDLING COST

It is the cost of handling the material on the shop floor, during the manufacturing process material flows from one machine to the next machine until all the process is completed. The objective always to minimize the total material handling cost of the system. Hung, et al., [23] proposed, to determine the material handling cost for one of the possible layout plans, the production volume, production routing, cost of travel between the machines/location should be known.

Material Handling Cost (MHC):`

$$MHC = \sum_{i=1}^{M} \sum_{j=1}^{M} F_{ij} C_{ij} D_{ij} \qquad (1)$$

F_{ij}: flow between machines/departments *i* and *j (i , j* = 1,2,3,…..,M*)*

C_{ij}*:* unit material Handling cost between locations of machines/departments *i* and *j (i , j* = 1,2,3,…..,M*)*

D_{ij} *:* rectilinear distance between locations of machines/departments *i* and *j*

3. COMPARATIVE EVALUATION

There are various methods to solve the facility layout problem, in every method the evaluation stage comes, at this stage the available methods are evaluated on the basis of some criteria. This evaluation can be done on Material Handling Cost Criteria, for doing this the available alternatives is to be compare on the Total Material Handling Cost.

The following steps to be followed for evaluating by this method:
Step1: collect the rectilinear distance between machine to machine or departments to departments, on the shop floor for the layout alternatives.

Step 2: collect the numbers of flow between machines/departments per months.

Step 3: calculate the unit material handling cost between the machines/departments.

Step 4: calculate the MHC for all layout alternatives available and make a comparative table for total material handling cost obtain in the last step for all the available alternatives.

Step 5: select the layout with least material handling cost as a solution.

4. CASE STUDY

A case study is taken from the industry xyz. This industry manufacturing tractor parts like, gears, gear box housings, rear axle housings, etc., It was new establish industry and for the facility layout problem of this industry, technique 'Systematic Layout Planning' by Muther [24] has been used, and in the evaluation stage of this problem solution technique 'comparative evaluation based On MHC' was used, there were two layout alternatives at the evaluation stage. In this paper the evaluation is shown only for two products, Gear Box Housings and Gears only.
Step 1: collect the rectilinear distance between machine to machine or departments to departments, on the shop floor for the layout alternatives **(Table 1 and Table 2)**

Step 2: collect the numbers of flow between machines/departments per months. **(Table 3)**
So value of Fij for Gear Box Housing is 35 and for Gear it is 50

Step 3: calculate the unit material handling cost between the machines/departments.

At Indrason the material Handling was manual, Cij = Rs. 0.00633 per meter distance

Step 4: calculate the MHC for all layout alternatives available with eq. (1), **(Table 4)**

Step 5: selection on the basis of results

Table 1: Travel Distance for Gear Box Housing Manufacturing

Sr. No.	Symbol	Description	Travel Distance (m) (Layout Alternative -1)	Travel Distance (m) (Layout Alternative -2)	Travel Distance (m) Difference (Alternative-1) – (Alternative-2)
1		Inspection			
2		Transport	37.3	15.6	21.7
3		VMC			
4		Transport	24.5	23.3	1.2
5		HMC			
6		Transport	44.4	15.7	28.7
7		Milling			
8		Transport	32.8	4.4	28.4
9		Boring			
10		Transport	19.1	16.0	3.1
11		HMC			
12		Transport	27.0	21.9	5.1
13		Drilling			
14		Transport	14.4	11.3	3.1
15		Tapping			
16		Transport	34.0	13.1	20.9
17		Inspection			
18		Transport	44.3	7.0	37.3
19		Storage			
Total Travel Distance			277.6	128.3	
Total Travel Distance Difference					149.3

Table 3: Production of Batch per Month

Sr. No.	Batch Product	Batch Production
1	Gear Box Housing	35
2	Gear	50

5. RESULTS AND DISCUSSION

The evaluation of the available alternatives is done in this paper, which is based on material handling cost. There are two layout alternatives for an industry for comparisons. The Total cost of material handling on layout alternative -1 is ***Rs. 131.32*** and on the alternative-2 is ***Rs. 78.17***, so on the basis of this comparison , it is clear that layout alternative-2 is better solution for the present problem of facility layout.

Table 4: Material handling cost

Sr. No.	Product	Batch Production	MHC (In Rupee)	
			Alternative Layout-1	Alternative Layout-2
1	Gear Box Housing	35	61.50	28.42
2	Gear	50	69.82	49.75
Total material handling cost			**131.32**	**78.17**

6. CONCLUSIONS

Facility layout plays a very important role, it directly impacts the productivity of any kind of industry. At design stage of layout, the designer should evaluate the available alternatives very carefully. Comparative analysis of available alternative based on material handling cost has been considered in this research paper. The main objective has been considered to compare the cost of material handling of the available alternatives. The results shows that alternative 1 layout cost more than the 2, so the alternative 2 is more suitable for installation. In this analysis, few steps have to follow for implementing it. Every industrialist try to minimize the cost of the product and it is better to select the layout with less material handling cost.

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