LAYOUT DESIGN AND EVALUATION USING COMPUTER RELATIVE ALLOCATION OF FACILITIES TECHNIQUE

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Abstract - Design of a facility is a strategic issue that has a significant impact on manufacturing units. The design of facility involves the placement of equipments, departments and their support system in such a way that they accomplish the work in required time, reduce travelling distance of the material between the work stations and thus reduce the material handling cost. The main objective for a factory layout design is to minimize the material handling cost. This paper aims to reallocate the plants equipments in a way that they do not alter the manufacturing process but reduces the distance between different workstations which in turn reduces the material handling cost. After designing the plant from the existing layout the individual layouts are checked by CRAFT for their material handling cost.

Keywords- Facility Layout Planning, Facility Layout Design, CRAFT

I. INTRODUCTION

Layout determines the way in which materials and other inputs (like people and information) flow through the operation. Relatively small changes in the position of a machine in a factory can affect the flow of materials considerably. Facility layout design has always been a topic of concern and is complex to solve. It is important to have a well developed plant layout for all the available resources in an optimum manner and get the maximum utilization of the capacity. The need to design and construct a new factory layout or reconfigure the current one has increased largely because of the fast changes in customer demand both from product quantity and product variety aspects. This requires companies to be more agile to plan, design and reconfigure the factory layout to be able to introduce new products into the market and sustain their competitive strength. The challenge of determining the best arrangement of the workstation is one of the elements that have great impact on system performance. It is known as “facility layout problem”.

The most crucial element that affects efficiency of a production process is the facilities layout. A good layout keeps costs low and reduces unnecessary material handling while maintaining the product flow through the facility. Improving the layout also increases the machine utilization that enhances the machining capacity of the shop floor. One of the reasons for designing a new layout may be improving the performance of the existing plant. Replacing the old facility with more advanced machines may also be essential in many cases. Facility layout design could improve the performance of production line such as decrease bottleneck rate, minimize material handling cost, reduce ideal time, raise the efficiency and utilization of labour, equipment and space.

II. PROBLEM FORMULATION

The facility layout problem is concerned with finding the most efficient arrangement of individual workstation with unequal area requirements within a facility. The objective of the facility layout problem is to minimize the material handling costs inside a facility which is subjected to two sets of constraints: (1) workstation and floor area requirements and (2) workstation location restrictions (workstation must be placed within the facility, and some must be fixed to a location or cannot be placed in specific regions).

The present layout is studied in detail which has unutilized spaces. The facility design should be such that it accounts for most of the production. The present layout supports 10% of the production, most of the processes for the products are the same but the present is designed for the product that accounts for 10% of the total annual production and due this the material handling cost has increased for the product that has 90% of the annual production.

Besides the placement of workstation another problem also exists due to the placement of some workstation, which is the length of conveyor or the movement of the crane for lifting material in batches. The length of the conveyor for some of the workstations is in excess which is of no use, it only increases the material handling cost, consumes more time and occupies more length and area of the facility. The present paper utilizes the unutilized space and is designed for the product that accounts for the 90% of the annual production.
III. DETERMINE THE LAYOUT PLAN

The first step for designing is to make clear the manufacturing flow of the facility which is an optimum issue. Consideration should be reasonable and in suppleness for a standard manufacturing flow. After maintaining the standard manufacturing flow and the production capacity of the plant is settled, the next step is choose the appropriate workstation to evaluate and to optimize the existing layout for reconstruction.

The facility layout can be reconstructed accordingly and optimum layout can be obtained that has an optimum cost. The main principle of optimization is to shorten the entire transport distance, to depress transportation cost and to benefit the logistic most.

Steps that are used in designing process:-

Designing of the facility is concerned with the relocation of the workstations in an optimum sequence so that the completion of the product takes less time during movement (i.e. the time of completion of one unit is reduced), the unused spaces in the plant are utilized that in turn reduces the material handling cost.

The present layout is analysed and is searched for spaces where the workstations can be relocated or placed so that the material handling cost is reduced and then the new designs were generated which are evaluated by CRAFT.

The layout evaluation plays an essential role in the process of designing an effective facility layout. The figure shown below shows the present plant layout:

The workstations shown in the figure 2 are:-

1) Storage
2) End Tapering
3) Bar Heating Furnace, Bar Coiling and Quenching
4) Re-Work Furnace
5) Tempering
6) End Grinding
7) Hardness Testing
8) Shot Penning
9) Crack Testing
10) Phosphating
11) Priming
12) Scragging
13) Hot Scragging
14) Re-Pitching
15) Black Painting
16) Universal Testing Machine
17) Packing

A. Facility Layout Planning
There are various layouts for designing the plant like product layout, group layout and fixed layout. In this case it is the product layout that is redesigned to obtain the reduced material handling cost without altering the manufacturing process.

B. Total Facility Area
The facility area consists of workstations and material handling equipments. The total area of the facility is 14448 m².
IV. METHODOLOGY

A. Data Collection
The primary step to begin with is to collect data of the company’s existing layout that includes area of each workstation, transportation cost and distance between the workstations.

B. Relocation of Workstation
It involves the relocation of various workstation in the facility by placing them in the space left or by re-shifting the workstation so that the process is not disturbed and the material movement from raw material stage till dispatched is reduced and thud the time wasted in material movement is also shortened.

C. CRAFT INPUTS
- Factory Layout
- Flow Data
- Total Number of Workstations
- Cost per unit Workstation
- Area of Work Station
- Fixed Workstation

D. Cost Matrix
Cost matrix (\(c_{ij}\)) represents the cost of transportation per unit distance from workstation i to workstation j. Table I shows Cost Matrix.

E. Flow Matrix
Flow matrix (\(F_{ij}\)) represents the flow of material from workstation i to workstation j. The “from-to” chart is generally a table listing the departments to be considered and the number of trips (or flow) between them in a given period. Table II shows Flow Matrix.

V. APPLICATION
The alternative layout were developed according to the problem stated above in which the workstation are place in accordance with the 90% annual production of the product which is made most of the time in the plant, the unutilized spaces were used to relocate the workstation and the material handling costs is calculated as the distance is reduced or increased between the workstations and then these costs were entered into the CRAFT algorithm to obtain the value for the improved layout.

The CRAFT algorithm inputs are the cost matrix, the flow matrix and the area of the workstation. The cost matrix and the flow matrix are shown for the different generated layouts.

The Flow Matrix table represents the flow in terms of trips in a given period of time from workstation i to j. The table shown below is the flow matrix of the present plant layout. The Cost matrix (\(c_{ij}\)) is generated which has 17 workstations that show the transportation cost between the workstation.
In this case, the optimal sequence of the workstation in the facility is found by using CRAFT. The distance formula being used here is Euclidean distance between the two centroids of the workstation that can be calculated as follows:

\[ d_{ij} = \sqrt{(X_i - X_j)^2 + (Y_i - Y_j)^2} \]

Where, \((X_i, Y_i)\) and \((X_j, Y_j)\) are the centroids of workstation \(i\) and \(j\) respectively.

The total cost of material handling per day in three shifts for the existing layout is calculated by using

\[
\begin{align*}
\text{Min } Z = & \sum_{i=1}^{m} \sum_{j=1}^{n} f_{ij} d_{ij} c_{ij} \\
\text{Where, } & f_{ij} \text{ is the flow from workstation } i \text{ to } j, \\
& c_{ij} \text{ is the cost of moving from workstation } i \text{ to } j, \\
& d_{ij} \text{ is the distance between the centroids of the workstation } i \text{ and } j.
\end{align*}
\]

With the help of the equation stated above the table shown below is the flow matrix of the relocated facility layout 1, 2, and 3.

After relocating workstations the new layout obtained is shown:

![Layout Design and Evaluation Using Computer Relative Allocation of Facilities Technique](image-url)
The cost matrix for layout 3 is shown below:

The layout 4 is shown in the figure below:

The flow matrix for design layout 4 which is changed in comparison to the ones for the above three layouts are shown below:

The cost matrix for design layout 4 is shown below:

VI. RESULT AND DISCUSSION

The results obtained by CRAFT are computed that shows the cost of layout, total time consumed in the process (i.e. from raw material to finished product) and the total distance travelled by the product for different generated layouts.
CONCLUSION

In this paper the present plant layout is modified to obtain a new layout that saves cost of transportation between the workstations, reduces total time of production and distance moved by the product within the facility. It is the need of the hour for manufacturing units to have a layout that is more effective which saves time and money. The comparison results are plotted and shown for the present facility layout and the new layouts. The layout 4 is the best suited layout which has minimum distance of travel and minimum cost of layout.

REFERENCES


Figure No.8: shows Distance Travelled

Distance Travelled

Existing Layout  Layout 1 Layout 2 Layout 3 Layout 4

360 365 370 375 380 385 390 395 400 405 410

Distance Travelled