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Facility Layout Optimization Using Simulation: A Case Study of a Steel Utensils Industry

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Abstract- Facility Layout Problem (FLP) is one of the essential problems of several types of manufacturing and service sector. It is an optimization problem on which the main objective is to obtain the efficient locations, arrangement and order of the facilities. The utensils industry in this study is a typical instance of a work-flow shop based production system. The efficiency of production system depends on how well the various machines, services production facilities and employee's amenities are located in a plant. This research paper aims to study and improve the current plant layout. An attempt is made to simulate the current and the proposed factory layouts by using ARENA software. The efficiency of the current and the proposed plant layouts are compared.

Keywords: Computer simulation, Factory Layout, facility-layout problem, Manufacturing system, ARENA, Layout design.

1. Introduction

Plant layout is the arrangement of facilities such as machinery, equipment, furniture etc. within the factory building for flow of material at the lowest cost and with the minimum material handling in processing the product from the raw material to the finished product [1].

A good facility-layout problem (FLP) is known for to make significant impact on the manufacturing costs, work in process, lead-time and productivity. A good facility layout affect the overall efficiency and as well as reduced total operating costs up to 50% [2]. FLP used to finding the optimal facility-arrangement in the existing layout in such a manner that a set of criteria is met and/or some objectives are optimized. Also, it is a fundamental optimization-problem can be used in many industry such as manufacturing and service organizations [3].

This study focuses on developing a new production layout for a utensils industry in view of the need to increase the production capacity .The simulation is used to solve facility layout problem and hence minimizing the total material handling cost.

2. Literature review

Spending a little time to plan the arrangement before installation can prevent unnecessary losses [4. Producing products with high quality and provides good service with low cost in short time using the fewest resources is the objective of properly managing a facility [5]. It is important that the facilities must be managed properly in order to attain the objective. [6]

Stefan Bock [7], proposed the detailed layout-planning by simulation for determining machine-arrangement and transportation-paths. Facilities planning could be arranged the entire layout may have irregular shapes and sizes [8].Iqbal and Hashimi [9] demonstrate that factory-layout is the focal point of facility-design. It dominates the thinking of most managers.

Simulation is applied in various field such as manufacturing, services, defense, healthcare, and public services, etc. Simulation is recognized as the second mainly used technical instrument in the field of operations management [10].

Fox [11] presented the definition of factory simulation is defined as "extendable and interactive discrete simulation system constructed to interpret the factory model directly. It allows the user to dynamically query the simulation for state information (e.g., state of a machine, process, etc.), where objects are located (e.g., what operation is being carried out on an order), and regular statistical analyses. It also allows the user to alter the factory model before and during simulation. The factory can be simulated and displayed at variable levels of detail".

Bobby John et al simulate the factory layout using the software ARENA (student's version). They defines that production efficiency depends on various factors such as machines, production facilities and employee's amenities. A simulation study was under taken to find out the efficiencies of the machines in the industry [12].

3. Methodology

This research work has been done in respect of a small scale industry known as Chopra Industry Private Limited, Jodhpur. This industry basically manufactures steel utensils. The first task which this researches accomplished was to acquire the manufacturing lead time from current layout. This was done using ARENA software [13]. The

layout that I proposed in this research work was meant for improving the current layout.

The industry, under reference, namely, Chopra Industry is located in Industrial Area, Jodhpur. It manufactures three different types of utensils to meet customer demand. The three types are bowls, small plates and Pans. The industry produces 8000 pieces per day.

While working for this research work with the Chopra Industry, Jodhpur. I came across certain basic weakness in the existing layout (figure 1 and 2). They are as follows-

a. The distance from the last manufacturing process which is the designing process is too far from the warehouse. This has resulted in a longer material handling time to transport the finished products to the warehouse.
b. The products from all Pressing Machine to the next production processes for cutting, beading-curling process, polishing process and designing process. The arrangement of machine are irregular which caused high level of delay at production.
c. The floor condition increase the material handling and increase the time delay.

The components of factory-layout that will be taken into account for factory simulation modelling are as follows:

a. Complete department layout, including the distance between raw material storage with production area, distance between machines and distance between manufacturing areas with the warehouse.

b. Machines production rates and capability.

c. Raw materials and work part transfer.

d. Daily production target.

Summary of Existing Layout calculations and values that will be used in factory layout simulation modelling is shown in Table 1 (all dimension in seconds):

S.No.	Description	Part-1	Part-2	Part-3
1.	Material-handling time from Raw Material Storage to Pressing Machine	10	13	80
2.	Processing time on pressing machine	3	15	3
3.	Material-handling time from pressing machine to cutting machine	60	10	10
4.	Processing time on cutting machine	5	5	5
5.	Material- handling time from cutting machine to beading machine	35	35	35

6.	Processing time on beading machine	4	-	-
7.	Material-handling time from beading machine to polishing machine	420	420	420
8.	Processing time on polishing machine	10	10	10
9.	Material- handling time from polishing machine to designing machine and riveting machine	70	70	70
10.	Processing on designing machine	3	-	3
11.	Processing on riveting machine	-	5	-
12.	Material-handling time from designing machine and riveting machine to packing	25	25	25
13.	Processing time on packing	55	55	55
14.	Material-handling time from packing department to warehouse	120	120	120

i) Proposed layout-

In the proposed layout (figure 3), there is a change in the arrangement the machines on the ground floor are to be shifted to the first floor. The three pressing machines which were placed in a scattered manner are now proposed to be shifted to one place on the ground floor and installed in a parallel manner. The beading machine is now to be placed near the cutting machines.it is also proposed to shift the all polishing machines, designing machine, and riveting machine on ground floor.

Summary of the Proposed Layout calculations and values that will be used in Factory Layout simulation modelling is shown in Table 2 below (all dimension in seconds)-

S.No.	Description	Part-1	Part-2	Part-3
1.	Material-handling time from Raw Material Storage to Pressing Machine	4	4	4
2.	Processing time on pressing machine	3	15	3
3.	Material-handling time from pressing machine to cutting machine	15	15	15
4.	Processing time on cutting machine	5	5	5
5.	Material-handling time from cutting machine to beading machine	0	0	0
6.	Processing time on beading machine	4	-	-
7.	Material-handling time from beading machine to polishing machine	20	20	20
8.	Processing time on polishing machine	10	10	10
9.	Material-handling time from polishing machine to designing machine and riveting machine	10	10	10
10.	Processing on designing machine	3	-	3
11.	Processing on riveting machine	-	5	-
12.	Material-handling time from designing machine and riveting machine to packing	15	15	15
13.	Processing time on packing	55	55	55
14.	Material-handling time from packing department to warehouse	0	0	0

ii) Result and Discussion-

The result we draw from ARENA Simulation for the existing layout and for the proposed layout is 43 and 46 average pieces per day respectively. It may be noted that I have use ARENA Simulation (Student Version) as my research tool which is a limited version, that is why I first reduced the input value by 10 times and I made a batch of 20 pieces which were forwarded further resulting in a reduction in value by 20 times.

Now finally our result for existing layout is 8600 and for proposed layout is 9200 pieces per day. The overall improvement in production is 6.9%.

The further discussion in this regard in terms of per piece production-improvement is to be as follows –

Existing layout- 8600 pieces in an 8 hours shift-one piece to be manufactured in 3.34 seconds.

Proposed layout- 9200 pieces in an 8 hours shift.one piece to be manufactured in 3.13 seconds.

Total time saved for one piece comes to be 0.21 seconds.

Percentage of improvement per piece comes to be 6.2%.

4. Conclusion

This research study has provided a good exposure to facility planning and layout designs for the improvement of the efficiency in an industry. The correct choice of the type of facility-layout method to be adopted in this context can have a significant impact on the long-term success of an industry. The study of facility-layout therefore has become extremely important. The most common objective of layout design, that is to minimize distance travelled.

The production-efficiency of layout depends upon how well machines, men and materials are located in a plant. Therefore, there should be an optimum relationship among the output, floor area and manufacturing process. According to my analysis of the operation sequence of each product in manufacturing industry, it was found that for a convenient workflow-the pressing, cutting, polishing and designing machines involved should be modified. By this modification it was found that the total distance of workflow is was reduced. It was also found that the improvement in workflow resulted in the reduction of accidents. Finally the rearrangement of the layout decreased distance-travel-time consumed in transportation and also cost of flow of material, resulted in an increase in productivity.

5. References

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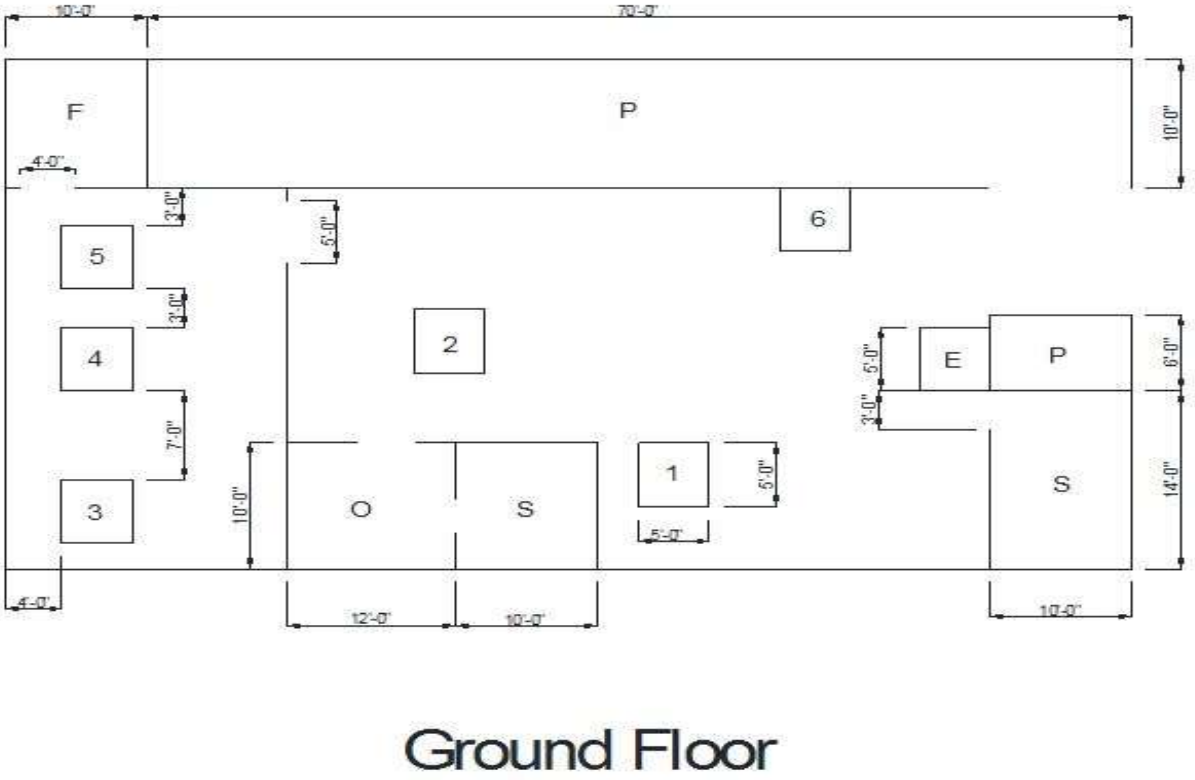

Figure: 1: Existing Layout Ground Floor

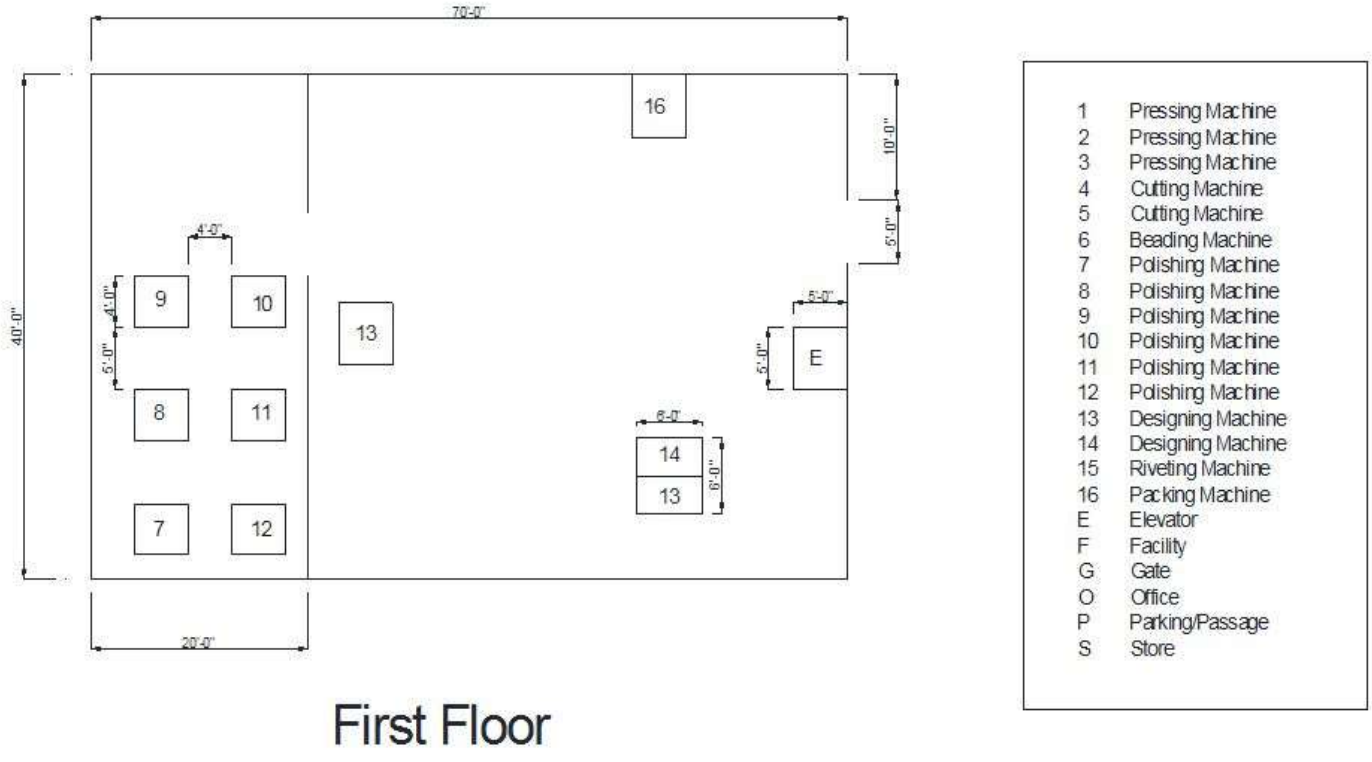

Figure: 2: Existing Layout First Floor

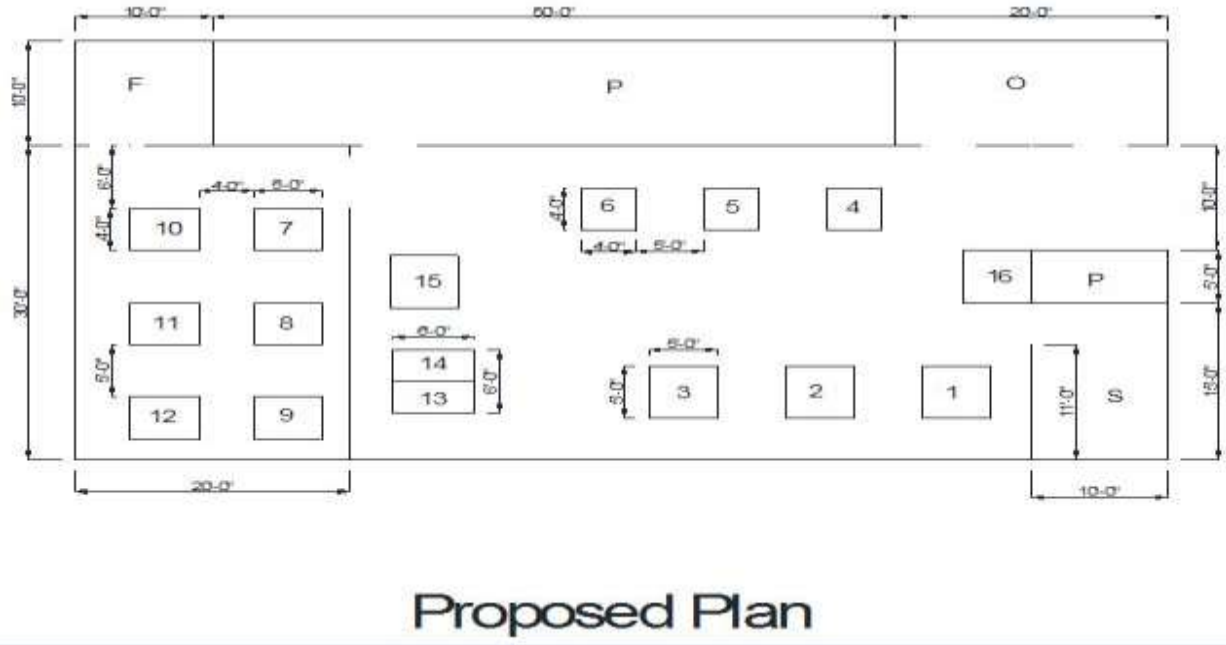

Figure: 3: Proposed Layout

