Implementation of New Facility Layout to Improve Plant Utilization

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***Abstract*: This Plant facility layout is the arrangement of all equipment and its facilities on the floor area in a particular form by determining size or function of particular setting. It is very important for any industry to have plant facility layout in optimum manner so that it will give maximum utilization of area and improve its efficiency. Efficiency of space resource is maximum when all facilities, equipment are arranged in efficient way. Also, product flow plays an important role in efficiency by minimizing the product travelling distance one can improve productivity. Thus, we benchmarked an old facility layout and implemented a new facility structure which yields higher efficiency and utilization.**

***Index Terms*: Industrial engineering, Lean manufacturing, Plant facility layout, Area utilization, Product Flow.**

I. INTRODUCTION

Nowadays plant facility layout plays a crucial role in improving resource utilization and improving efficiency. Various organization follows different configuration of facility and equipment layout to improve standard and utilization. For competitive market facility layout with higher efficiency is must to grow and sustain. Plant facility layout is the arrangement of all equipment and facilities by using product and process flow within the plant from raw material to finished component. The paper gives solution for XYZ company by using product flow optimization and area utilization.

Layout is majorly varying in two type product layout and process layout. In product layout the machines and equipment are arranged in one line depending upon the sequence of operations required for the product. It is also called as line layout. The material moves to another machine sequentially without any backtracking or deviation i.e., the output of one machine becomes input of the next machine. It requires a very little material handling. It is used for mass production of standardized products. While in process layout the machines of a similar type are arranged together at one place. This type of layout is used for batch production. It is preferred when the product is not standardized, and the quantity produced is very small.

This research paper present solving travelling problem by using string diagram. String diagram can be used to plot travelling of man, machine, and material in plant.

1. The string diagram is a simple tool for analyzing and designing workspaces in such a way that the movement. of material, men, equipment etc... Are minimized.[1]
2. The string diagram is a form of flow diagram, in which a thread is used to measure the distance of material, men movement. It is important that the string diagram drawn to an exact scale.[1]
3. The string diagram is carried out in exactly the same way as all other method studies, by recording all the relevant information and facts from direct observation.[1]

Company XYZ is leading manufacturing and supplier for centrifugal pump. XYZ Company was facing problem with floor utilization and product flow efficiency. This paper was giving efficient solution for optimization of resource and utilization.

II. LITERATURE REVIEW

Plant layout is the arrangement of desired machinery and equipment of a plant in a way which will permit. The easiest flow of materials, at the lesser cost with minimum handling, in processing the product from the raw materials to the dispatched of the finished product. The research paper presents solving an industrial problem using the principle of string diagram and simulation software.[1]

Plant layout or a facility layout is the joint determination of location, sizes, and configuration of multiple activities within facility it strives to achieve lowest cost with minimum material handling. Study and improve layout using systematic layout planning (SLP) theory for better plant area utilization and increased productivity by using different types of lean manufacturing tools.[2]

Implementation of a new facility layout is a very time-consuming process, and it requires a huge investment in order to implement all of the identified changes. Although no practical analysis is conduction to observe the implementation of the new layout made, the development was prove through the heuristically way such as manual calculation and simulation using tool.[3]

The basic objective of planning the deployment of workstations is to develop a system that would be the most suitable for production and bring savings. Among the types of workstation placement, one can distinguish process-oriented locations such us nesting system – related machines in production sockets, the product such us flow system – machines arranged according to the order of tasks and production lines such us grouping of machines into lines for similar products.[4]

Layout problems are found in several types of manufacturing systems. Typically, layout problems are related to the location of facilities (e. g. machines, departments) in a plant. They are known to greatly impact the system performance. Most of these problems are NP hard. Numerous research works related to facility layout have been published. A few literature reviews exist, but they are not recent or are restricted to certain specific aspects of these problems.[5]

III. Problem Statement

Highly efficient resource planning is important factor in the organization for efficiency. Implementation of new facility layout was decided because of following reasons.

- To reduce the distance travel by material(product) so that travelling time will reduce.
- Low utilization of resources (space, time) in previous model.

IV. Objectives

Problem statement led to following objectives.

- To utilization of maximum floor area and time (resources).
- To reduce travelling of material so travelling time will reduce.

V. Study Of Existing Model

XYZ Company product was centrifugal oil lube cleaner which are manufactured in batches according to size e.g., LC10, LC20, LC30 and LC40 they are subdivided into main assembly and sub-assemblies.

The existing layout was drawn by using AutoCAD tool and the process flow were studied by using process flow charts and product flow. The existing layout was studied to find out area occupied, distance travelled and space utilization.

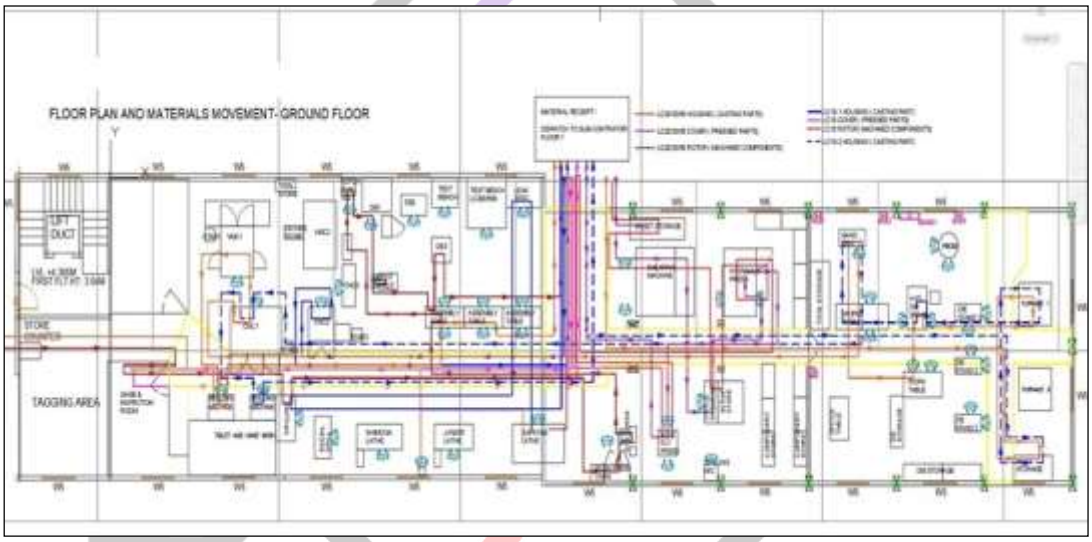

Figure 1 Current Ground Floor Layout.

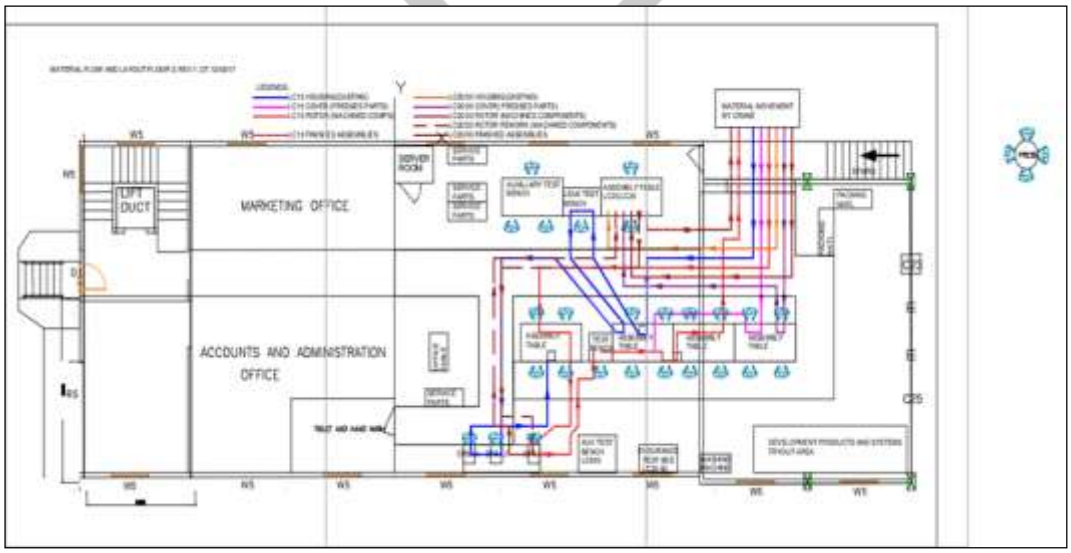

Figure 2 Current First Floor Layout.

From the current layout by using tool string diagram were plotted which shows complete travel flow of products assembly and sub-assemblies from raw material to finished component.

Following analysis was done in current layout:

- On ground floor mainly machining, forming operations were performing.
- First floor was used for assembly purpose.
- On both floor area utilization was not efficient also product flow was not in line which causes increase in travelling distance and reduce plant efficiency.

In layout complete product cycle which was shown by using string diagram in AutoCAD and distance for the same product flow was calculated in calculation section.

VI. Proposed Model For Layout

During analysis of the shop floor in industry it was observed that two separate floors were utilized for the manufacturing. Ground floor was used for machining and first floor was used for assembly and testing. In analysis it was got that the distances travelled by the product were large which results in more time consumption. Also, the area utilization by the machines was less which was around 43% of the total area.

It was essential for layout to manage product as well as process flow because of some constraints like forming operation must be at one side of plant, assembly operation should be at one section and testing should be at one section.

So, it was decided to bring all the facilities on the ground floor so that maximum area can be utilized and distance travel by parts will get reduced. So, three model were proposed by considering product and process flow of production.

The three iterations of layouts were prepared in Auto-CAD as shown below.

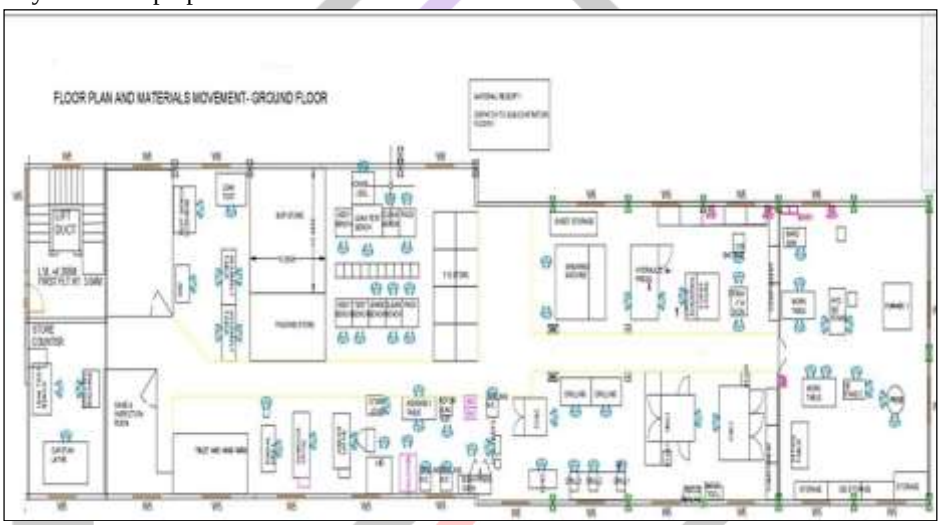

Figure 3 Proposed Layout (Iteration 1).

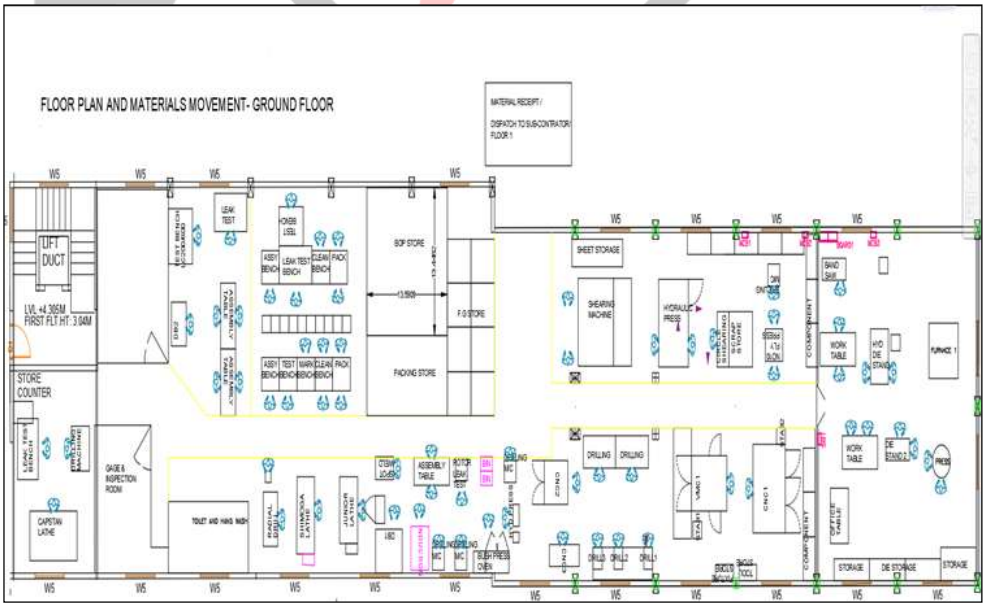

Figure 4 Proposed Layout 2 (Iteration 2).

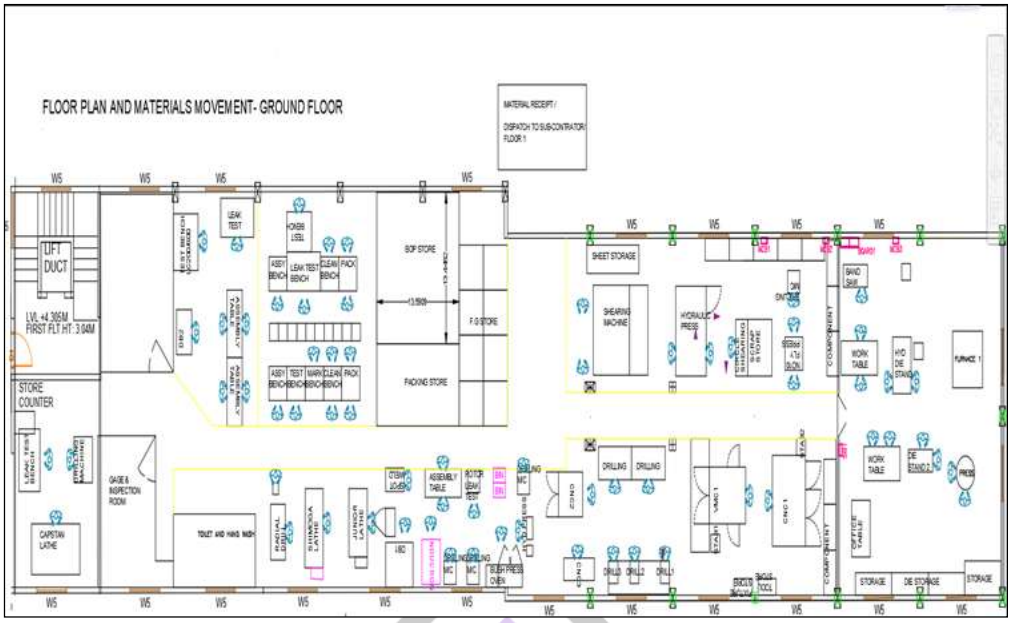

Figure 5 Proposed Layout 3 (Iteration 3).

VII. CALCULATION

A. Current Layout Analysis

This analysis was percentage area based where the total percentage of occupied area on each floor was calculated to find out the space utilization.

1. Total Shop floor area available:

Shop floor area available on (Ground floor) is 4456sq.ft
Shop floor area available on (First floor) is 2265sq.ft
Hence,
Total Shop floor area available = Shop Floor Area Available on Ground floor + Shop floor area Available on First floor
=6721sq.ft

2. Total area occupied by machines:

Area occupied by machines on Ground floor = 767. 35sq.ft
Area occupied by machines on First floor = 280sq.ft
Hence,
Total area occupied by machines **= 1047. 35sq.ft**

3. Total area occupied by fixed store:

Area occupied by fixed store on Ground floor =220. 75sq.ft
Area occupied by fixed store on First floor =95sq.ft
Total area occupied by fixed store = **315.75sq.ft.**

4. Total Walkway:

Walkway on Ground floor = 857sq.ft
Walkway on First floor =677sq.ft
Total Walkway = **1534 sq. ft**.

5. Total area occupied:

Total area occupied on Ground floor = Area occupied by machines on Ground floor + Area occupied by fixed store on Ground floor + Walkway on Ground floor **=1845. 1sq.ft**
Total area occupied on First floor = Area occupied by machines on First floor + Area occupied by fixed store on First floor + Walkway on First floor **=1052sq.ft**
Total area occupied =**2897.1sq.ft.**

6. Total Percentage area occupied:

Total Percentage area occupied on Ground floor.

$$= \frac{Total\ area\ occupied}{\text{Total shop floor area}} \times 100$$
$$= \mathbf{41.41\%}$$

Total percentage area occupied on First Floor.

$$= \frac{Total\ area\ occupied}{\text{Total shop floor area}} \times 100$$

=46.45%

$$\textbf{Total Percentage area occupied} = \frac{Total\ area\ occupied}{\text{Total shop floor area}} \times 100$$

=43.11%

Table 1 Area Utilization in Current Layout.

Description	Ground floor	First Floor	Total area (sq.ft.)
Total shop floor area	4456	2265	6721
Area occupied by machines	767.35	280	1047.35
Area occupied by fixed store	220.75	95	315.75
Walkway	857	677	1534
Total Area occupied	1845.1	1052	2897.1
Percentage area occupied	41.41	46.45	43.11

Distance Travelled by product in current layout.

Process flow diagrams were used to analyze the exact process flow. With the help of string diagrams, the distance travelled on both ground floor and first floor for each process was calculated (in. feet).

Calculated distances are given in following table:

Table 2 Distance Travelled in Current Layout.

Sr. No.	Product	Distance Travelled on Ground floor(ft.)	Distance travelled on First floor (ft.)	Total dist. travelled
1	LC10-1 Housing	158.5	135.6	294.1
2	LC10 Rotor	318	52	370
3	LC10 Cover	187	42	229
4	LC10-2 Housing	411	95	506
5	LC10-1 Finished Assy.	0	44	44
6	LC10-2 Finished Assy.	0	44	44
7	LC20/30 Housing	439.42	39	478.42
8	LC20/30 Rotor	318	44	362
9	LC20/30 Cover	164	56	220
10	LC50 Housing	439.42	0	439.42
11	LC50 Rotor	318	0	318
12	LC50 Cover	164	0	164
13	LC20/30 Finished Assy.	0	35	35
14	LC50 Finished Assy.	55	0	55
	Total Distance (ft.)	2972.34	586.6	3558.94

B. Analysis of proposed layout

Calculation of distances travelled:

By using string diagrams distance travelled in each layout was calculated in feet. The distance was then compared to select final layout.

Table 3 Distance Travelled in Proposed Three Layout.

Product	**Distance Travelled in Iteration 1 (ft.)**	**Distance Travelled in Iteration 2 (ft.)**	**Distance Travelled in Iteration 3 (ft.)**
LC 10 -1 Housing	276.57	323.01	185.61
LC 10 Cover	173.81	156.78	137.68
LC 10- Rotor	327.22	338.14	275.93
LC 10-2 Housing	345.42	335.79	300.03
LC20/30 Housing	499.02	463.42	395.17
LC20/30 Rotor	321.95	325.86	275.31
LC20/30 Cover	290.44	313.96	137.80
LC50 Housing	499.02	463.42	395.17
LC50 Rotor	321.95	325.86	275.31
LC50 Cover	290.44	313.96	137.80
Total Distance	3345.84	3360.20	2515.81

From above comparison, it was concluded that for all manufacturing process iteration 3 was superior to iteration 1 and iteration 2 as it travels less distance which reduces distance as well as time. This would help to improve the utilization of the plant, so it was decided to implement iteration 3.

Area occupied in new layout:

After implementation of new layout, the area occupied by machines and fixed store on shop floor was calculated. As in old layout the area occupied by machines as well as by fixed store was 43%. In new layout, the area occupied was increased by 15.85% which was 58.96% of the shop "Ground Floor". So, in new layout maximum floor area was utilized. Following table shows the total area occupied by machines and stores.

Table 4 Area Utilization In Proposed Layout Three.

Description	**Ground Floor (area occupied) in ft^2**
Total shop floor area	4456
Occupied by machines	1047.35
Occupied by fixed store	315.75
BOP store	407.5280
Walkway	857
Total occupied	2627.628
Percentage	58.96%

VIII. Results and Comparison

Proposed plant layout gives maximum utilization of floor area as well as it reduces the time travelled by the material and reduces the distance travelled by material.
Following table shows the result of area utilization in new model as compared to previous.

Table 5 Comparative Table of Area Utilization.

Description	**Ground Floor (Proposed layout) (area occupied) in ft²**	**Previous model Area occupied**
Total shop floor area	4456	6721
Occupied by machines	1047.35	1047.35
Occupied by fixed store	315.75	315.75
BOP store	407.5280	-
Walkway	857	1534
Total occupied	2627.628	2897.1
Percentage	58.96%	43.11%

As the above table shows that optimization of floor area from 43.11% to 58.96% is carried out in proposed model.
Also following table showing the distance travel by material or product in shop floor by using string diagram.

Table 6 Comparative Table of Distance Travelled.

Product	**Distance Travelled in Iteration 3 (ft.)**	**Distance travelled in the previous model**
LC 10 -1 Housing	185.61	294.1
LC 10 Cover	137.68	229
LC 10- Rotor	275.93	370
LC10-2 Housing	300.03	506
LC20/30 Housing	395.17	478.42
LC20/30 Rotor	275.31	362
LC20/30 Cover	137.80	220
LC50 Housing	395.17	439.42
LC50 Rotor	275.31	318
LC50 Cover	137.80	164
Total Distance	2515.81	3380.94

From the above table it was resulted that proposed layout minimized the distance travelling by the product by 865.13ft. which also reduces time of travelling.
Following graph shows comparative travelling distance of product/material in proposed model and current model.

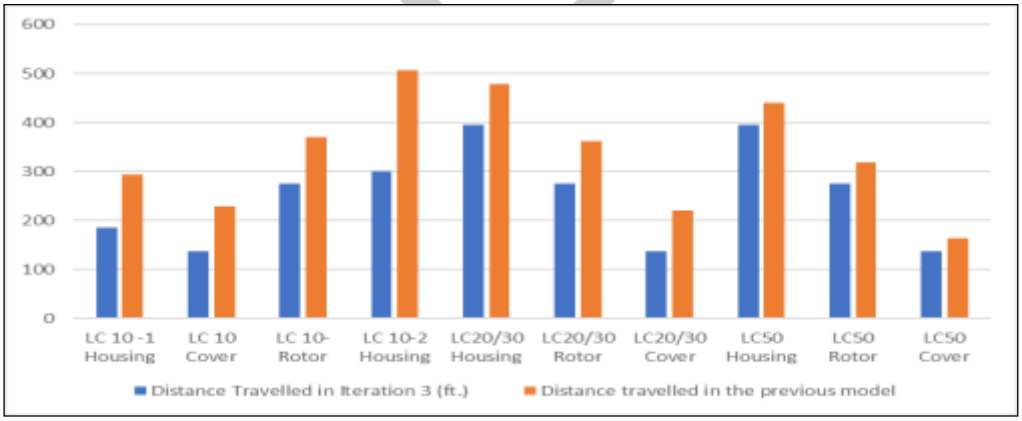

Figure 6 Graph Displays Benchmark of Total Distance Travelled.

IX. CONCLUSION

It is essential for industry to utilize its maximum resource in optimum manner to improve efficiency. This paper was focused on the facility layout design and implementation. The most common objective of the facility layout is to minimize travelling distance with co-ordination with product and process flow. In this research paper the well exposure of facility layout with considering distance travelled by product as well as resource (space, time) utilization is explained, as the objective of this paper was to increase utilization of resource was completed by proposed model. Which gives result of reduction in distance travelling by 865.13ft. & also increased area utilization from 43.11% to 58.96%.

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Ganesh M. Chaudhari received BE degree in Production engineering from University of Pune. He has expertise in projects related to industrial engineering. He is currently pursuing Master's in project management. His current interest lies in resource planning, Project Management, and Industrial engineering.

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