

Improvement of Plant layout Design for Effective Production: –A Case study

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ABSTRACT: In order to achieving an efficient production flow plant layout is very important in a manufacturing process. A case study conducted on a medium job type industry located in Ethiopia, which manufactures Sacks (Jute Bags). The existing plant layout and the sequence of operation process of each work station have been investigated. These paper discuses to redesign the plant layout thus obtain maximum effective production. This result showed that new design of plant layout to reduce the distance of material flow, which increases the production and reduced the total coat.

KEYWORDS: Material Handling, Material flow, Plant layout, Redesign, Transportation.

I. INTRODUCTION

The overall performance of an industrial firm is significantly affected by the design of its manufacturing facility. It may be a machine tool, a work centre, a department, a machine cell, a manufacturing cell, a warehouse, etc. A plant layout is an arrangement of everything needed for production of goods or delivery of services. A well–designed plant layout results in efficient material handling, small transportation time, and short path. This in turn, leads to low work-in-process levels, effective production management, decreased cycle times and manufacturing inventory cost, improved on- time delivery performance, and consequently, higher product quality. The efficiency of a layout is typically measured in terms of material handling (transportation) cost. The material handling costs are directly influenced by the distances a unit load must travel). An efficient plant layout results in an effective material flow path with no backtracking, congestion, undesirable intersections with other paths, and bypassing.

To design a plant layout there are several methods available such as SLP, Algorithms, and Arena simulation. Based on these methods, SLP method studied to design the entire plant layout, the result showed was the possible arrangement between workstations in the plant layout under significance. The factors are be considered while improving a plant layout design such as machine positions, relationship between machines and work, employees and work flow. The primary process for improvement of plant layout should be started with indentifying the problems of the existing plant layout to reduce material movement and decreases total cost. This paper aims design plant layout and compared the total cost of the existing plant layout. These thus reflect the importance of the plant layout design to bring about to reduce the total cost and increase in production.

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II. LITERATURE SURVEY

Table: 1. Plant Layout Review

Sl.No	Author and Title	Results and Discussions
1.	Richard Muther, 'Plant layout and flow improvement'	Plant layout and flow improvement efficiency of a plant layout can be increased by redesigning the plant layout using string diagram and systematic layout planning
2.	Micheal schenk, "Manufacturing Facilities - Location, Planning and Design"	It explains about the planning methods and procedure for various types of production facility
3.	Nehal Elsayar, Elwood S., Armour G. C. and Volkmann, T. E., "Allocating Facilities with Computerized Relative Allocation Facility Technique"	It discussed about the use of activity relationship charts and diagram for layout redesign and layout planning
4.	Saifallah benjafaar & Hillier, F. S., "Quantitative Tools for Plant Layout Analysis, Journal of Industrial Engineering"	It focuses a flexible layout is one that maintains low material handling costs despite fluctuations in the product demands levels
5.	Tobiah r. master, Francis, R. L.; L. F. McGinnis; and J. A. White. "Facility Layout and Location: An Analytical Approach"	It explains about the warehouse redesign of a manufacturing plant layout and also the problem faced during the redesign of the layout
6.	Thomas lacknsonen, "Facilities Layout Optimization Method Combining Human Factors and SLP"	It discusses about the different type of parts in a layout and identification of a material handling solution for a material flow.
7.	Anucha Watanapa, "Analysis Plant Layout Design for Effective Production"	The present plant layout and the operation process of each section have been investigated and a new layout has been designed
8.	Dr. M. Khoshnevisan Francis, R. L. and J. A. White, "Facility Layout and Location: An Analytical Approach"	It explained semi-heruristic optimization algorithm (CRAFT) for designing optimal plant layout in process focused manufacturing facilities.

III. CASE STUDY

New wave industry was established in 2005 in the town of Dire Dawa, 515km east of Addis Ababa, Ethiopia. It is a private company established as per the commercial code of Ethiopia. Case study was conducted in a medium small scale industry located at Dire Dawa, Ethiopia. The Company is to manufacturing the sacks (Jute bags) through which having fifteen different departments are given in table2. These departments are performed in the one area of building which is approximately 150*150 sizes. In an existing plant layout the sequence operations are shown in figure 2, the following problems were identified such as inefficient utilization of a available floor space, unable to utilize labor efficiently, poor maintenance and equipment utilization, difficulty in supervision and control. Maintenance difficulties, reduction in productivity. These all factors lead to lower the productivity and consequently increases the final cost of its product.

Existing Plant Layout Analysis

Figure 3 show an existing plant layout. The material handling cost is the important criterion for the analysis and selection of a plant layout. Depending on the existing plant layout, an analyst may follow a procedure is given below:

Step 1: The interdepartmental moves of existing plant layout are summarize

Step 2: By combining moves and countermoves between any two departments are simplify.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 11, November 2016

Step3: Prepare the Material handling cost matrix of the existing layout by multiplying the unit material handling cost by the number of moves between various departments.

Step4: Calculate the total material handling cost of the existing layout.

Step5: Search the possible departmental changes that will reduce the number of moves and calculate the total material handling cost

IV. ANALYSIS AND RESULTS

The assumptions and constraints used in the proposed plant layout redesign for the analysis are administration block; Manager Room and generator complex are not changed because they are not involved in a material transfer. The improvement of plant layout redesign as shown in Fig 4, in this position of looming station are interchanged horizontal to vertical direction and other departments at the same positions and number of movements between different department is not changed in the existing plant layout. The total material handling cost of the proposed plant layout is Rs. 343.04 per day is lesser than the total material handling cost of existing plant layout is Rs. 598.89 per day and efficiency of redesign plant layout was increased also reduction in total distance travelled by various department was achieved and shown table . The comparative analysis of existing and proposed plant layout is also shown in table3 & 4.

Table: 3 Existing Plant Layout material flow

No	Department From-To	Distance in Meter M_i	No of moves per day D_i	Total distance travelled per day in meter $M_i \times D_i$
1	A -B	170.00	6	1020
2	B -C	2.00	50	100
3	B -D	2.00	30	60
4	C- E	7.13	40	285.2
5	D- F	9.14	20	182.8
6	E- F	1.24	26	32.24
7	E -G	9.14	38	347.32
8	F- G	2.50	24	60
9	G -H	4.10	30	123
10	H- I	2.00	36	72
11	I -J	2.00	72	144
12	J -K	2.40	20	84
13	K -L	2.10	20	42
14	L- M	1.83	20	36.6
15	M -N1	4.30	38	163.4
16	M- N2	12.61	28	353.08
17	N1 -O	9.95	15	149.25
18	N2 -O	7.50	11	82.5
19	O- P	3	60	180
20	P -Q	10.6	8	84.8
21	P -A	185.00	6	1110

Table: 4 Purposed Plant layout material flow

No	Department From- To	Distance in Meter M_i	No of moves per day D_i	Total distance travelled per day in meter $M_i \times D_i$
1	A-B	37	6	222
2	B-C	2	50	100
3	B-D	2	30	60
4	C-E	7.13	40	285.2
5	D-F	1.24	20	182.8
6	E-F	9.14	26	32.24
7	E-G	1.24	38	347.32
8	F-G	2.50	24	60
9	G-H	4.10	30	123
10	H-I	2.00	36	72
11	I-J	2.00	72	144
12	J- K	2.40	20	84
13	K- L	2.10	20	42
14	L-M	1.83	20	36.6
15	M-N	9.65	36	347.4
16	N-O	8.73	54	471.42
17	O-P	3	15	45
18	P-Q	5.5	11	60.5
19	P -A	44	8	352
20	Q-A	38.5	6	231
$\sum M_i D_i = 3298.48m/day$				

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 11, November 2016

22	Q-A	174.4	6	1046.4
$\sum M_i D_i$				5758.59m/day

Calculation of Material Handling Cost For existing plant layout design

1. Total distance travelled by various departments per day

$$\begin{aligned} & \sum \text{Distance } M_i \text{ (meter) } \times \text{Number of moves per day } (D_i) \\ &= \sum M_i D_i \\ &= 5758.59 \text{m/day} \\ &= 5758.59 \text{m/day} / 3 \text{shift} = \mathbf{1919.53 \text{m/shift per day}} \end{aligned}$$

2. Average material handling cost/meter

$$\begin{aligned} &= (\text{Wages of worker per shift}) / \text{Average distance travelled per shift per day} \\ &= \text{No. of worker salary of one worker per day} / \text{Average distance travelled per shift per day} \\ &= 1 \times (6000/30) / 1919.53 \\ &= \text{Rs. } 0.104 / \text{meter.} \end{aligned}$$

3. Total material handling cost per day (Including all three shifts)

$$\begin{aligned} &= \text{Total distance in meter } \times \text{Average material handling cost per meter} \\ &= 5758.59 \times \text{Rs. } 0.104 \\ &= \text{Rs. } 598.89 \text{ per day} \end{aligned}$$

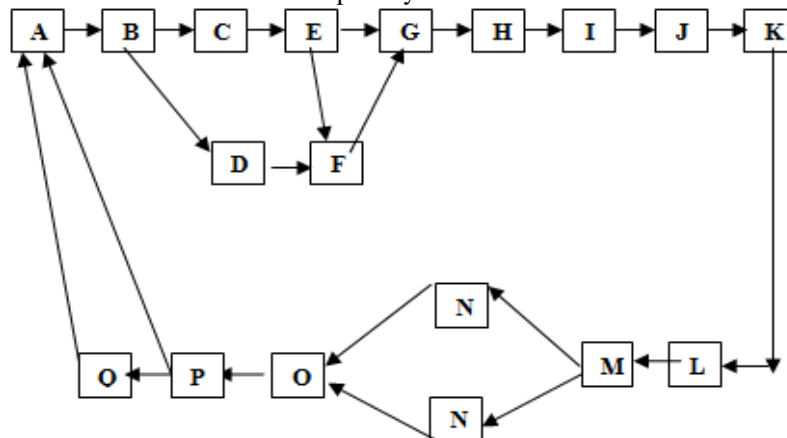


Figure .2. Sequence of operations in existing plant layout.

Table.2. List of Departments

Department	Description
A	Store (ware house)
B	Selection and cutting
C	Spreader machine
D	Teasser machine
E	Breaker machine
F	Intermediate machine
G	Finisher machine
H	1 st drawing machine
I	2 nd drawing machine
J	3 rd drawing machine
K	Spinning machine
L	Winding machine
M	Beaming machine

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 11, November 2016

N	Looming machine
O	Cutting machine
P	Stitching machine
Q	Printing machine

Calculation of Material Handling Cost For proposed plant layout design

1. Total distance travelled by various departments per day

$$\begin{aligned} & \sum \text{Distance } M_i \text{ (meter)} \times \text{Number of moves per day (D}_i) \\ &= \sum M_i D_i \\ &= 3298.48\text{m/day} \\ &= 3298.48\text{m/day} / 3\text{shift} = 1099.49/\text{shift per day} \end{aligned}$$

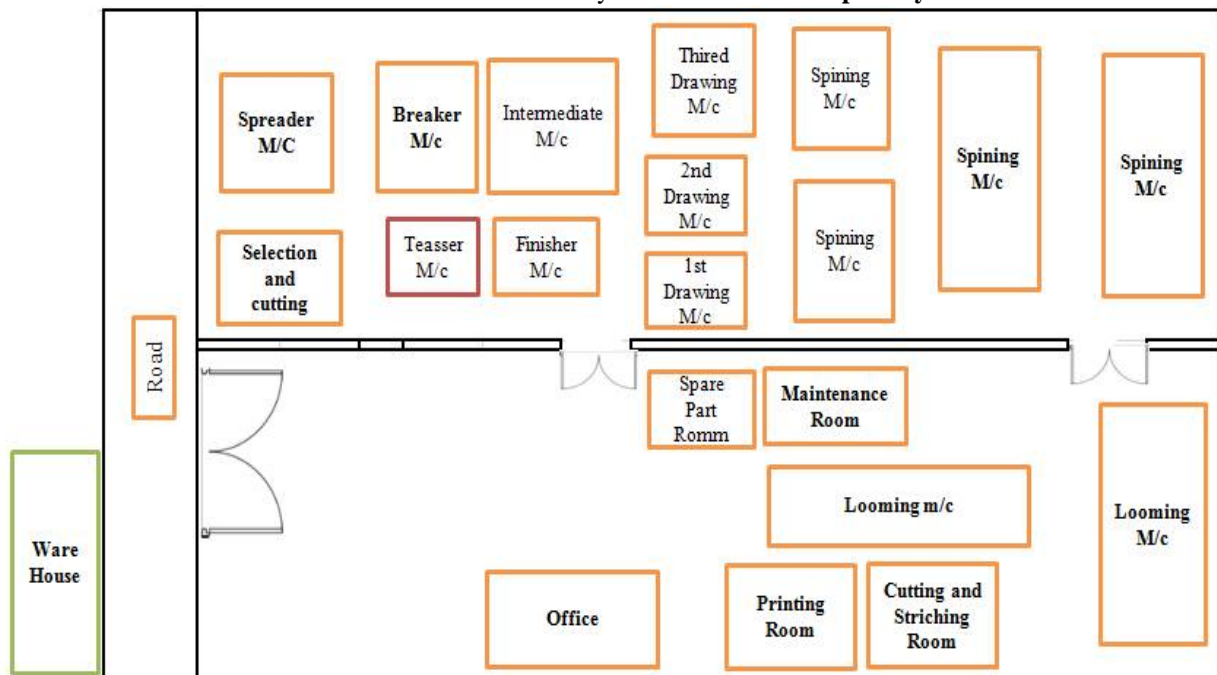


Figure3. Existing Plant layout

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 11, November 2016

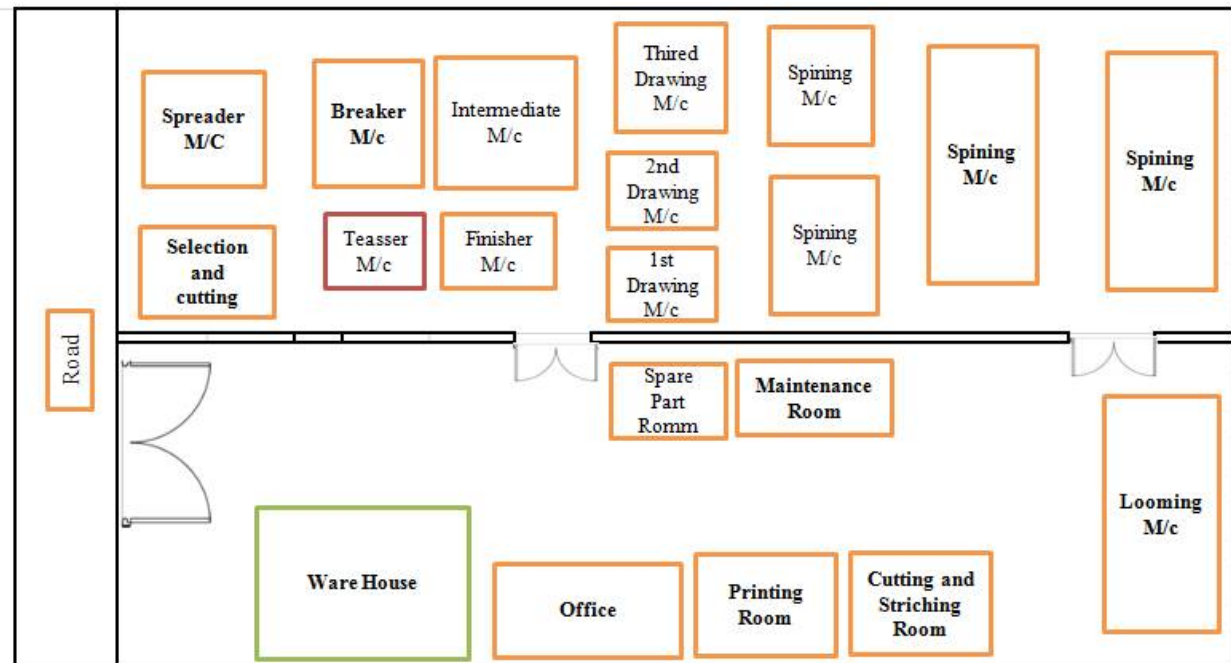


Figure.4. Plant layout

2. Total material handling cost per day (Including all three shifts)

$$\begin{aligned}
 &= \text{Total distance in meter} \times \text{Average material handling cost per meter} \\
 &= 3298.48 \times \text{Rs. } 0.104 \\
 &= \text{Rs. } 343.04 \text{ per day}
 \end{aligned}$$

Percentage reduction in transportation length

$$\begin{aligned}
 &= (\text{Difference in material movement} / \text{current material movement}) \times 100\% \\
 &= (1919.53 - 1099.49) / 1919.53 \times 100 \\
 &= \mathbf{42.72\%}
 \end{aligned}$$

V. CONCLUSION

This paper has provided a good exposure to plant layout designs for the improvement of the material handling cost and reduction of transportation length. The most common objective of layout design, that is to minimize distance travelled. In existing plant layout have been modified by using travel chart technique analysis and considering material handling cost as the criterion. By implementing the redesign plant layout, the total material handling cost reduced and reduction in transportation length. As a results in saving in amount of resources and increased the productivity

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Vol. 5, Issue 11, November 2016

REFERENCES

- [1] Saifallah benjafaar & Hillier, F. S., "Quantitative Tools for Plant Layout Analysis, Journal of Industrial Engineering", IIE Transaction, Vol. 14, No. 1, pp. 33-40, 1963
- [2] Amrita Kirtanu, Nagendra Sohani, "Improvement in plant Layout Using Material Handling Technique", International Journal of Science and Research(IJSR), Vol.3, issue 5 pp.1496-1472, 2014
- [3] Vivekanand s Gogi, Rohith D, "Efficiency Improvement of a plant Layout ", International Journal of Innovative Research in Science Engineering and Technology, Vol.3 Issue 4, pp.11203-11209, 2014
- [4] FilippoDe Carlo, Maria Antonietta Arleo : Layout Design for a low Capacity Manufacturing Line: A Case Study:, International Journal of Engineering Business Management Special Issue on Innovations in Fashion Industry , Vol.5 , 2013
- [5] Micheal schenk, "Manufacturing Facilities- Location, Planning and Design", PWS-KENT Publishing Boston U.S.A., Vol.13, pp. 337-339, 1988.
- [6] Anucha Watanapa, Phichit Kajondecha, Patcharee Duangpitakwong , and Wisitsree Wiyaratn. "Analysis Plant Layout Design for Effective Production", Proceedings of the International Multi Conference of Engineers and Computer Scientists , Vol.II, IMECS 2011, March 16-18. Hong Kong.
- [7] Chandra Shekhar Tak, Mr.Lalit Yadav, "Improvement in Layout Design using SLP of a small size manufacturing unit: A case study", IOSR Journal of Engineering (IOSRJEN), Volume 2, Issue 10, PP 01-07, 2012.
- [8] Rohit Monga, Varinder Khurana, "Facility Layout Planning: A Review", International Journal of Innovative Research in Science, Engineering and Technology, Vol. 4, Issue 3, March 2015
- [9] Jia Zhenyuan, LU Xiaohong, Wang Wei, Jia Defeng, Wang Lijun, "Design And Implementation Of Lean Facility Layout System of A Production Line", International Journal of Industrial Engineering, Vol. 18 Issue 5, pp. 260-269, 2011.
- [10] Eduardo J. Rodrigues. Paula A. Alexandrino, Maria S. Carvalho, "Implementation of a Logistics Process Improvement System – a Case Study", Proceedings of the World Congress on Engineering 2013. Vol I, WCE 2013, July 3 - 5, 2013, London, U.K.
- [11] Shukla Abhinav , Vimal Jyoti,,Chaturvedi Vedansh, "Analysis of Plant Layout for Reducing Production Cost", International Journal of Scientific Research and Reviews, IJSRR, 2(1) Suppl., 141- 147,2013.
- [12] Bobby John,, Jubin James,, R. Mahesh Rengaraj, "Analysis and Optimization of Plant Layout using Relative Allocation of Facilities Technique", international Journal of Emerging Technology and Advanced Engineering), Volume 3, Issue 8, pp. 514-520, August 2013.