

“Optimization of Plant Layout in Manufacturing Industry”

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ABSTRACT: *The world's globalization and consolidation result in increased competition for manufacturing industry. A factory must always attempt to achieve world class manufacturing and quality to survive long in the growing market. Therefore it is important for a MSME sector (Manufacturing Industry) to develop their way of working continuously as per World Class Standards. In this research work, current layout of a manufacturing MSME industry is studied and a new layout is developed based on the systematic layout planning to reduce the meter movement, searching time and increase productivity. The company has presently working on processes layout. The number of equipment/machineries available and meter movement have been analyzed. The detailed study of the plant layout such as operation process chart, activity relationship chart and the relationship between equipment and area has been investigated. The new plant layout has been designed and compared with existing plant layout with the help of Spaghetti Diagram. The new plant layout shows that distance and overall cost of material flow from stores to dispatch area are significantly decreased. The implementation of proposed model will help in the overall improvement of production performance of manufacturing industry. This research work also helps to other small industries having such type process layout in increasing their productivity and achieving 100 % efficiency.*

INDEX TERMS: *Optimization, Plant Layout Optimization, Systematic Layout Planning, Spaghetti Diagram*

I. INTRODUCTION

“Think of a rope. When it's tugged, knotted, coiled, or shaped to take a form, the entire length is affected. Facility layout is similar: all parts make up one interconnected whole.” Plant layout optimization means getting the things in its appropriate position so that there is a ease of future expansions, there is effectiveness in material handling in terms of cost and time, proper space utilization, safety and housekeeping, proper working conditions, proper appearance, proper equipment utilization, higher pay-out, return and profitability.

Due to improper plant layout there is no scope for further expansion in small scale manufacturing industry, there is a lot of material handling by skilled workers which adds on the cost of production, a lot of space is wasted in the plant in

keeping scraps at any positions, due to scraps located anywhere in the plant it gives bad appearance to the plant, also the working conditions of the workers is not suitable as they are performing their duties without proper training and capacity building. All of these reasons justify the idea of relocation of certain facilities to have an improvement in all of the area stated above.

II. LITERATURE REVIEW

The various references and research paper belongs to Optimization of Plant Layout in Manufacturing industry have been study during the research work and considered for the review. Some of these are:

Carlo, Antonietta, Borgia, & Tucci, 2013^[1] One of the main goals of a manufacturing system is the maximization of its productivity. This depends upon several factors, such as the kind and the complexity of the product made, the quality of the raw materials, the complexity of the manufacturing process and the arrangement of the workstations constituting the production process. Some of these parameters are determined by the product and, for this reason, are unchangeable; others, however, are variable and thus improvable. The challenge of determining the best arrangement of the workstations is one of the elements that have a great impact on system performance. It is known as the —facility layout problem. The literature gives lot of definitions of various layout problems.

SINGH, 2012^[2] The production process needs to be equipped with the ability to have lower cost with higher effectiveness. Therefore, the way to solve the problem about the production is very important. There are many ways that is quality control, total quality management, standard time, plant layout to solve the problems concerning productivity. Out of these entire plant layout being the cheapest method to increase productivity. According to the study of manufacturing process, it was found that the long distance could be reduced for moving raw materials and the problem about useless area could be solved. The way to improve the plant was to apply SLP method to make the workflow continually by arranging the important sequence of the manufacturing.

WIYARATN & WATANAPA, 2010^[3] in the present, there are several methods for plant layout design such as systematic layout planning (SLP) algorithms and arena simulation can apply to design plant. Nowadays few researches for SLP because using program computer to simulate is more popular. However SLP method seems interesting to design the plant layout, it is basic fundamental and quite simple method, including it can use into practice.

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SHUBHAM BARNWAL, PRASAD DHARMADHI KARI^[4] to develop a new layout based on the systematic layout planning pattern theory. Conclusion: The proposed model based on Systematic Layout Planning Pattern Theory (SLP) was found to be effective. Production rate increased, the production time was reduced and total distance travelled by material also reduced. Paper Name: Optimization of Plant Layout using SLP method.

Dr. Devendra S. Verma, Rajdeep Chaurasia^[5] a study to identify the factors affecting employee turnover in small scale industries. Aim and objectives of the study is to examine the employee turnover of a small scale industry with the use of Quality of work life in both voluntary and involuntary aspect, find out various dependent and independent factors that affects the employee turnover directly or indirectly in small scale industry and to get how Managers can take appropriate actions to improve employees’ QWL and subsequently reduce employees’ turnover. Based on regressions analysis done in study paper, the largest beta coefficient belongs from opportunity for promotion. This means that this is the most significant factors influencing the job satisfaction. Besides that, top management’s appreciation recorded second largest .Meanwhile; the third significant factor influencing turnover intention is fair compensation. Then, it is followed by job security, team work, training program, fringe and welfare benefits and work stress.

Dr. Devendra Singh Verma, Shashank Singh Pawar^[6] Paper Name: Design Cost Engineering through Quality Function Deployment. Due to increase in awareness of customer about environment issues, eco-friendly products have gained more and more importance. Such interests in customers about environment issues have forced the manufacturer to consider the environment impact of the product during the design stage. When environment requirements are considered during the product design stage the cost becomes relatively low. In this research paper Green parameters are used to enhance the quality of the product using quality function deployment (QFD). After that the optimized estimated cost of the product on the basis of its feature attributes is evaluated with the help of multi attribute utility theory (MAUT) model. Finally conclusion of product is that when the changes in the designing level occur, the cost of the product get change.

III. SCOPE

The scope of this research work is to study the existing plant layout and to suggest some improvements at shop floor level along with implementation of 5S concept, JIT, KAIZEN that will enhance inventory turnover ratio which would improve working conditions and skills of manpower. In this research work, the Systematic Layout Planning Method (SLP) is proposing for solving the current layout problem having inner structure walls and passages. The current layout is having 2 floor manufacturing arrangement with zigzag process. With the help of SLP, a comparison with an existing layout and proposed layout will evaluate. The comparison results show that the proposed layout is superior

to the existing one. The approach is the best for the small scale manufacturing industry layout. It is also recommended to implement other tools like Lean Manufacturing Concept, 5S, KIAIZEN, JIT etc those will improve the efficiency in men, machine and material.

IV. OBJECTIVE

The prime objective of research work is to design optimized plant layout, which will maximize the profit by arranging all the facilities to the best advantage of total manufacturing of the product. Any good planning is the best relationship between outputs, space and manufacturing cost. The main objectives of plant layout are to design a optimize plant layout based on SLP approach, increase in productivity, reducing material handling, preparation of activity relationship chart and effective utilization of men, machine and material etc. :

V. METHODOLOGY

Present condition of plant may lead to less productivity with less efficiency utilization of plant. It may also lead to non-effective utilization of men, machine and material. Systematic Plant Layout (SLP) against all the methods stated as above is an organized method for plant layout optimization. For optimization of plant layout, following analysis were taken into account:

Activity Analysis In order to plan a layout all the activities of this plant have been studied in depth. All the analysis to identify the base level situation has been done form and printing area.

Sr. No.	Process	Change over time	Output/Shift (Lac)
1	Printing	30	20
2	Coating-UV	45	1.25
3	Lamination	15	3.5
4	Punching	180	3.5
5	Pasting	60	15

Table 1: Change Over Time and Output

Sr. No.	Process	No. of Machines
1	Cutting	3
2	Printing	3
3	Coating-UV	1
4	Lamination	2
5	Punching	2
6	Pasting	1
7	Packaging	1

Table 2: No. of Machines

Situational Analysis: Activities movement is the key component to design a new plant layout for optimization activity. For calculation of activity movement, meter movement tool is used for analysis. With the help of this, the differences between changes in meter movement for different processes are found out.

Sr. No.	Process	Before	After
1	Godown	20.6	20.6
2	Cutting	15.24	15.24
3	Printing	35.46	35.46
4	Coating-UV + Lamination	43.74	14.72
5	Punching	7.12	16.45
6	Stripping	4.34	4.34
7	Pasting	7.22	7.22
8	Dispatch	6.9	6.9

Table 3: Meter Movement

Spaghetti Diagram of Current Plant Layout

Based on the data collected and activity analysis, spaghetti diagram of current layout is designed. This is showing the movement between various processes like cutting, printing, coating-UV, lamination, punching, pasting and packaging. The below figure showing the continuous flow line between process. It is also clear from the research work that men, machine and material movement is in the zigzag way, resulting loss of productivity.

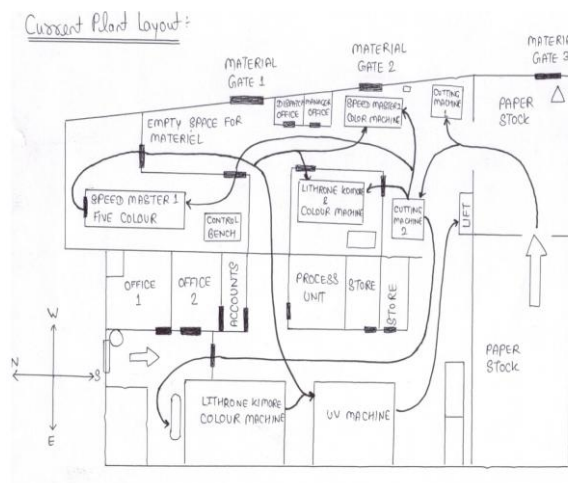


Figure 1: Spaghetti Analysis of Current Plant Layout

Plant Layout after Implementation

Proposed new layout based on the systematic planning technique after implementation will reduce the distance between workflow and smooth flow of material throughout the cycle. Therefore rearranging the layout improves material flow, reduced travelled distance and cost resulting in an increase in production. In the proposed layout the position of

various departments are altered with various others based on activity relationship chart.

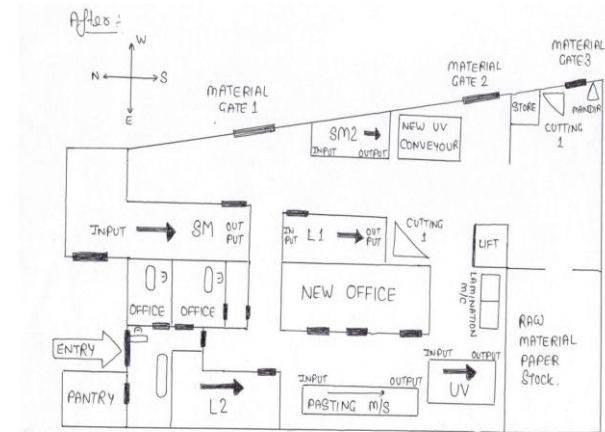


Figure 2: Plant Layout based on study

The UV machines, cutting machines are also shifted in such a way that will render the less space. Earlier two floors were used for the printing process but as per new proposed plant layout, pasting machine was shifted to the ground floor. Therefore extra movement had reduced.

VI. RESULT

It is very clear that after the plant is laid down using the Systematic layout planning by an area saving of 120.93 Sq. Mt. (Approximately 14%) is achieved. This area can be effectively be used for future expansion, stocking of raw material and finished products in times of demand fluctuations or raw material cost decrement. In total, the use of SLP has resulted in new layouts involving eight processes. Choosing the best layout was the most important part of the research work. There are several methods that can be used to find the best layout among alternatives. In this case, the use of the algorithm requires a long time as the industry is small scale industry. Therefore, direct suggestion based on activity relationship chart was a good solution as it was able to reduce the lengthy calculations and raise the accuracy. The layout in Fig. 02 illustrates the arrangement of the processes and machines in plant layout according to the order that was finalize by the management of the industry. The targets and achievements of the study are as follows:

Sr. No.	Particulars	Target	Achievement
1	Reduction in Material Movement	20 % (Before 140.62 Meter)	14 % (After 120.93 Meter)
2	Financial Saving	20 Lac/Year	14.23 Lac/year
3	Inventory Turnover Ratio	12.93	30.29

4	Labor Productivity Company	287.75 (45%)	398.70 (38%)
5	Searching Time	2.5 Hrs/Shift	2.0 Hrs/Shift

Table 4: Result

VII. CONCLUSION

The goal of the research work is to develop a new production layout in view of the need to increase the production capacity using facility planning and design techniques. The aim of the research work is to generate layouts with improving efficiency. Systematic Layout Planning Technique (SLP), which is widely used in previous studies during the past decades, is the best optimization activity which explores the relationship in between various activities. The proposed model based on SLP is found to be effective in solving the various problem of small industry. The inventory turnover ratio has increased by 30.29, the labor productivity of company has increased to 398.7 (38%) and total meter movement by material came down by 14%. In the research work distance are considered to improve existing layout but there are many other parameters to analyze the layout that may be number of workers, requirement of area and adaptation of advance technology. The problem of existing layout is the large comparative distance between several departments that’s forced to travel a long distance and impedes the smooth material flow and leads to higher cost. In proposed layout the position of various departments is altered with various others based on activity relationship chart. It is expected that this proposed model will mostly be preferable while setting up a new plant implementation and will help in the overall improvement of production performance.

The proposed plant layout and optimized materials handling system were welcomed by management because of the evident change in a number of performance indicators such as; reduction in cost and throughput time as well as improvements in storage space and controls, quality and a safe working environment. There was a marked decrease in the distances travelled by components and number of movements due to an increase in loads per movement.

VIII. ACKNOWLEDGMENT

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REFERENCES

- Carlo, F. D., Antonietta, M., Borgia, O., & Tucci, M. (2013). Layout design for a low capacity manufacturing line: a case study. *International Journal of Engineering Business Management: Special Issue on Innovations in Industry*.
- Singh, M. (2012). Innovative Practices in Facility Layout Planning. *International Journal of Marketing, Financial Services and Management Research*.
- Wiyaratn, W., & Watanapa, A. (2010). Improvement Plant Layout Using Systematic Layout Planning For Increased Productivity. *World Academy of Science, Engineering and Technology*.
- Shubham Barnwal, Prasad Dharmadhikari. Optimization of plant layout using SLP method. *IJRSET /Vol. V/ Issue III/March 2016*.

- Dr. Devendra S. Verma, Rajdeep Chaurasia. A study to identify the factors affecting employee turnover in small scale industries.
- Shashank Singh Pawar, Dr. Devendra Singh Verma Paper Name : Design Cost Engineering Through Quality Function Deployment.

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