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An Overview of Different Methods to Improve Productivity of Plant

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ABSTRACT-
Optimization and product process layout plays a major role in small and big industries. This paper focusses on various methods and simulated theories which eventually lead to optimization and product process layout. The elements such as coolant properties, cycle time of the product on a particular machine, improvements in cutting tool, reduction in time required for product handling etc. The main aim behind researching such varied range of review papers was to study and understand the best possible as well as innovative parameters to lead to a positive output. Similarly, various simulation software's were used such as ARENA, Flex Sim, CRAFT, and CORELAP etc. in order to simulate the designed processes and furthermore validate them as well.
KEYWORDS – *Optimization, product process layout, Process flow, productivity, material handling, Kaize*

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I. INTRODUCTION-

The manufacturing process workflows or product process layout, detail the granular activity levels steps that must be completed to create finished goods from the time raw materials are received at the manufacturing facility until those materials are turned into finished goods. A process layout is based on the nature of the process through which the product should move in the course of manufacture. The operation performed in each department are allotted to particular machines on the basis of the capability of the machine to perform that operation, the capacity required, the availability of the machine, the precision required and so on. Process optimization is a process that adjusts a current process to optimize some specified sets of parameters without violating constraints. Material handling and process flow goes hand in hand. Total production cost has great dependency on the material handling. The men and material both need to travel maximum distance which further results in more time for the delivery of the product. The choice of proper process layout is necessary to increase productivity and also the crossflow caused by workers during manufacturing.

There are many benefits of process optimization which includes reduction in cost, increased productivity, reduction in rejection rate, smooth and easy work flow process and time reduction. The optimization of coolant resulted in better tool life, reduction in operational cost, good surface finish and have provided odour less operation. The tool change resulted in good surface finish, longer tool life and dimensional accuracy to avoid the rejection rate.

II. REVIEWED RESEARCH PAPERS-

The present review paper deals with the effect of the following parameters as follows-

Study of cutting fluids

Amitava Ray et.al [1] considered the impact of cutting fuel on the Environmental. Here three different cutting fluids were compared and then they were ranked and segregated by AHP (Analytical hierarchy model) and VIKOR respectively.

The development of decision matrix and the computing of criteria weights is done by AHP method and VIKOR is used for ranking of the alternatives. The analysis shows the Syntilo 990c (SCF2) is optimal in comparison with others as shown in figure. (Jagadisha, et al., 2014)

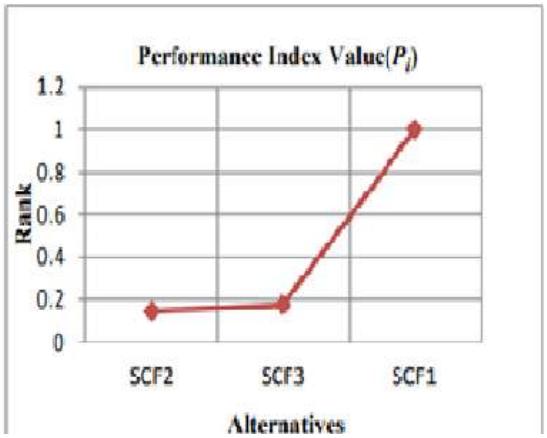


Figure 1 : Ranking alternatives based (P) [1]

T. S. Ogedengbe et.al [2] analysed the effect of coolant in regards to heat generation on the workpiece and tool. Ansys 19.1 software is used to calculate the heat removal percentage. Different machining conditions like dry, wet, flooded cryogenic machining are used to determine different types of tool wear and their impacts on dimensional accuracy, tool life, and corrosion.

1. Cooled coolant helped improve machining of AISI 1050 steel bar.
2. 86.9% and 58.6% reduction in heat was observed while using cooled and wet machining respectively.
3. Delta values are significantly impacted by cutting speed and depth of cut. (Ogedengbe1, et al., 2018)

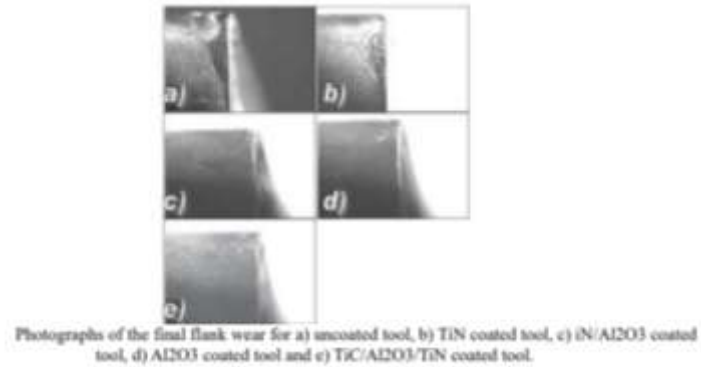
Study of tool

Halil Çalişkana et.al [3] used VIKOR and TOPSIS methods to find optimum cutting parameters like surface roughness, cutting force and rate of material removal. The observations were carried out on the CNC machine without using coolant for milling on the basis of maximum cutting speed, feed rate, surface finish, small tool wear and maximum depth of cut.

a. Complex cutting parameter selection problems can be solved using the MCDM approach.
b. To assess correlation between two ranking methods spearmen ran correlation coefficient is a good option. (Çalişkana, et al., 2012)

M. Narasimha et.al [4] used different coatings like Al2O3, TiC/TiN, etc. on tools to increase rate of production, increase tool life, decrease cost of production. Comparison was also made on parameters like flank wear and surface roughness for uncoated and coated tools.

Addition of all coating but TiN/Al2O3 decreased surface roughness when machined when compared with machining without coated tool. If the tools were to position in ascending order of surface finish the standings would be TiN/Al2O3, uncoated tool, TiN coated tool, Al2O3 coated tool, TiC/Al2O3/TiN coated tool. These results are confirmed by the test conducted in previous sections. (Narasimha, et al., 2013)



Photographs of the final flank wear for a) uncoated tool, b) TiN coated tool, c) iN/Al2O3 coated tool, d) Al2O3 coated tool and e) TiC/Al2O3/TiN coated tool.

Figure 2 : Photographs of Final flank wear [4]

Study of plant layout

K.V. CHANDRATRE et.al [5] use different optimization techniques such as concurrent engineering, hybrid algorithm and genetic algorithm for optimizing facility layout. This helps industry to increase efficiency, maximize utilization of space and reduction in material handling cost.

1. Modern machine tools help enhance layout planning process as a whole.
2. In the present context it is necessary to develop new hybrid algorithm techniques for comparing the alternate layout proposals which can be done by developing hybrid algorithms and comparing them. (Chandratre, et al., 2011)

S. M. Kadane et.al [6] use FLEXSIM Simulation software for analysing material handling and process layout optimisation.
Understanding existing processes, raw material requirement, time study and layout design and simulation are key components of this paper.
Full welding and finishing workstations are sufficient, we don't find any stacking of components in the simulation.
When tack welding is done, we see reduced rate of bottlenecking. Also the throughput rate is observed to be increased. Maximum throughput giving rate is selected for implementation in the process. (Kadane, et al., 2011)

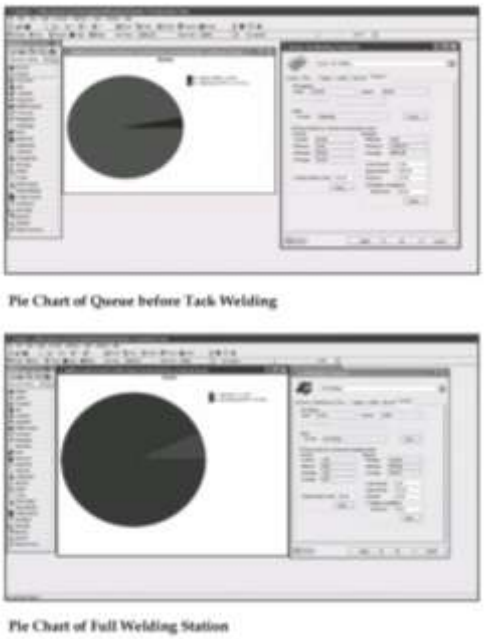


Figure 3 : Pie Chart for welding process [6]

Mahendra Singh [7] for increasing productivity and overall efficiency focus on using various softwares like CRAFT (Computerised Relative Allocation of Facilities Technique), SLP (systematic layout planning), and QAP (quadratic assignment problem). This resulted in ease of operations and reduction in the accidents.

Efficiency is increased vastly but reduction in accidents, hazards were desirable by-products which was observed due to good plant layout. A better facility has an enhanced manufacturing setup which has a higher output, better facilities also help with ease of transport of goods within the factory and for delivery and dispatch as well.

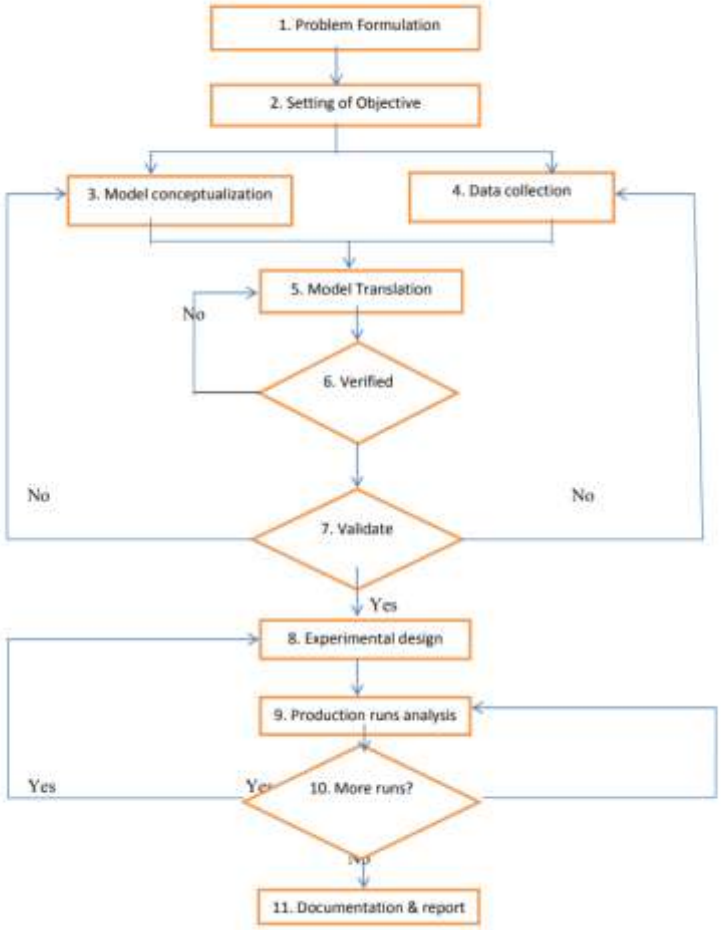


Figure 4 : Flow chart for better solution [7]

The above flowchart helps us understand the activities to be done and find a better solution. (Singh, 2012)

Amir J Khan et.al [8] concluded that cost and space are the biggest problems faced by small and medium scale industries, to solve this problem computer aided plant layouts like auto lay 2010, corelap, and craft are used. The layouts, which of existing and modified are compared and decided which of them enhanced productivity.

Performance and efficiency of SME's can be enhanced by redesigning the existing layout. In plants where cell formation is not possible, CRAFT can be used to replace the existing departments with facilities and layout of plant with departments for SME's. (Khan, et al., 2013)

Here Da-wei ZHOU et.al [9] says, manufacturing units and plants (traditional ones) generally struggle to keep up with the growing demand of the output not in terms of production but the transportation and the handling of the produced part or job. There is a delay in inspections, transportation etc. and also there is a big problem of waste material handling or in layman terms scrap. The process layout optimisation helped in tackling these problems leading to increasing overall efficiency of the plant and cost reduction in daily process.

This optimisation process is fairly easy to apply. It can be used for small and medium sized plants which focus on specific sector or specific job as the processes are less and it takes less time to optimise the processes. This method can reduce plan cycle of production or in other words reduce the time taken for raw material to come on the production line and leave as dispatch. This ultimately leads to reduction in cost of handling and improvement in efficiency of overall process. (ZHOU, et al., 2014)

Charles Chikwendu et.al [10] cycle time is an important factor to calculate and optimize in addition to number of cycles. Different simulation softwares can be used to increase productivity. The optimization results can be shown on graphs which are easy to read and understand. The results show that there should be an in increase in number of machines and change in the order of work done. When the optimization was done the result came out to be 37.5% that too without addition of new machines but only changing and optimizing the product process flow which is commendable. (Charles Chikwendu Okpala, 2016)

Yash Chauhan et.al [11] investigated different type of lean manufacturing tools in order to optimize the plant layout. Similarly, the methodology used in this paper is to study the existing operation process chart, activity relationship chart and flow of material. On the other hand, SLP was implemented for improving the manufacturing process and developments in the production rates. After charting out of the new plant layout, there was an increase in the production efficiency by 50% due to appropriate use of material handling and elimination of reversing of material flow. (pal, et al., 2017)

Mr. S. B. Naik [12] focused the research on implementation of lean manufacturing tools on the new layout. Graphical form was finalised for representing lean tool utilisation in small and medium enterprises. Control methods such as VSM, 5S, 6 Sigma, Kaizen, visual workplace, Just In time and Poka yoke were applied for the study of the survey. (Naik, et al., 2018)

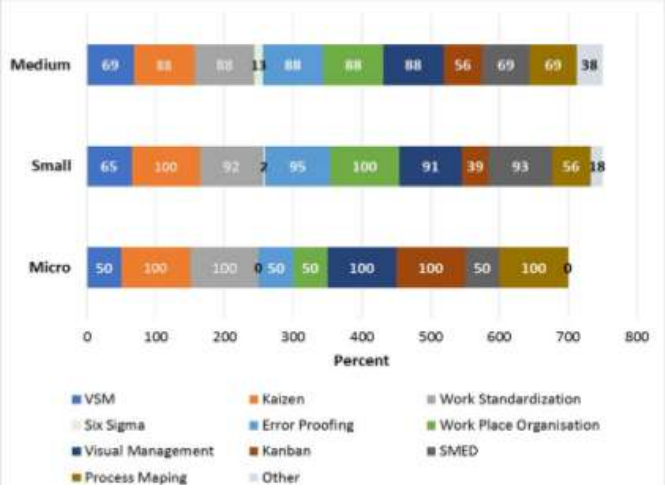


Figure 5 : Graphical representation of lean tools survey [12]

Gaurav Goel et.al [13] used Microsoft Visio to change the complete process layout. The study focused on defying time consumption and optimizing shop floor layouts. The increase in productivity was observed by 17% due to elimination of issues such as difficulty in accommodation of moulds, unavailability of work machines etc. (Goyal, et al., 2019)

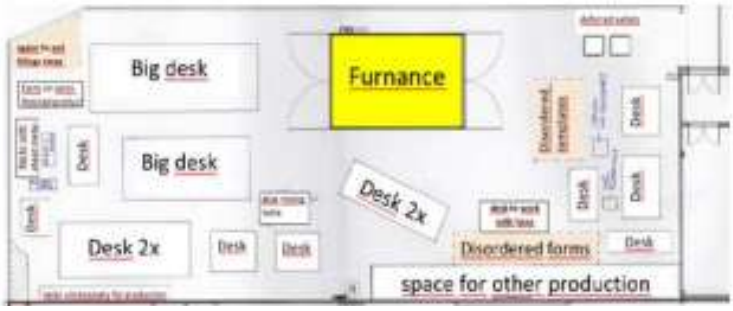


Figure 6 : Original Plant layout [13]

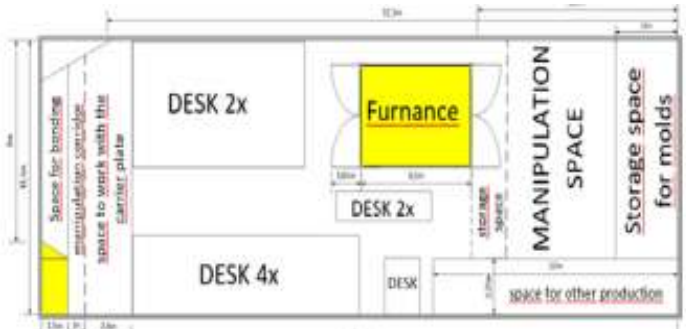


Figure 7 : Modified plant layout [13]

Harshrajsinh. B. Kher et.al [14] brought about 38% of increase in productivity by cutting down unused area by about 14%. He practiced the phenomenon that when a rope is tugged, knotted or coiled to take a form, it affects the entire length. Similar parameters will be observed when a small deformity will affect the complete production line. Methods such as Spaghetti Diagram, SLP were used for planning layout. (Kher, et al., 2018)

Study of production line

Jia Zhenyuan et.al [15] worked on increasing production rate and overall efficiency of the machines by implementing Lean manufacturing methods. For easy understanding the paper was divided into four parts- preliminary design phase, layout design phase, modelling and simulation phase. Design and functional model of the plant was based on analysis carried out at respective parts. A production line mildly based on lean production concept and computer simulation technology for optimum design layout. (Zhenyuan, et al., 2011)

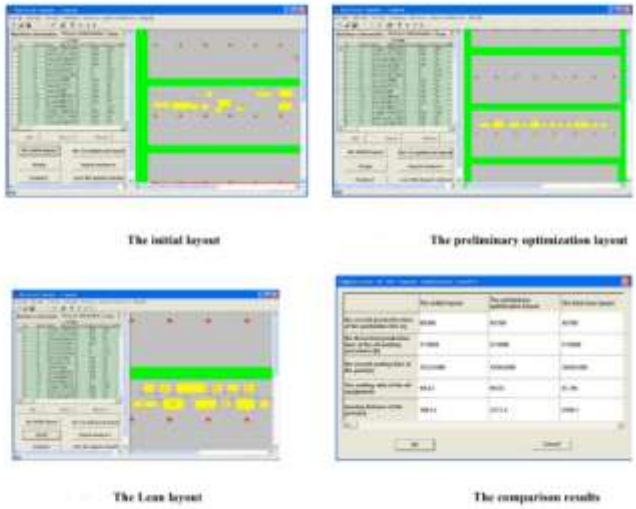


Figure 8 : Different layouts shown [15]

Study of manufacturing line

Filippo De Carlo et.al [16] observed that optimization of the process layout based on investigation through graphical methods was difficult and didn't give the expected output. Hence, the use of simulation software's was implemented for better analysis of production time and material handling. Use of lean manufacturing methods for profoundly implemented. (Carlo, et al., 2013)

	Throughput time [%]	Workers moving time [%]	Orders fulfilled per year [#/y]	Yearly revenue [€/y]
Empirical	- 2.95%	+ 8%	-0.25	-500
SLP	- 3.9%	- 15%	+1.8	+3,600
Lean	- 4.15%	- 24%	+3	+6,000

The layouts' production performance. The table shows the production efficiency performance of each layout tested in comparison to the actual layout's performance.

Figure 9 : Production efficiency [16]

Study of facility layout

Md. Riyad Hossain et.al [17] observed that rearranging the elements (machines) improves material flow, cost cutting and travelling distance which eventually results in increase in production. Methodologies like flow of materials, activity relationships, space requirements and space available, relationship diagram were considered for optimizing the current layout. (Hossain, et al., 2014)

Vaibhav Nyati et.al [18] stated about 80-90% was observed by implementing intelligent shop floor management control using FlexSim. He has presented analytical methods and simulation techniques for the access of a maintenance unit. The key points observed in this paper are plant layout, importance of plant layout, factors affecting plant layout and simulating techniques. (Nyati, et al., 2017)

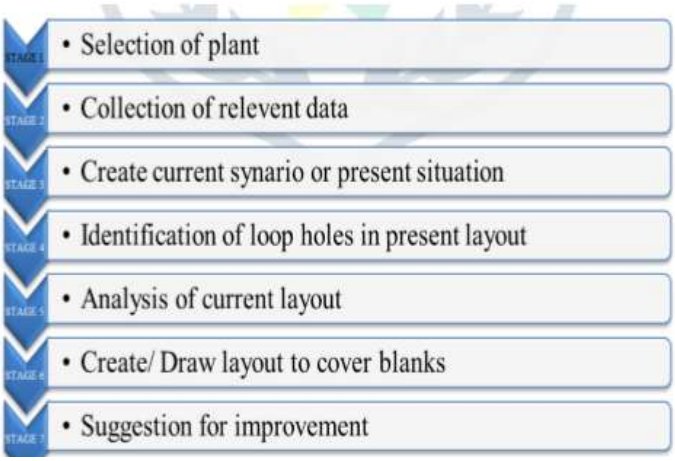


Figure 10 : Methodology steps for implementing new plant layout [18]

Weibo Ren et.al [19] used optimization methods such as ALDEP, CORELAP to be used to design a new layout. He stated that minimizing the distance travelled by workers and improving the existing layout can be carried out by using CRAFT. The paper represented tools for optimizing layout, special tools for specific departments as well as study of all processes. (Ren, et al., 2019)

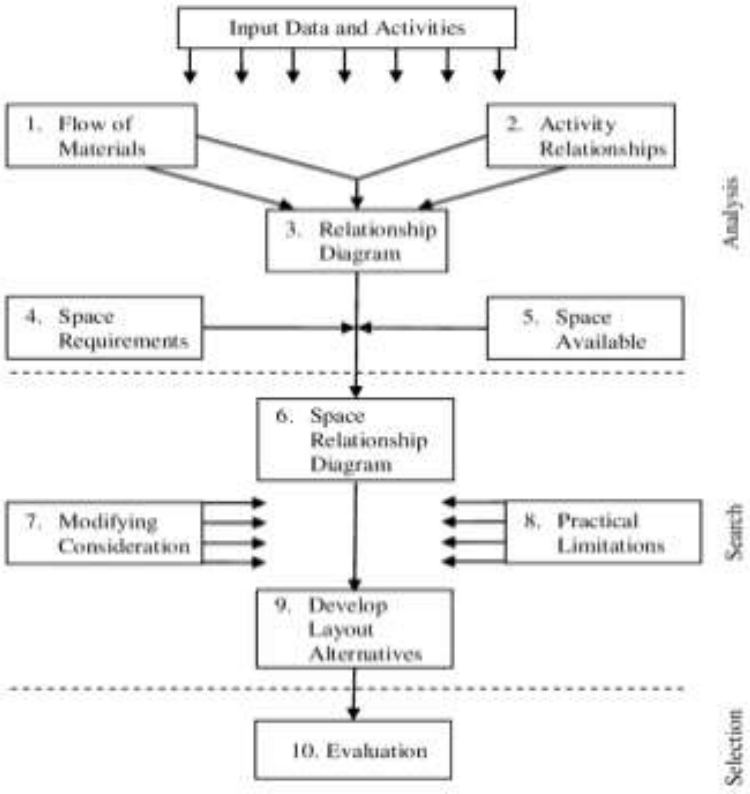


Figure 11 : Systematic layout planning procedure [19]

Layout planning

Manivel Muralidaran V et.al [20] studied specifically about lathe and winding operation and methods to optimize their process lines and operational structure. The utilization of all the parameters is given in the Fig. and analysing it gave results of improvement by 96.63% in the Assembly section. Optimization for the current layout was necessary in order to increase productivity, smooth workflow, minimum material handling and less waiting time for the operations. ARENA software was used for planning of the layout. (V, et al., 2014)

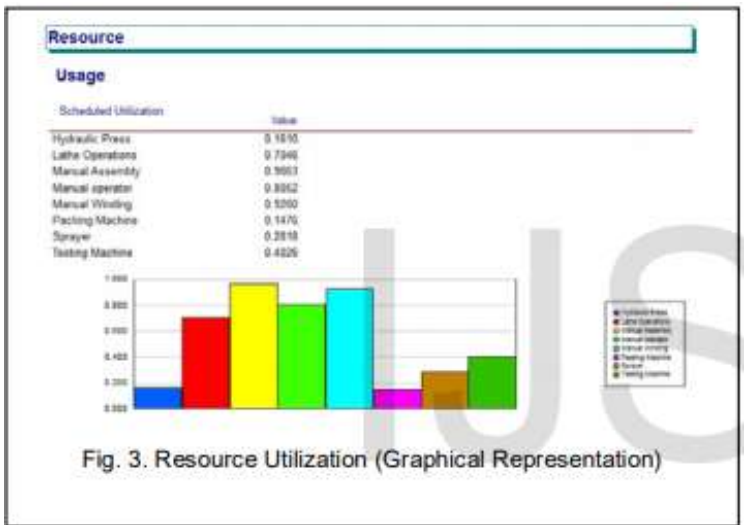


Figure 12 : Resource utilization (Graphical representation) [20]

Plant location and plant layout

Vikas Dave et.al [21] stated that the whole study revolved around the analysis of men, machine and material relation. The study started with investigation and comparison of many layouts based on the parameters optimum material handling, safety of the workers and more productivity. Most primary objective observed in most layouts is minimal travel of workers in between the machines, but it is not necessary that it could be applied for every other industry. Instead of focusing on minimizing the total distance travelled, one can focus on reduction in travel of the material. Simultaneously, adapting to issues such as feasibility of changing the layout as well as congestion in a specific area of the industry. (Dave, 2015)

Study of production process

N S B VENUGOPAL [22] implements use of Overall equipment effectiveness (OEE) and Total Quality Management to increase the productivity of a small-scale industry. Considering minute observations such as cleaning the machines before starting and after working, shifting inventory room near the industry to eliminate the fatigue and excess cost of transportation, providing appropriate training to the workers can lead to eventual increments in the productivity rate. The paper concludes that overall productivity can be increased by combining the operations, reducing number of machines and worker's fatigue. (Venugopal, 2015)

Pavel Viskup et.al [23] brought about changes in the production line layout and the overall process cycle by using Delmia Quest Simulation. Increase in the rate of productivity was about 19% according to the observations made while comparing the previous and modified plant layout. (Viskup, et al., 2019)

Study of assembly line

Parminder Singh et.al [24] studied distance matrix and flow matrix to calculate the overall layout cost. The distance matrix is obtained by converting the layout diagram into STEP File format which is taken as input to java program and output is obtained as distance matrix. The layout cost of the industry is reduced by shifting the machines from their original position to an appropriate position according to the optimum process sequence obtained through the matrices. CRAFT and RPW methodology was implemented for optimization of the plant layout. (Kumar, et al., 2016)

Study of production layout

W.M.K. Sajidah et.al [25] stated that the best arrangement of industrial production layout should be developed to increase production efficiency and to avoid the bottleneck problem. The time study methodology is implemented in this paper by considering the time required for a well-trained worker to complete the manufacturing of a specific product. Similarly, on the obtained studies FOL simulation model is presented. The paper also focuses on use of lean manufacturing methods in order to eliminate excess material consumption. (Kadir, et al., 2015)

Study of process layout

David Bennett [26] used FOL simulation model in order to present the time study based on the overall time required by an efficient worker for completing a manufacturing process of a particular product. Lean manufacturing methods were used in order to increase the productivity of the industry by eliminating or reducing the wastage of every parameter involved in the production process. (Bennett, 2015)

Vimal Kumar et.al [27] used relationship charts to achieve the secondary objective "closeness" in between the machines to find an efficient way of implementing the appropriate method. The paper also focuses on theoretical information about process layout, simulation software's used for designing a layout and advantages and disadvantages of a process layout. (Kumar, et al., 2016)

I Siregar et.al [28] stated that planning and scheduling is an efficient way to increase production. An algorithm based on optimization of assembly module is also proposed which can provide the manufacturer a basic structure for efficient planning of an industry layout. Theoretical study of manufacturing optimization using lean manufacturing methods, Total Quality Management, Kaizen and 6 Sigma is also included in the paper. (Siregar, et al., 2019)

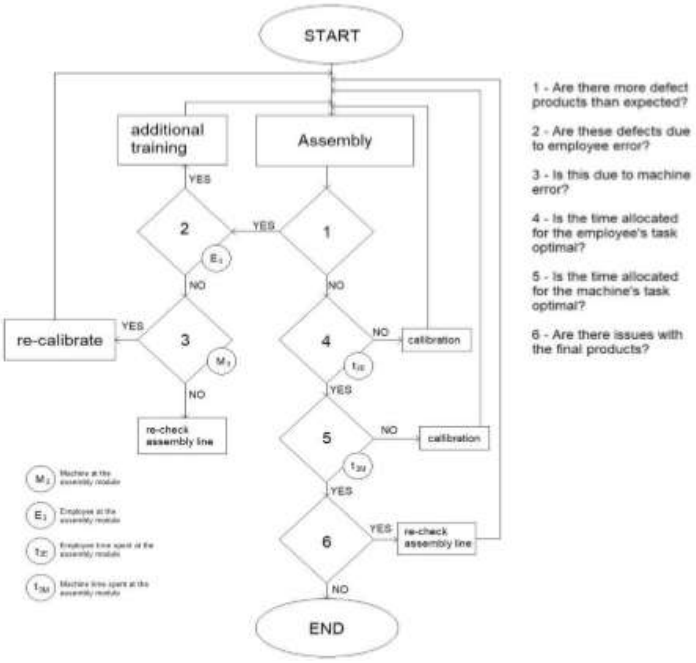


Figure 13 : Algorithm for optimization [28]

Study of systematic layout planning

Syed Asad Ali Naqvi et.al [29] implemented the use of Systematic layout planning in the modified plant layout. Pictorial as well as graphical representations are used for the ease of understanding depleting rates of productivity. Advantages and disadvantages of the functional plant layout are also mentioned in the project. Similarly, optimization methods such as PQRST analysis, flow of material analysis, activity relationship analysis were studied to increase the efficiency of the plant layout. Modifications were imposed on the structure of SLP as its primitive use represented to be very slow and time-consuming. (Naqvi, et al., 2016)

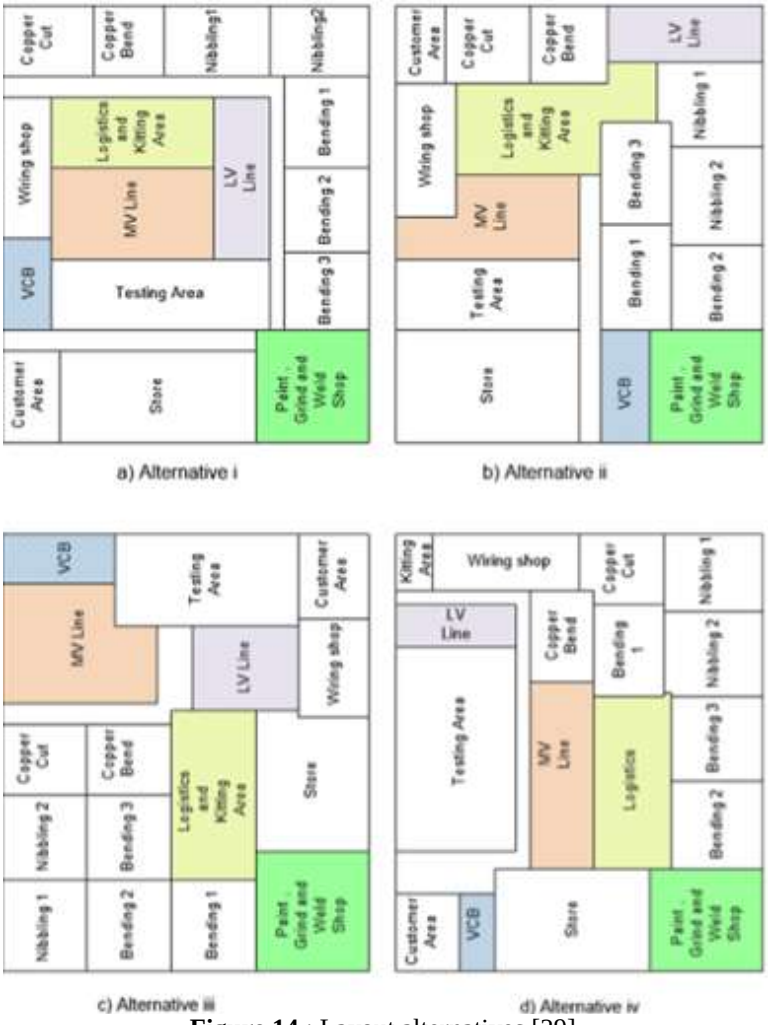


Figure 14 : Layout alternatives [29]

Study of lean principles

Surabhi Hathwar P et.al [30] used graphical representation for time analysis between existing and modified layout. The proposed efficiency through study of FlexSim simulation software and graphical study of the calculations was about 90.71%. The practical implementation of the modified parameters let to reduction of efficiency to about 85.71% but the difference in time was from 265 to 280 respectively which is pretty appreciable. The paper focuses on reduction of the time required to maintain the locomotive services. (V, et al., 2017)

Optimization of process layout

Suyash Sugandhi et.al [31] included the use of Value stream mapping (VSM) and 5S methodology in the modified manufacturing process. Use of lean manufacturing techniques was implemented in order to reduce the cycle time and identification of the non-value activities curbing the further developments in the process. 5S technique was used to implement selective inventory control approach and redesigning of the storage area. (Sugandhi, et al., 2017)

Study of utilization of tool

Arvind Kumar Shrimali et.al [32] studied distance between various machine groups and the time required to carry out the same operations and used pie charts to represent the similar study. Simulation techniques such as CORELAP, CRAFT and ALDEP were used. (Kumar, et al., 2016)

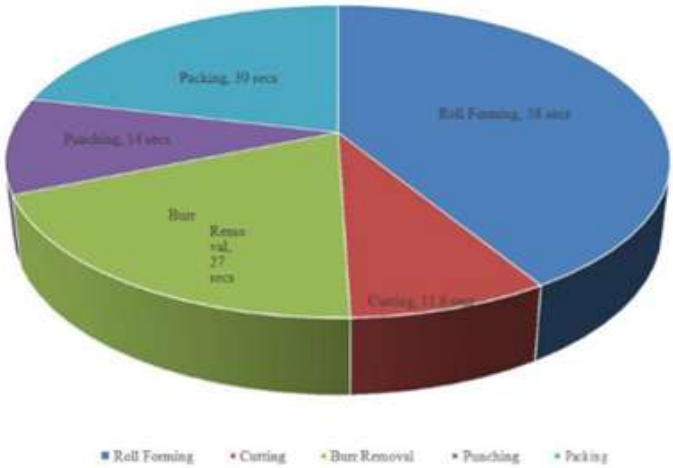


Figure 15 : Production timing for 3 meter channel [32]

Study of manufacturing optimization

Mihalj Bakator et.al [33] proposed three modified layouts in which each of the layout was based on different aspectual data. Focused on use of SLP to establish relationship between different activities along with data collection and analysis and finally implementing the required alternatives and filtering down the structure of modified layout. (Ćoćkalo, et al., 2018)

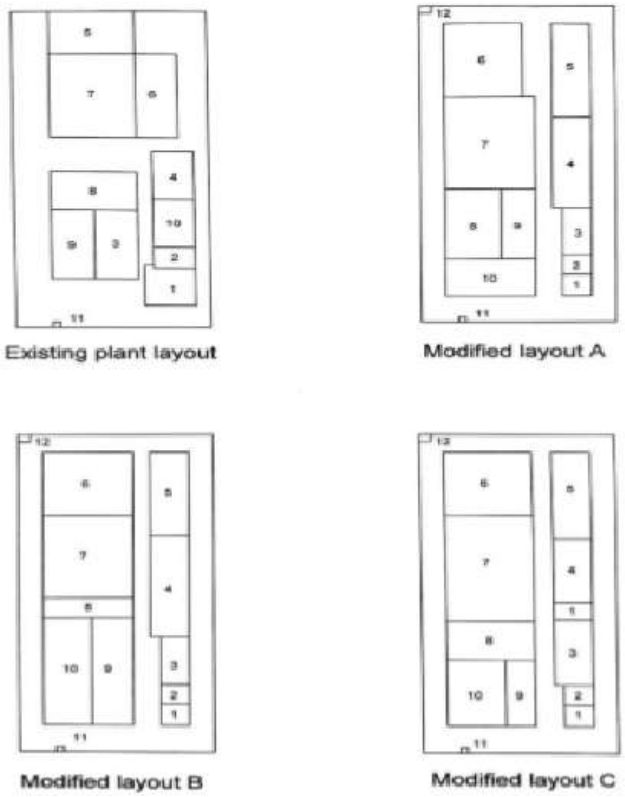


Figure 16 : Modified and existing layout [33]

III. CONCLUSIONS:

- The study of the research papers acquainted about the parameters which could be considered in the procedure of optimization of plant and process layout.
- The primary goal of the review paper was resolved as different types of plant layouts and their feasibility rate was calculated during the research.
- Numerous simulation software's were observed and were further categorized along their compatible criteria's for their optimum operation.

- Filtering down the combination of the parameters was carried out in order to acquire the optimum structure of the processes and layouts.
- Various methods of graphical and pictorial distribution were observed based on their results obtained.

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