A PROJECT REPORT

ON

"OPTIMIZATION OF PLANT LAYOUT"

Submitted by

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In partial fulfillment for the award of the Degree

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ABSTRACT

The objective of this thesis is to improve the production floor layout of a manufacturing firm using systematic layout planning (SLP) and to evaluate the proposed alternative layouts. This project is conducted at Otoklin Global Business Ltd., a filter Manufacturing company located in at Sakinaka near Chandivali junction. The major problem faced by the company is poor utilization of space, poor material handling and safety hazards. There is high flow intensity between departments which have high interrelationship. This leads to high travelling time and high travelling cost which in turns decreases overall productivity of the company. An alternative layout is proposed using the 11 steps in Systematic Layout Planning, which is a systematic way of generating layout alternatives. The proposed layout involves transferring the departments which have high interrelationship close to each other. The proposed alternative layout is evaluated later. The layout is chosen based on the performance measures which have the most significant improvement, which are total travel distance, total travel time, output, average resource utilization, total average WIP level, total average waiting time and total time spent in manufacturing certain product either job order or in batches. The proposed layout results in smooth material flow, efficient utilization of floor area and increased in the area which can be used for producing more products simultaneously.

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CHAPTER NO. 1

INTRODUCTION

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INTRODUCTION

1.1 Background of the problem

In the 21st century business world, companies are exposed to continuous challenges. One of it is to equip organizations with the ability to compete in a global marketplace. Schonberger states that "world class performance is dedicated to serving the customer". Thus, to keep track of performance, organizations must develop measures of performance. The current trend in the industry, which is experiencing very competitive era like many others is striving hard to reduce manufacturing costs, improve quality and customer satisfaction.

Materials handling equipment and the facilities it operates can contribute to as much as 70 percent of the total cost of the manufactured product. Facilities layout design is part of facilities planning. It is the arrangement of work space which, in general terms smoothest way to access facilities that have strong interactions. The main concern with the plant facility layout planning is to reduce the cost of materials handling as poor materials handling can generate business problems. As Sims (Industrial Engineering May 1990) states "The best material handling is no handling". Subsequently, a good layout will enable the manufacture of the product economically in the required volume and variety. Other objectives can be stated as effective utilization of manpower, space and infrastructure, as well as providing overall wellbeing and morale of the worker.

Today s manufacturing industry is facing problems that have been growing and complexity over the last several years. As a result, there is an immediate need for procedures or techniques in solving various problems encountered in today's manufacturing arena without extended shutdown's or expensive modifications (Clark,1996).

Based on the above facts, it is obvious that layout optimization is crucial to any facility planning and layout study. If not tackled in the early phases, it can generate logistics implications for the company involved.

1.2 Statement of the problem

Otoklin global business ltd, is a filter manufacturing company located at Sakinaka near Chandivali junction. The products are manufactured by going through various processes. The plant suffers from poor utilization of workspace, poor material handling and safety hazards. Also, placement of raw materials hinders manufacturing process. Processes which have high interdependency are not located close to each other. This causes high travelling time for the operator.

In response to the above problems, the need for facilities layout optimization is essential to achieve the manufacturing goals of the company. This thesis proposes to use Systematic Layout Planning (SLP) as the infrastructure for layout optimization. The factory performance improvements are in terms of cycle time reduction, productivity increase, reduction in travelling cost and reduction in travelling distance.

Fig.1.1. Poor utilization of space

Fig.1.2. Poor placement of In-process inventory

1.3 Objective

i. To study the current flow pattern and relation of overall plant layout.
ii. To develop a new plant layout.
iii. To propose an appropriate material storage system.

1.4 Scope

In this thesis, the case study is limited to production floor area of Otoklin Global Business Ltd. This work focuses on improving the facilities design of the production floor. The layout of the production is process oriented layout. The Systematic Layout Planning (SLP) methodology will be utilized in this case study as part of the strategy to portrait the relationship between each department to generate improved layout alternatives.

1.5 Significance of Study

An approach from Muther (1973), Systematic Layout Planning (SLP) is used as the improvement method. It uses a graphical representation and builds up a proximity matrix which represents the closeness of each facility. Flowcharts can also be developed showing quantitative relationships. From the above proximity matrix, a trial and error process can be used to generate the layout.

This case study which focuses on manufacturing activities in the filter industry can also be easily applied with minimal modification in other types of facilities such as offices where workflow processes may be present. Thus, the model described possesses a general applicability in other domains that can be achieved through mapping of equivalent governing parameters to those that have been identified in the manufacturing sector.

1.6 Conclusion

In the beginning of this chapter, an overview of the facilities layout planning and its importance to existing companies is written to further enhance the importance for using it as the main principle for this project. The objectives are also defined to be linked to the deliverables in this case study. The boundary of this project is also defined based on the statement of problem. Some justifications of conducting this case study and its importance is also discussed.

CHAPTER NO. 2

LITERATURE REVIEW

CHAPTER NO. 2
LITERATURE REVIEW

2.1 Introduction

In this chapter, an overview of Facilities Layout Planning, types of layout, Systematic Planning methodology and simulation will be discussed. This will give a brief overview on the tools and techniques used for this case study.

2.2 Plant Layout

Plant layout planning includes decisions regarding the physical allocation of the economic activity centres in a facility. An economic activity centre is any entity occupying space. The plant layout process starts at an aggregate level, taking into account the different departments. As soon as the details are analysed, different issues arise and the original configuration maybe changed through a feedback 13 process. Most layouts are designed properly for the initial conditions of the business, although as long as the company grows and has adapted to internal and external changes, a re-layout is necessary. Symptoms that allow us to detect the need for a re-layout:

- Congestion and bad utilization of space.
- Excessive stock in process at the facility
- Long distances in the work flow process
- Simultaneous bottle necks and workstations with idle time
- Qualified workers carrying out too many simple operations
- Labour anxiety and discomfort.
- Accidents at the facility.
- Difficulty in controlling operations and personnel.

2.3 Facility Layout Planning

A facility layout is an arrangement of everything needed for production of goods or delivery of services. A facility is an entity that facilitates the performance of any job. It may be a machine tool, a work centre, a manufacturing cell, a machine shop, a department, a warehouse, etc. (Heragu,1997). It means planning for the locations of all machines, utilities, employee workstations, customer service areas, material storage area, aisles, restrooms, lunchrooms, internal walls, offices and computer rooms. This is for the flow patterns of materials and people around, into and within buildings. The layout design generally depends on the products variety and the production volumes. Four types of organization are referred to, namely fixed product layout, process layout, product layout and cellular layout (Dilworth, 1996)

2.3.1 Objectives of Facility Layout Planning

The main objective consists of organizing equipment and working areas in the most efficient way, and at the same time satisfactory and safe for the personnel doing the work.

- Product design and Volume (Product strategy)
- Process equipment and capacity (process strategy)
- Quality of work life (human resource strategy)
- Building and site constraints (location strategy)

These main objectives are reached through the attainment of the following facts:

- Congestion reduction.
- Elimination of unnecessary occupied areas.
- Reduction of administrative and indirect work.
- Improvement on control and supervision.
- Better adjustment to changing conditions.
- Better utilization of the workforce, equipment and services.
- Reduction of material handling activities and stock in process.
- Reduction on parts and quality risks.
- Reduction on health risks and increase on worker safety.
- Moral and worker satisfaction increase.
- Reduction on delays and manufacturing time, as well as increase in production capacity.

All these factors will not be reached simultaneously, so the best solution will be a balance among them.

2.3.2 Factor Affecting Facilities Layout Planning

The final solution for a Plant Layout has to take into account a balance among the characteristics and considerations of all factors affecting plant layout, in order to get the maximum advantages.

The factors affecting plant layout can be grouped into 5 main categories:

- Materials
- Machinery
- Labour
- Material Handling
- Waiting Time

2.3.2.1 Material

The layout of the productive equipment will depend on the characteristics of the product to be managed at the facility, as well as the different parts and materials to work on. Main factors to be considered: size, shape, volume, weight, and the physical-chemical characteristics, since they influence the manufacturing methods and storage and material handling processes. The sequence and order of the operations will affect plant layout as well, taking into account the variety and quantity to produce.

2.3.2.2 Machinery

Having information about the processes, machinery, tools and necessary equipment, as well as their use and requirements is essential to design a correct layout. The methods and time studies to improve the processes are closely linked to 16 the plant layout. Regarding machinery, the type, total available for each type, as well as type and quantity of tools and equipment has to be considered. It is essential as well to know about space required, shape, height, weight, quantity and type of workers required, risks for the personnel, requirements of auxiliary services, etc.

2.3.2.3 Labour

Labour has to be organized in the production process (direct labour, supervision and auxiliary services). Environment considerations: employee's safety, light conditions, ventilation, temperature, noise, etc. Process considerations: personnel qualifications, flexibility, number of workers required at a given time as well as the type of work to be performed by them.

2.3.2.4 Material Handling

Material handling does not add value to the product; it is just waste. Objective: Minimize material handling as well as combining with other operations when possible, eliminating unnecessary and costly movements.

2.3.2.5 Waiting Time

Objective: Continuous Material Flow through the facility, avoiding the cost of waiting time and demurrages that happen when the flow stops. On the other hand, the material waiting to flow through the facility not always represents a cost to avoid. As stock sometimes provides safety to protect production, improving customer service, allowing more economic batches, etc. It is necessary then to consider space for the required stock at the facility when designing the layout. Resting time to cool down or heating up.

2.3.3 Importance of plant layout

Plant layout can be varied and can significantly impact the overall effectiveness of production systems. Since 1955, approximately 8 percent of the gross national product (GNP) has been spent annually on new facilities, and it is generally accepted that effective facilities planning can reduce material handling cost by at least 10 to 30 percent (Tompkins et al, 1996). The magnitude of the investment in the new facilities each year renders the criticality to the plant layout generations function. The main objectives of the plant layout function are to enable the manufacture of the product economically in the required volume and variety. Other objectives can be stated as effective utilization of manpower, space and infrastructure, as well as providing for the overall wellbeing and morale of the worker.

2.4 Traditional types of facilities layout

Traditionally 4 types of layout are considered appropriate for a manufacturing facility:

- Process (Job Shop)
- Layout Product (Flow Shop)
- Layout Fixed Position
- Group technology Layout

2.4.1 Process (Job Shop) Layout

In the job shop layout, machines are grouped according to function to machine centres. Orders for individual products are routed through the various machine centres to obtain the required processing. Designed to facilitate processing items or providing services that present a variety of processing requirements. The layout includes departments or other functional groupings in which similar kinds of activities are performed. This type of plant layout is useful when the production process is organized in batches. Personnel and equipment to perform the same function are allocated in the same area. The different items have to move from one area to another one, according to the sequence of operations previously established. The variety of products will lead to diversity of flows through the facility. Variations in the production volumes from one period to the next one (short period of

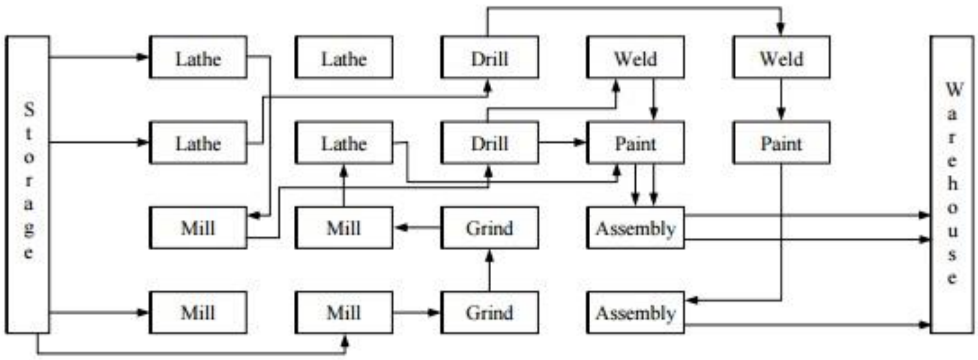


Figure 2.1: Process Layout

time) may lead to modifications in the manufactured quantities as well as the types of products to be produced.

Diagram of process layout is shown in Figure 2.1

2.4.1.1 Advantages of Process Layout

- A high degree of flexibility exists relative to equipment or manpower allocation for specific tasks.
- Smaller investment in equipment as duplication is not necessary unless volume is large.
- The diversity of tasks offers a more interesting and satisfying occupation for the operator.
- Supervisors for each department become highly, knowledgeable about their functions.
- Better utilization of machines can result in fewer machines used.

2.4.1.2 Disadvantages of Process Layout

- Lack of process efficiency as back tracking and long movements may occur in the handling of materials.
- Lack of efficiency in timing as workers must wait between tasks
- Complications of production planning and control
- Workers must have broad skills and must be paid higher wages than assembly line workers.
- Comparatively large amounts of in process inventory as space and capital are tied up by work in process.
- Lowered productivity as each job requires different setups and operator training.

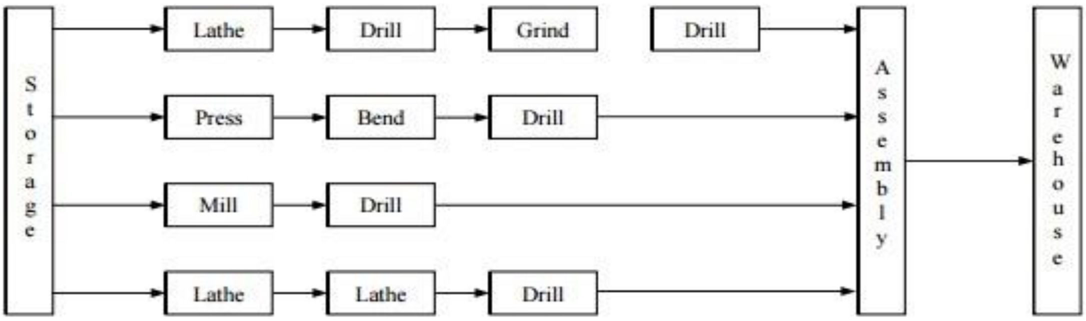
2.4.2 Product (Flow Shop) Layout

Here the product (or products) follows a fixed path through the production resources. The resources are arranged to minimize the material movement. This type of plant layout is useful when the production process is organized in a continuous or repetitive way.

- Continuous flow: The correct operations flow is reached through the layout design and equipment and machinery specifications.
- Repetitive flow (assembly line): The correct operations flow will be based in a line balancing exercise, in order to avoid problems generated by bottle necks.

The plant layout will be based in allocating a machine as close as possible to the next one in line, in the correct sequence to manufacture the product. A job is divided into a series of standardized tasks, permitting specialization of both labour and equipment. Because of the high volume of production, the machines on the line can be designed with a high level of fixed automation, with very little manual labour. Operations are arranged in the sequence required to make the product.

Diagram of Product Layout is shown in Figure 2.2



2.4.2.1 Advantages of Product Layout

- Since the layout corresponds to the sequence of operations, smooth and logical flow lines result.
- Since the work from one process is fed directly into the next, small in-process inventories result.
- Total production time per unit is short.
- Since the machines are located so as to minimize distances between consecutive operations, material handling is reduced.
- Simple production planning control systems are possible.
- Less space is occupied by work in transit and for temporary storage

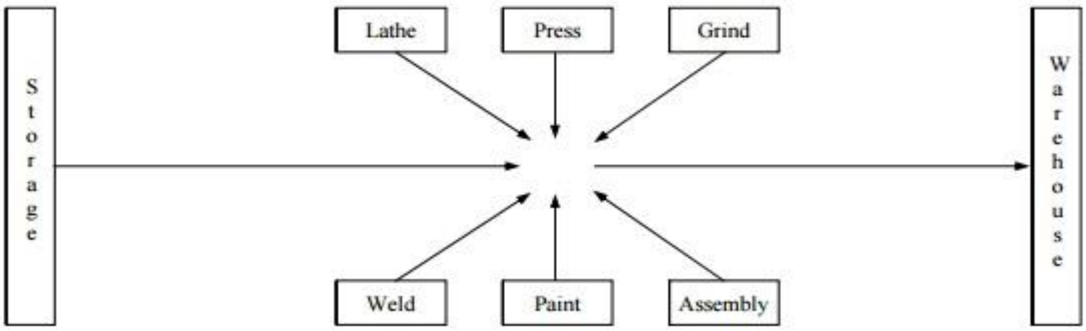
2.4.2.2 Disadvantages of Product Layout

- A breakdown of one machine or absence of enough operators to staff all work stations may stop the entire line.
- Lack of process flexibility, since the layout is determined by the product, a change in product design may require major alternations in the layout.
- Lack of flexibility in timing, as the product cannot flow through the line faster than the slowest task can be accomplished unless that task is performed at several stations.
- Supervision is general, rather than specialized.
- Worker fatigue as workers may become bored by the endless repetition of simple tasks.

2.4.3 Fixed Position Layout

For tasks on large objects such as the manufacture of an electrical generator, the construction of a building, or the repair of a large airplane, the machines implementing the operation must come to the product, rather than the product moving to the machine. In fixed position layouts, the item being worked on remains stationary and workers, materials and equipment are moved as needed. Fixed positions layouts are used in large construction projects (buildings, power plants and dams), shipbuilding and production of large aircraft and space mission rockets. Fixed position is widely used for farming, firefighting, road building, home building, remodelling and repair and drilling for oil.

Diagram of Fixed Position Layout is shown in Figure 2.3



2.4.3.1 Advantages of Fixed Position Layout

- Material movement is reduced, minimizes damage or cost of moving.
- Promotes job enlargement by allowing individuals or teams to perform the whole job.
- Continuity of operations and responsibility results from team. This reduces the problems of re-planning and instructing people each time a new type of activity is to begin.
- Highly flexible; can accommodate changes in product design, product mix, and product volume.
- Independence of production centres allowing scheduling to achieve minimum total production time.

2.4.3.2 Disadvantages of Fixed Position Layout

- Increased movement of personnel and equipment may be expensive.

- The necessary combination of skills may be difficult to find and high pay levels may be necessary.
- Equipment duplication may occur. Higher skill requirements for personnel as they are involved in more operations.
- General supervision required.
- Cumbersome and costly positioning of material and machinery.
- Low equipment utilization as equipment may be left at a location where it will be needed again in a few days rather than moved to another location where it would be productive.

2.4.4 Group Technology Layout / Cellular Layout

Definition of Group Technology

Group technology us the technique of identifying and bringing together related or similar parts in a production process in order to utilize the inherent economy of flow production methods. V.B Solaja, 24 Institute of Machine Tools, Belgrade, Yugoslavia. Group technology is also called cellular layout. Cellular layout is a type of layout in which machines are grouped into what is referred to as a cell. Groupings are determined by the operations needed to perform work for a set of similar items or part families that require similar processing. It is the physical division of the manufacturing facilities into production cells. Each cell is designed to produce a part family. A part family is a set of parts that require similar machinery, tooling, machine operations and jig or fixtures. The parts within the family normally go from raw material to finished parts within a single cell.

Diagram of Group Technology Layout is shown in Figure 2.4

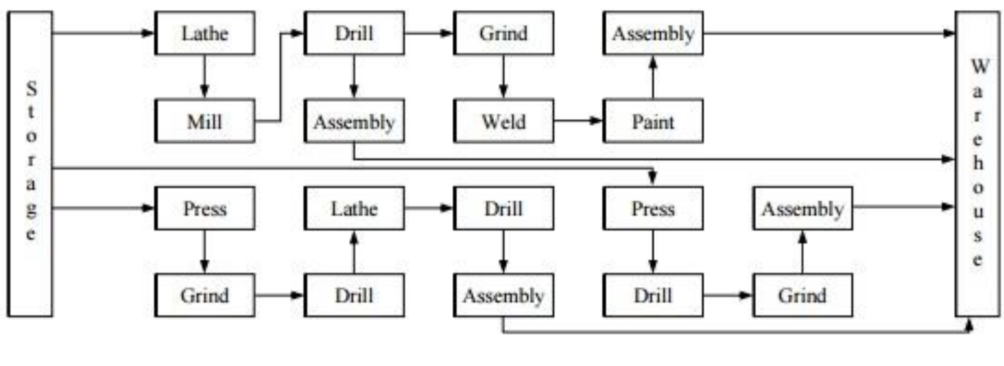


Figure 2.4: Group Technology Layout

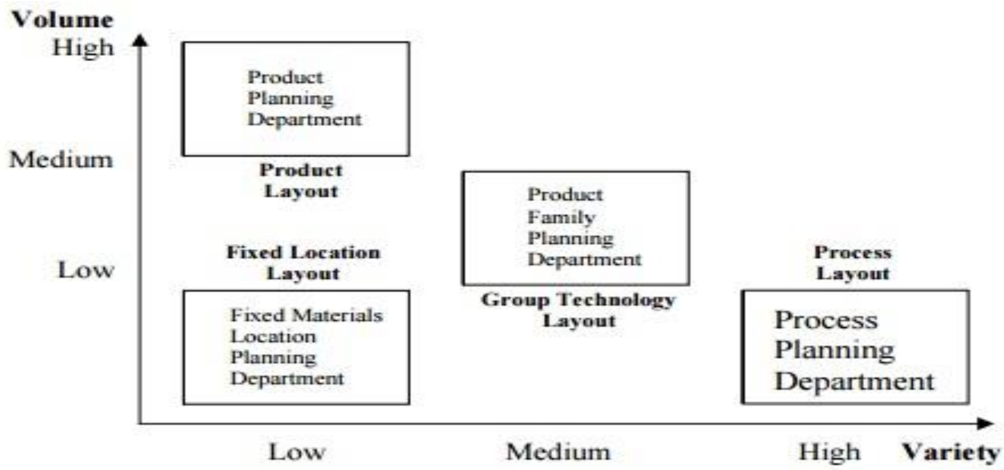
2.4.4.1 Advantages of Cellular Layout

- Reduced material handling
- Reduced set up time
- Reduced tooling
- Reduced in process inventory
- Increase operator expertise
- Supports the use of general purpose equipment

2.4.4.2 Disadvantages of Cellular Layout

- General supervision required.
- Higher skills level required of employees than for product layout.
- Reduced shop flexibility
- Lower machine utilization than for process layout
- Extended job flow times.

Types of layout in relations to volume and product variety are shown in Figure 2.5



2.5 Review of literature survey

2.5.1 Improvement in plant layout using systematic layout planning (SLP) for increased productivity. (Pramod P. Shewal, Manmath S. Shete, Prof. DR. S. M. Sane)

The objective of this research is to study plant layout of compressor manufacturing based on the systematic layout planning pattern theory (SLP) for increased productivity. In this case study, amount of equipment and tools in compressor production are studied. The detailed study of the plant layout such as operation process chart, flow of material and activity relationship chart has been investigated. The new plant layout has been designed and compared with the present plant layout. The SLP method showed that new plant layout significantly decrease the distance of material flow from stores until dispatch.

According to the analysis of the workflow, it was found that the distance from the moving out of the stores to machining, assembly and to keeping at dispatch was 320 m., reduced to 143 m or reduced by 176 m. As for the c-shaft in the new plant layout, the distance for moving materials is 82 m, reduced from 106 m. or reduced by 24 m. As for the flywheel in the new plant layout, the distance for moving materials is 67 m, reduced from 172 m. or reduced by 105 m. Finally, rearrange layout decreased flow of material, resulting in reduction in waste and increased production

2.5.2 Improvement in Layout Design using SLP of a small size manufacturing unit: A case study (Chandra Shekhar Tak, Mr.Lalit Yadav)

The paper presents an application of the SLP (System Layout Planning) method for establishing, in an efficient manner, the layout of a productive enterprise. A case study is described in the paper, referring to a factory designated for manufacturing steel almirah. The phases of the SLP method application are described in the paper together with the presentation of one particular product given as example. The optimal solution of the productive system's layout is selected by analysing three possible identified alternatives.

The paper presents an application of the SLP (System Layout Planning) method for establishing, in an efficient manner, the layout of a productive enterprise. A case study is described in the paper, referring to a factory designated for manufacturing steel almirah. The phases of the SLP method application are described in the paper, together with the presentation of one particular products given as example. The optimal solution of the productive system's layout is selected by analysing three possible identified alternatives. The case study of SLP at this company illustrate that small and medium firms can successfully layout and re-layout their facilities with this easy to use technique. The results arrived from SLP does not completely satisfy all but it clearly shows why decisions are made. This study shows that SLP process was as valuable as the final layout.

2.5.3 Optimization of Plant Layout Using SLP Method (Shubham Barnwal, Prasad Dharmadhikari)

In this paper, ongoing engine reconditioning process layout of an automobile industry are studied and a new layout is developed based on the systematic layout planning pattern theory to reduce engine reconditioning cost and increase productivity Since it is an automobile assembly plant, the company has both processes as well as product layouts. The number of equipment and travelling area of material in engine reconditioning have been analysed. 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. The new plant layout shows that the 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 the engine reconditioning unit of the corporation.

The proposed model based on SLP is found to be effective in solving the above-mentioned problems. The production rate increased by 28%, the production time per bus came down by 3.34% and total distance travelled by material came down by 14%. In this paper per unit cost and distance are considered to improve existing layout but there are many other parameters to analyse the layout that may be worker number, the area required, equipment required. Due to Lack of opportunity and practical limitations above two parameters are used in our calculation. 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 our 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 of the engine reconditioning unit of MSRTC.

2.5.4 Facility Planning for a Gas Manufacturing Plant (Chui Wing Cheong & Chu Lap Keung)

This case study is regarding facilities planning carried out in a manufacturing plant, named Hong Kong Oxygen. Oxygen supply in tanks is the main products of this company.

Plant relocation is needed due to new town planning scheme, by the Hong Kong government. The new town ship will be a residential area replacing the area of this plant. Some of the objectives of this relocation are also better safety could be achieved in the new plant; considerable profit could be derived by re-developing the existing piece of land into a residential and commercial area. There are 3 locations whereby the company needs to select the lowest transportation cost among 3 locations to minimize delivery cost. After the selection of the strategic location, Systematic Layout Planning is used to develop block plans based on the data input, activity relationship diagrams, activity relationships charts. The best solution is this case study utilized computer aided planning (CORELAP), which is a construction type of layout program, to generate layout alternatives, to generate a new layout from the activity relationship diagram, space requirements and shape. The best layout is selected based on the most favorable compromise among a list of competing criteria. The layout alternative which has the highest score of competing criteria is selected. Results are relocation of new plant to new location, Tseung Kwan, which has minimum transportation cost. The best layout selected has the most compromising among the competing criteria in terms of economy of material handling, safety, ease of supervision, room for expansion, flow of material and convenience. The limitations however, are it did not publish the quantitative improvements as it only uses the ratings. No actual data of performance measures indicators. The reader will not have a clear idea on the improvements before and after re-layout.

2.6 Conclusions

In this chapter, the literature review of facilities planning and types of layout is discussed. Apart from that, some review on previous trends of layout improvement methodology is reported, followed by systematic planning layout (SLP) methodology.

From the review of the literature indicated in the above section, it can be concluded that there have been numerous research activities in the area of layout design. There also have been a number of algorithms developed. Existing literature for a layout design problem often fall unto two major categories as algorithmic and procedural approaches Algorithmic approaches usually simplify both design constraints and objectives in order to reach a surrogate objective function which solution can then be obtained (Peters and Yang 1997; Cardarelli and Pelagagge,1995; Geiger et al,1997). These approaches usually involve quantitative input data. Their design solutions are easier to be evaluated by comparing their objectives functions.

The output from algorithmic approaches often need further modifications in order to satisfy detailed design requirements such as departmental shapes, utilities supply, material handling system, ergonomics concerns, work in process storage, space utilization, etc. Advance training in mathematical modelling techniques are often pre-requisites for a designer to use algorithmic approaches. Accordingly, many companies hesitate to adopt algorithmic approaches as their design methodologies.

Procedural approaches can incorporate both qualitative and quantitative objectives in the design process (Padilli et al,1997; Apple ,1997; Muther 1973) For these approaches, the design process is divided into several steps that are then solved sequentially. The success of a procedural approach implementation is dependent on the generation of quality design alternatives that are often from the output of an experienced designer.

Systematic Layout Planning (SLP) is a procedural layout design approach. The process involved in performing SLP is relatively straight forward; however, it is a proven tool in providing layout design guidelines in practice in the past few decades. This case study proposes to use Muther's systematic layout planning (SLP) (Muther 1973) as the infrastructure to solve an electronic layout problem.

CHAPTER NO. 3

COMPANY BACKGROUND

CHAPTER NO. 3

COMPANY BACKGROUND

3.1. Introduction - OTOKLIN GLOBAL BUSINESS LTD.

Established in the year 2004, Otoklin Global Business Ltd. is widely reckoned amongst the foremost manufacturers and exporters of a finest quality assortment of Self Cleaning Filter, Back flushing Filter, Automatic Valve-Less Gravity Filter, Tee and Y Strainers, Automatic Back Flushing Strainer, Basket Strainer, Bag Filter, Horizontal Vacuum Belt Filters, Water Treatment Plant and much more. Their offered products are broadly known and demanded for the features such as easy installation, safe usage, longer working life, precise design, high efficiency, ruggedness and hassle free performance. The highest qualities of raw material and cutting-edge techniques have been utilized in the manufacturing process to ensure the quality. Raw material has been procured from some of the genuine vendors of the market.

In accordance with the industry laid standards, they had built a sophisticated infrastructure, which assists them to accomplish all possible necessities of esteemed customers. To ensure hassle free manufacturing process, they had divided their infrastructure in different departments. With the aid of our competent crew of professionals, they had been able to achieve the set targets of the firm. Before the final delivery, the whole product range is gone through quality check process, which is conducted on several parameters of industry standards. In order to maximize the satisfaction level of their patrons, they provide the complete range of products as per their detailed specifications.

3.2. Range of Products

fig. 3.1.
BACKFLUSHING FILTERS

fig. 3.2. AUTOMATIC VALVELESS GRAVITY FILTER

fig. 3.3 TEE AND Y STRAINERS

Section 1.01 **fig. 3.4. AUTOMATIC BACK-FLUSHING STRAINER**

fig. 3.5. PUSHER SELF CLEANING FILTER

fig. 3.6. BASKET STRAINERS

fig. 3.7. CARTRIDGE FILTER

fig. 3.8. ZERO LIQUID DISCHARGE WATER TREATMENT PLANT

3.3. General information

Having profound knowledge in the respective domain, they are occupied in providing superior quality assortment of products. Our prompt delivery, ethical business practices, customized solutions and competitive prices makes us highly esteemed business name in the industry. Moreover, to accomplish bulk orders of our customers, our dedicated professionals are working in sync with them. Some other factors of our firm are:

- Industrious professionals
- International quality standards
- Customer-oriented approach
- Industry leading prices
- Ethical business practices

3.4. Major market

- Jordan
- Qater
- Saudi

3.5. Plant Layout of company

The fig. shows the dimensional layout of the industry. In this the constraints areas are clearly mentioned.

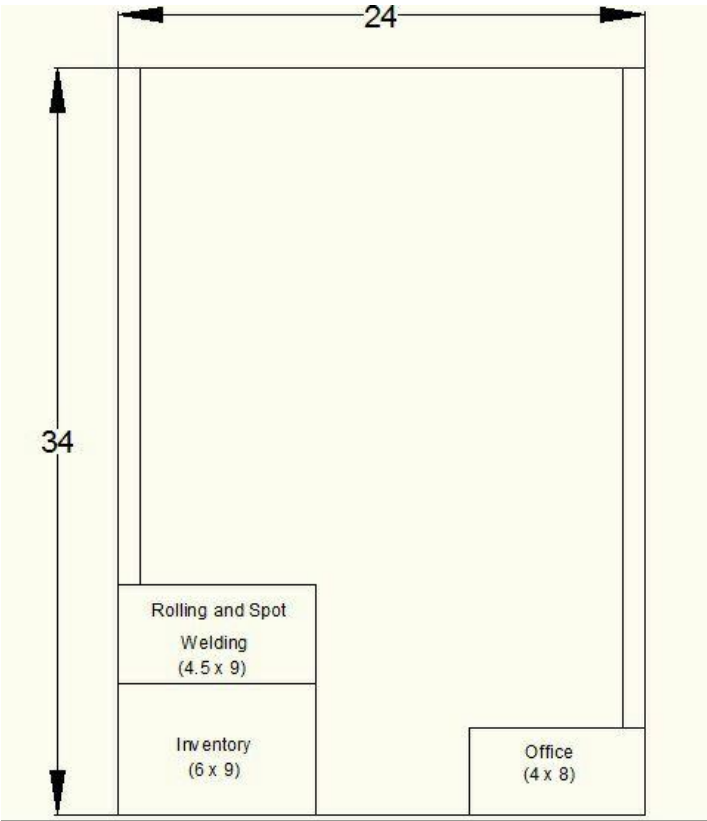


FIG. 3.9. DIMENSIONAL LAYOUT OF THE PLANT (IN METRES)

3.6. Conclusion

The. background of the case study company is briefly discussed in this chapter. This covers the products, factory layout and product manufacturing process. The subsequent chapter will discuss on the problems face by this company.

CHAPTER NO. 4

PROBLEM IDENTIFICATION

CHAPTER NO. 4

PROBLEM IDENTIFICATION

4.1. Introduction

This chapter discusses about the identification of area where facilities layout planning is to be implemented. Process flow diagram and from-to-chart will be used to determine relations between various departments.

4.2. Flow of material

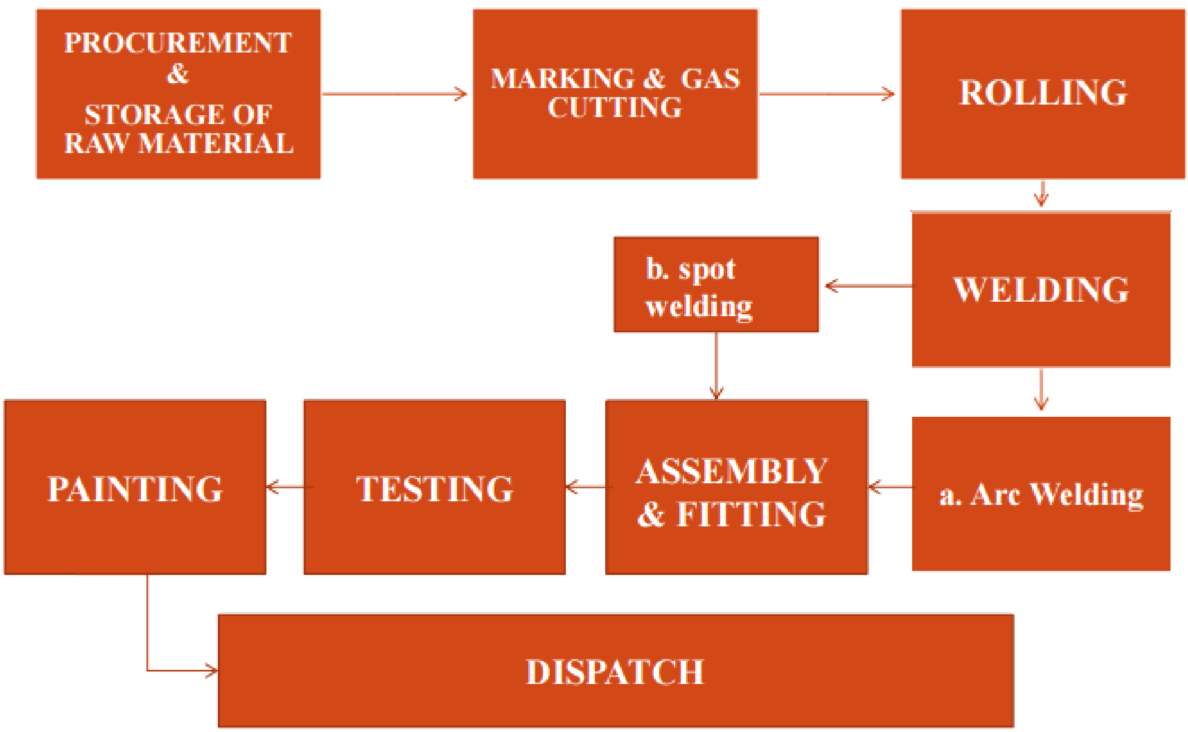


Fig. 4.1. FLOW OF MATERIAL

4.3. From-To-Chart

The From-To-Chart is a popular tool for material flow analysis. It represents the flow intensity between each process. The more the flow intensity, the more important the relationship between each process.

From the chart, we can see that cutting, fabrication and assembly have the highest flow intensity due to both products also shares the same process as shown in the chart.

Painting and testing has lesser flow intensity as there is only one product for each of the process.

Dept.	Storage	Machining	Rolling	Fabricate	Fitting	W.I.P.	Testing	Painting	Dispatch	Office	Inventory	Scrap
Storage		A	O	U	U	U	U	U	U	U	U	X
Machining			I	A	U	U	U	U	X	U	I	I
Rolling				I	U	U	U	U	U	----	----	U
Fabricate					I	I	U	I	U	X	I	U
Fitting						A	A	O	U	U	E	U
W.I.P.							A	I	U	U	U	U
Testing								I	U	X	O	U
Painting									A	X	E	U
Dispatch										U	U	U
Office											----	X
Inventory												U
Scrap												

Table 4.1. FROM-TO-CHART

Based on the rule of thumb for closeness ratings, ‘A’ represents absolutely necessary relationship and cannot be more than 5 % of the relationships. ‘E’ represents especially important relationship and cannot be more than 10% of the relationships. ‘I’ represents important relationship and cannot be more than 15% of the relationships. ‘O’ represents ordinary relationship and cannot be more than 20% of the relationships. ‘U’ represents unimportant relationship and consists about 50% of the relationships. Lastly, ‘X’ represents undesirable relationship and consists of not more than 5% of the relationships.

4.4 Conclusions

From the analysis, From-To-Chart, it is obvious that the layout of the products is a major contribution to the high cost and the high cross-over quantity. This is further justified by the from-to- chart where significant flow intensity occurs within processes which are currently located far apart.

We conclude the following problems in the company:

- Improper utilization of workspace area.

Fig. 4.2. IMPROPER UTILIZATION OF WORKSPACE AREA.

- Poor placement of machining equipment.

Fig. 4.3. POOR PLACEMENT OF MACHINING EQUIPMENT.

- Problems in material handling causing unnecessary increase in production time and cost.

Fig. 4.4. POOR MATERIAL HANDLING.

- Several injuries of labours due to improper precautionary measures.

Therefore, in the following chapter, systematic layout planning will be used as a methodology to define, analyse and synthesize the current problem faced by the company.

CHAPTER NO. 5

SYSTEMATIC LAYOUT PLANNING

CHAPTER NO. 5

SYSTEMATIC LAYOUT PLANNING

5.1. Introduction

In this chapter, the Systematic Layout Planning methodology is analysed in detail for different layout alternatives generations. Basically, the SLP methodology literature has a total of 11 steps. First is input data, followed by flow of materials, activity relationships, relationship diagram, space requirements, space available, space relationship diagram, modifying constraints, practical limitation, developing layout alternatives and lastly evaluation.

However, in this chapter only the first 10 steps will be discussed as evaluation will be discussed in Chapter 6.

5.2. Systematic Layout Planning

In 1973, Richard Muther proposed the Systematic Layout Planning (SLP) method that formalizes the whole layout process as a pattern of procedures through which each layout project passes. The design of process is being treated stepwise starting from the generation of alternatives, evaluation, selection and implementation. It has been widely used since its introduction which has proven to work well in many situations. Overall there are 11 stages required to complete an SLP.

1. Gather input data

2. Identify flow of material/information

3. Identify relationships between activities and resources.

4. Create a string diagram.

5. Determine space requirements

6. Quantify space availability

7. Create a space relationship diagram

8. Identify modifying considerations

9. Apply practical limitation

10. Developing layout alternatives

11. Evaluation of final design

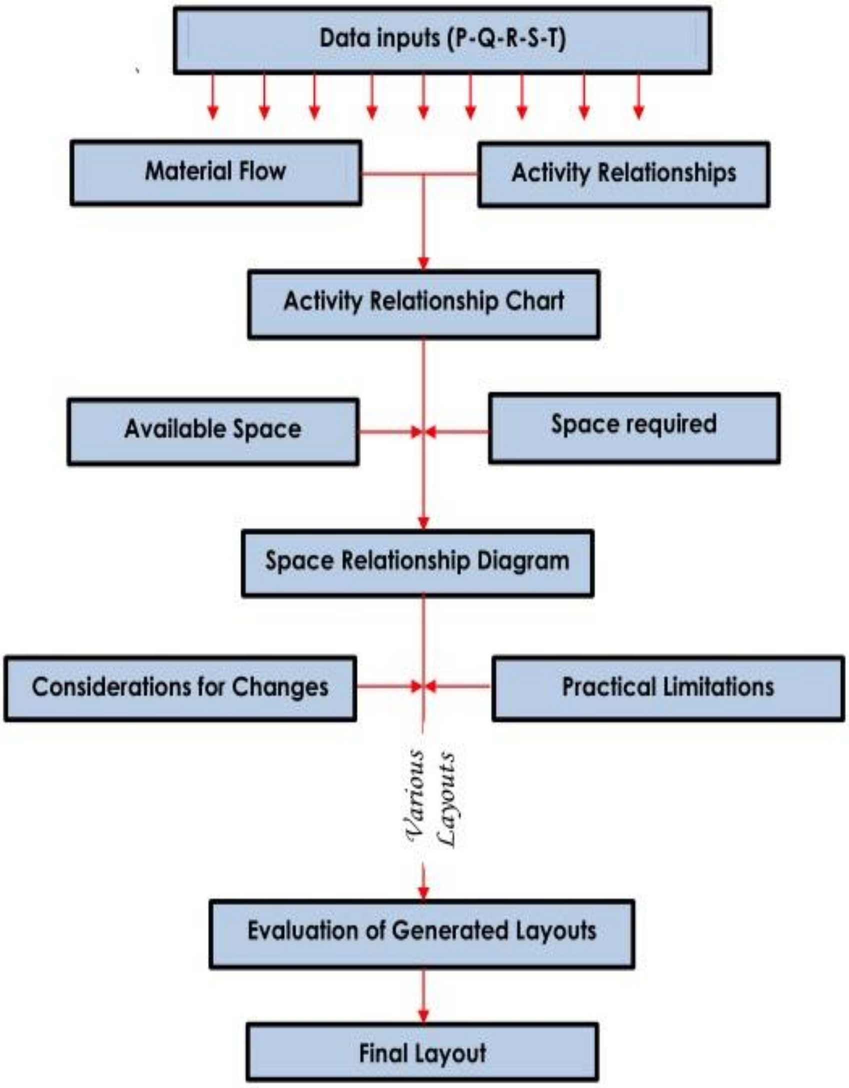


Fig. 5.1. PROCEDURE OF SYSTEMATIC LAYOUT PLANNING

Step 1: Input Data and Activities

The input variables for every SLP and P, Q, R, S and T. P (Product), material or service that will be processed. Q (Quantity), is the volume each item to be processed. R (Routing), is the path an item travels to be processed. S (Services), refers to services required to complete this processing and T (Time), refers to the overall time required to complete processing should be scrutinized in order to assure the validness of the input data at the design stage. This requires gathering and analyzing data required for the project. This must occur before any planning of relationships, space or adjustment. The preliminary data gathering-and analysis step is termed as Input Data & Activities and follows the general sequence found below:

1. Identify specific elements of input data needed as design criteria for the project.
2. Project this data into the future. (This involves restructuring information supplied by others in the organization.)
3. Seek general approval and top management endorsement of the input data
4. Examine the data for distinctive dissimilarities to arrive at a basic layout.
5. Identify and define the activities to be used in subsequent planning.

Step 2: Flow of Materials

Analysis All material flows from the whole production line are aggregated into a from-to-chart that represents the flow intensity among different departments. The analysis of material flow involved determining the most effective sequence of work and material. An effective flow means that the materials move progressively through the process and should always advance without excessive detours. In traditional manufacturing applications, the flow is determined from either the product or the process as shown in Figure 5.2

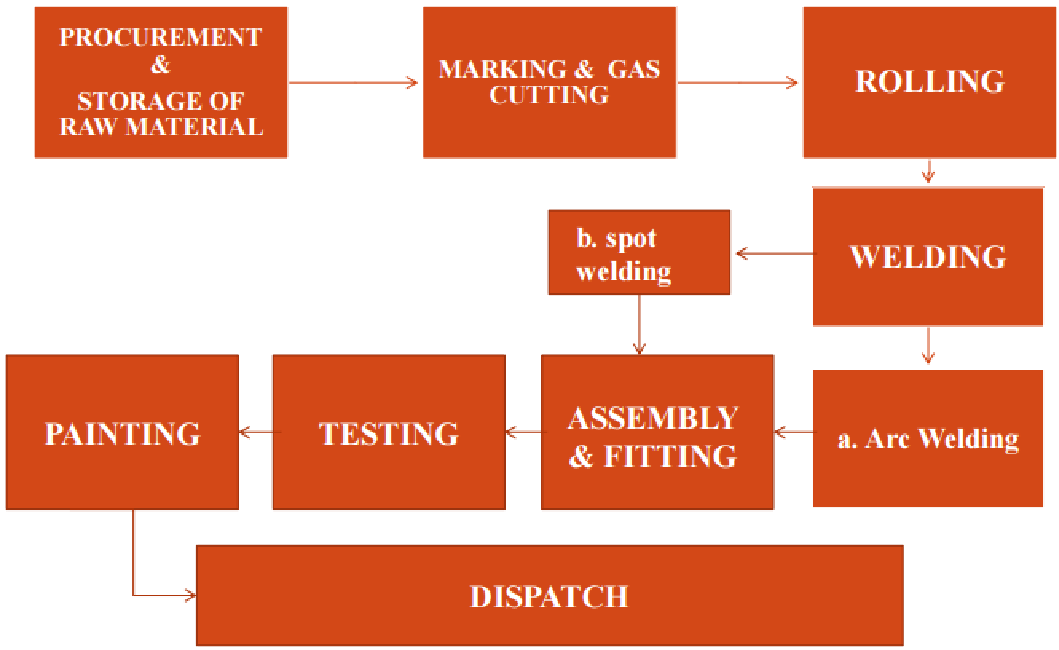


Fig. 5.2. FLOW OF MATERIAL

Step 3: Activity Relationship Diagram

The step of activity relationships performs qualitative analysis towards the closeness relationship decision between activities and resources. The results will be displayed into an activity relationship chart. The relationship chart displays which entities are related to others and it also rates the importance of the closeness between them. These ratings make the relationship chart one of the most effective tools for layout planning and are the best way of planning the arrangement of facilities. The activity relationship chart itself is a record keeping tool to organize data into a usable form. With this data and Activity Relationship Diagram was generated where proximity and relationship are visually evident. The relationship is defined by a closeness rating system:

- ‘A’ meaning that it is absolutely necessary that the activities be next to each other.
- ‘E’ meaning that it is especially necessary that the activities be close to each other.
- ‘I’ meaning that it is important the activities be close to each other.
- ‘O’ meaning that ordinary closeness be maintained (meaning that it is only necessary that these activities be in the same facility).
- ‘U’ meaning that it is unimportant the activities be close to each other
- ‘X’ meaning that the activities should not be close to each other.

For each relationship defined, the reasons why a specific closeness ratings were used is also noted.

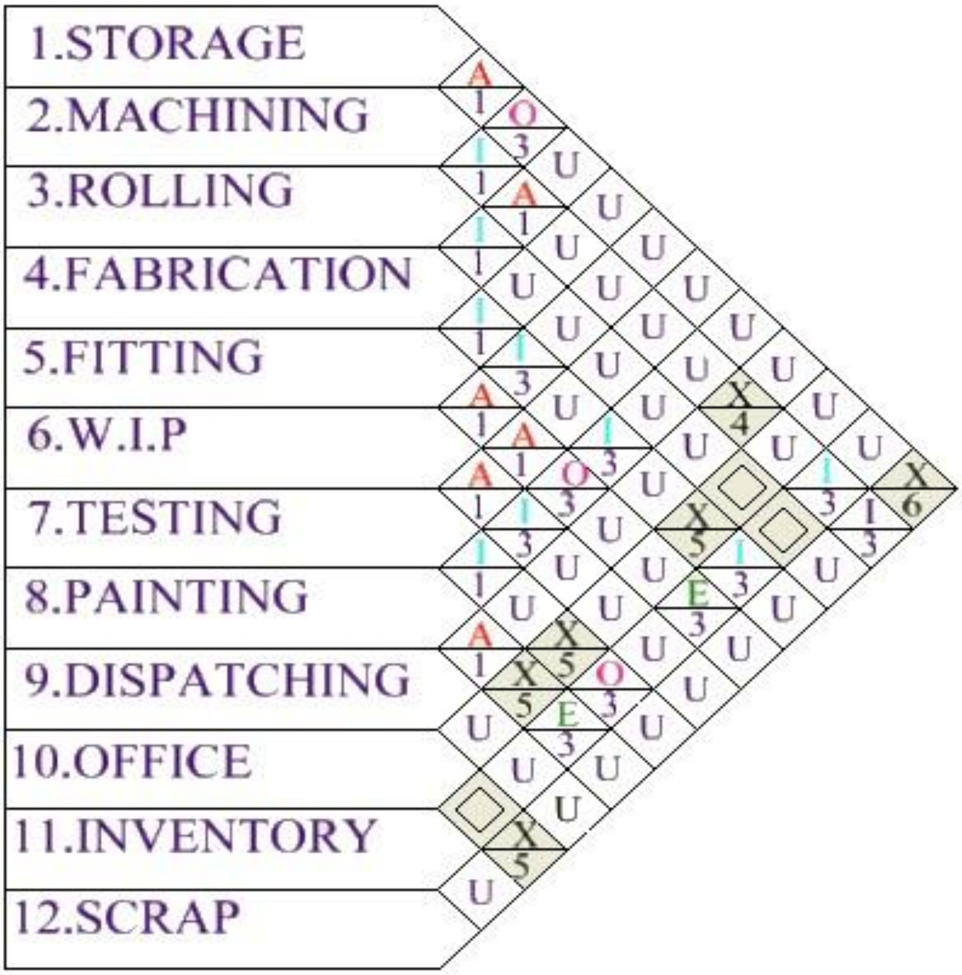


Fig. 5.3. ACTIVITY RELATIONSHIP DIAGRAM

Step 4: Relationship Diagram

This step positions departments spatially. For those departments that have strong interactions and/or closeness relationships are placed in proximity. The activity relationship diagram or string diagram is essentially a visual display of the activity relationship chart. Each entity on the chart is translated to a symbol to be place on the diagram and then lines are connected to show the value of the relationship. The string diagram shows near optimal placement without consideration for space requirements and exposes possible clustering of departments.

Step 5: Space Requirements

Now that relationships have been identified, special requirements must be analyzed and then applied to a spatial relationship diagram. The information to be included in terms of amount of space, equipment and operational improvements for each activity has to be determined as shown in Table 5.1

Sr.No.	Sections	Area (m^2)	Description
1.	Storage (For pipes)	7 x 2	Max. length of pipe=6m; Rack width= 2m.
2.	Machining (Gas Cutting)	7 x 2+7 x 2	Area besides the rack.
3.	Rolling	4.5 x 9	--Constraint--
4.	Fabrication	2.5 x 4.9	Max. product size=0.5 x 0.4 x 0.3; At a time 4 products will be fabricated.
5.	Fitting	3 x 3	Fitting of medium size Elements assembly (1 x 0.5 x1.5)
6.	Temporary Storage (WIP)	5 x 4	For the temporary storage before the product gets finished. (For max. 200 small product).
7.	Testing	2 x 2	One assembly at time.
8.	Painting	3 x 2	10 small products at time.
9.	Dispatch	5 x 5	250 no. of small items, divided in two layers one over other.
10.	Office	4 x 8	--Constraint--
11.	Inventory	6 x 9	--Constraint--
12.	Scrap	4 x 2	Approximated area; As being the rare utilisation area, hence kept behind the painting.

Table 5.1. SPACE REQUIREMENT

Step 6: Space Available

During this step, a square footage is assigned to each activity. The space assigned to each activity is predicated previously in the space requirements step. The total available space at the plant is reviewed. The area is divided at first approach to estimate the space required for each department. When performing the detailed layout, it is required to have more accurate shapes adjusted to the reality. Space requirement should be determined:

- For individual workstations.
- For departmental requirement.
- The total available area of the company is 24 x 34 = 840m^2

Step 7: Space Relationship Diagram

Adds departmental size information into the relationship diagram from step 4. At this point, the space requirements are applied to the space available. The purpose of the space relationship diagram is to combine established spatial constraints with the activity relationship diagram in Figure 5.4.

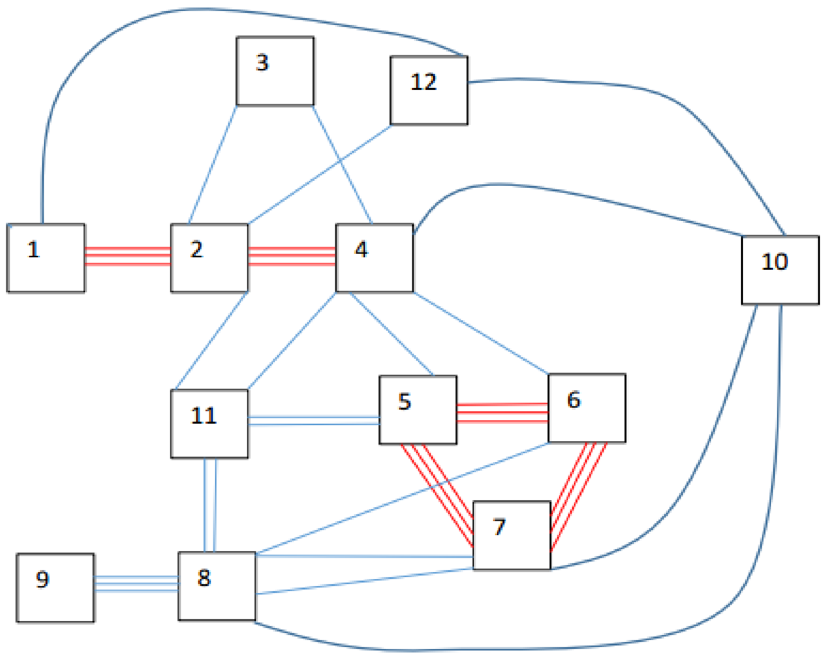


Fig. 5.4. SPACE RELATIONSHIP DIAGRAM

Step 8: Modifying Constraints

These are additional constraints for the department during the initial stages of the new layout design. It is in terms of space requirement or department personnel needs.

Step 9: Practical Limitations

Practical limitations can be in terms of budget or space**.**

Step 10: Develop Layout Alternatives

This step involves development of layout alternative as design candidate. These initial designs were created using the requirements and constraints described before. This is a layout of facility using blocks of space, no details. The block plan is developed by using the space available information and the relationship chart that have been previously developed. With this information, blocks of space are developed and positioned according to their relationships defined in the relationship chart. The pros and cons of each layout are compared as each layout had good traits that are combined into a final block plan layout. Usually these designs are brought to the management for further inputs and comments in Figure 5.5.

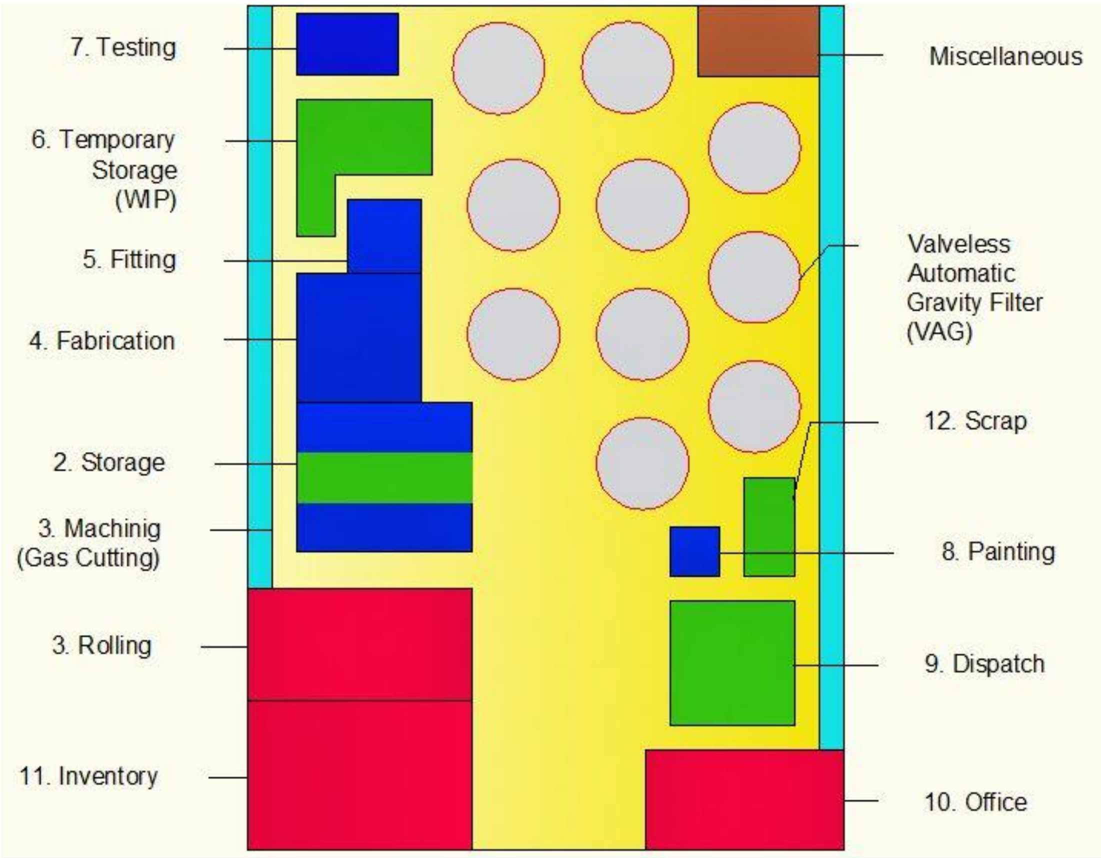


Fig. 5.5. GENERATED PLANT LAYOUT

Step 11: Evaluation

A final block plan layout has been selected, the equipment layout can then be developed. Equipment and machinery layout within each department is presented in the detailed layout.

5.3. Conclusion

In this chapter, the SLP is used as a tool for defining, analysing and synthesizing to generate layout alternative. This alternative will be evaluated using quantitative comparisons will be made in the next chapter.

CHAPTER NO. 6

EVALUTION AND DATA ANALYSIS

CHAPTER NO. 6

EVALUTION AND DATA ANALYSIS

6.1. Introduction

Handling and storing materials involve diverse operations such as hoisting tons of steel with a crane; driving a truck while loading; carrying bags or materials manually; and stacking other materials such as drums, barrels, etc.

The efficient handling and storing of materials are vital to industry. In addition to raw materials, these operations provide a continuous flow of parts and assemblies through the workplace and ensure that materials are available when needed. Unfortunately, the improper handling and storing of materials often result in costly injuries.

In this chapter, we will see installation of material storage system, their overall costing and influence over the space and mainly, the payback period to earn profits due to installation of such systems.

6.2. Problem with current storage of raw materials

Fig.6.1 Current storage of raw materials

When the materials are stored in an improper manner, it results in more space area required to store the materials which adversely affects the total production rate of the plant. Moreover, injuries can result from improperly handling and storing materials, workers should also be aware of accidents that may result from the unsafe or improper handling of equipment as well as from improper work practices. In addition, workers should be able to recognize the methods for eliminating—or at least minimizing—the occurrence of such accidents. Employers and employees should examine their workplaces to detect any unsafe or unhealthful conditions, practices, or equipment and take corrective action.

Other hazards include falling objects, improperly stacked materials, and various types of equipment. You should make your employees aware of potential injuries that can occur when manually moving materials, including the following:

- Strains and sprains from lifting loads improperly or from carrying loads that are either too large or too heavy,
- Fractures and bruises caused by being struck by materials or by being caught in pinch points, and
- Cuts and bruises caused by falling materials that have been improperly stored or by incorrectly cutting ties or other securing devices.

Thus, a proper material storage system can avoid such problems and can effectively utilize the floor area to increase the production rates.

6.3. Proposed alternatives for material storage

6.3.1. Cantilever Rack

Fig.6.2 Cantilever Rack

Cantilever racks are a superior storage solution in many situations. Cantilever racks are:

- **Easier to use:** With no front column in the way, cantilever racks are faster to load and unload, lowering handling time and costs.
- **More flexible:** Loads may be placed anywhere along the entire length of a row on a cantilever rack.
- **More compact:** The lack of a front column saves horizontal space normally lost to rack structure. Handling clearance is also more abundant.
- **More selective:** Any load or storage slot is immediately accessible.
- **More economical:** Both reduced handling times and increased space utilization make cantilever racks more cost-efficient. Additionally, cantilever racks become more economical as load length increases, while standard pallet racks increase in costs.
- **More adaptable:** Cantilever racks can store nearly any type of load. They are especially useful for storing long, bulky, or oddly-shaped loads.

Depending upon the weight to be carried by storage device and to decrease the space, we propose double sided cantilever racking system. Taking a survey through various websites, we found rack according to our dimensions and load carrying capacity on ‘GLOBAL INDUSTRIAL’ which offers various subparts to be assembled.

Overall costing to install such system is explained as follows:

DEPTH	83 inches
HEIGHT	8 feet
CAPACITY	21200 lbs
BRAND	Modern Equipment (MECO)
COMPATIBLE ARM LENGTH	36 inches
CONSTRUCTION	Steel
MANUFACTURER PART NO.	2DU883
MODEL	795632
TYPE	Double Sided Upright

WIDTH	71 inches
BRAND	Modern Equipment (MECO)
CONSTRUCTION	Steel
MANUFACTURER PART NO.	22B72
MODEL	795671
TYPE	Brace Kit for 8’H

LENGTH	36 inches
CAPACITY	3400 lbs
BRAND	Modern Equipment (MECO)
COMPATIBLE ARM LENGTH	36 inches
CONSTRUCTION	Steel
MANUFACTURER PART NO.	XHDSA36L
MODEL	482531
TYPE	Straight arms with lip

Sr no.	Particulars	Qty.	Cost per piece (Rs)	Total cost (Rs)
1	Double Sided Upright	04	20960	83840
2	Brace Kit	06	2845	17070
3	Straight arms with lip	24	3680	88320
				1,89,230/-

Total cost of racks = product cost + shipping cost

= 189230 + 20000

= 2,09,230/- INR

Thus, the total cost of such a racking system is approximately 2,10,000/- INR

6.3.2. Roll-out (space saver) Rack

Fig.6.3 Roll-out (space saver) Rack

Roll-out racks are more expensive than cantilever racks but on the other hand they are more compatible and space saver. Cantilever racks allow you to get stock (like steel, aluminium or iron) into racks and off the floor so you can utilize vertical space, but you'll need more space for forklift aisles. Space Saver racks free up precious floor space for work cells, conveyor lines, staging, or other operations. Like cantilever rack, Space Saver allows easy crane access, but it doesn't have to be forklift-loaded or unloaded, so space-eating aisles are reduced. This increases your storage capacity greatly. Also, when you have forklifts moving constantly to pick stock off racks, time is used that could be spent better elsewhere.

Whenever you handle bar stock, steel, and tubing, safety is always a concern. Because they eliminate the hazard of toppling piles, these racks enhance safety while they regain space. The improved access they provide minimizes man-handling that can lead to strains and injuries. Operating the racks is as easy as turning a crank. Loading or retrieving material from them is no different than if it were on the floor.

Space Saver racks are comprised of a control panel, followed by two or more grids connected with control tubes and bracing, spaced to accommodate a specified length. A grid is the support upright, and houses the roll-out receptacles.

The control panel is located at the front of the rack, and isn't weight-bearing. Receptacles are rolled in and out from the control panel. Control tubes connect to the control panel, and then to a built-in 2.5 to 1 reduction mechanism. Operators utilize a hand crank to move a receptacle outside the rack structure - typically between 8 and 14 turns. A fully-loaded receptacle may require a firm pull to start it moving, but only slight pressure to maintain momentum.

You can convert from one length to another easily with this modular design should your inventory change.

Racks are constructed to withstand the demands of storing steel. Considering the abuse storing heavy steel puts on a rack, they are quite simple with few moving parts or a complicated design, which makes them easy to operate and maintain. Simplicity and toughness make them practically maintenance free because there is little to service or break. Following are the advent of such system:

- Easily crank shelves out for access to bar stock, tubing, pipe, PVC, rebar, and more
- Levels extend to 100% for ease in using a hoist or other overhead equipment
- Manual locking mechanism prevents multiple levels being pulled out at the same time. Helps keep proper weight distribution within the rack framework
- Ergonomic heavy duty storage that saves space, too.

Not many of the manufacturer offers such type of racks, thus, upon the survey we found at “Cisco-eagle” as the most economical and suitable according to our requirement. The specification of this system along with the costing is as discussed below:

Specification:

Overall dimensions	12' 6"L x 62"D x 105-1/2"H
Arms dimensions	12"H x 20"D
No. of levels	4
No. of uprights	2
Capacity	13200 lbs per level
Stock lengths	12’L
Sides	Single Sided

Product cost (cost of roll-out rack) by cisco-eagle = $13,349.07 = 8,95,000 INR approx.

The overall cost of roll-our rack is discussed below:

Total cost = product cost + shipping cost

= 895000 + 35000

= 930,000/- INR

Thus, the total cost of such a racking system is approximately 930,000/- INR

6.4. Generated plant layout (with various dimensions)

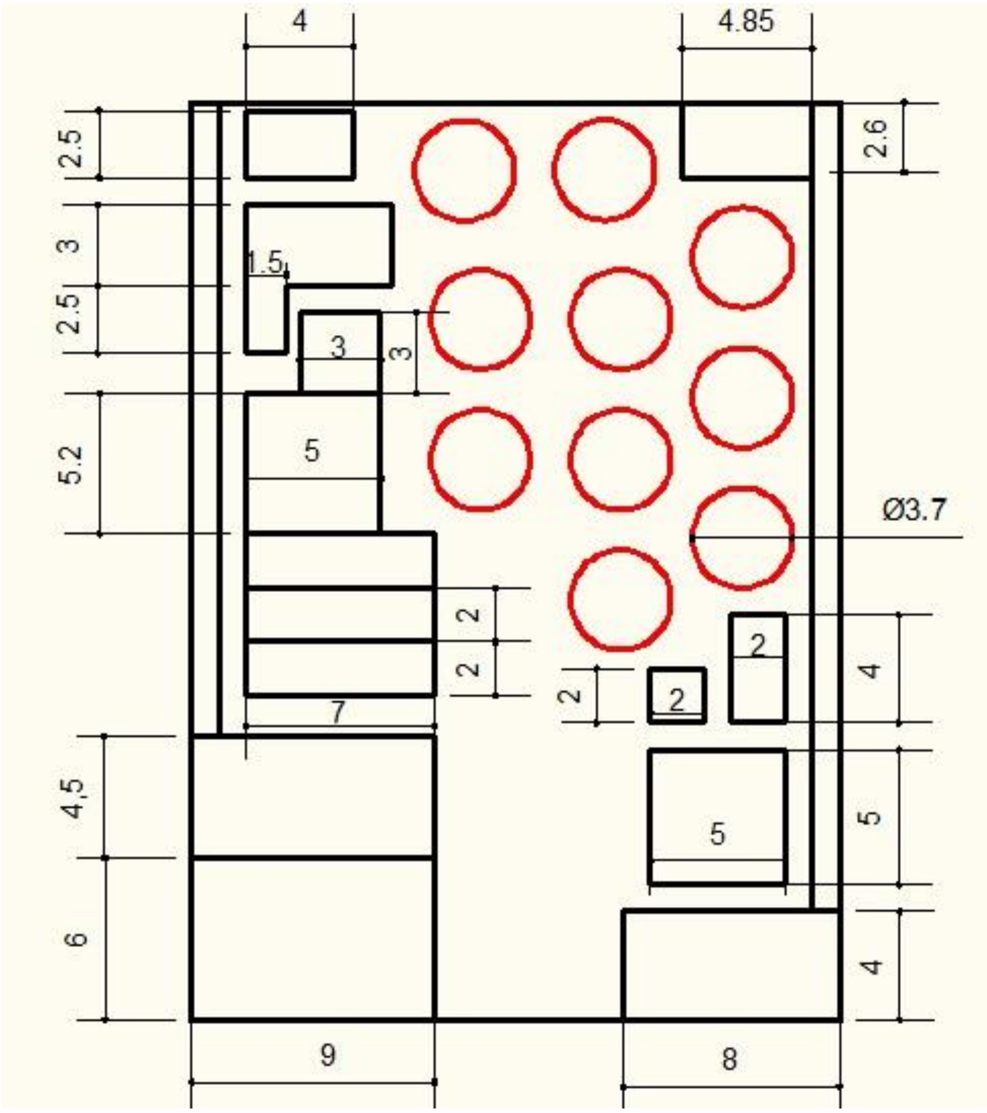


Fig.6.4 Generated plant layout (with various dimensions in meters)

6.5. Evaluation

The above plant layout shows the conclusion of all the studies done for the optimization. The area saved using this type of storage system can be used to increase production rate by increase the batch size and manufacturing more products simultaneously. The monetary advantage is explained as follows:

6.5.1. For large size product:

Current capacity for large size product = 04 VAGs

Total capacity with proposed layout = 05 VAGs

Relative increase in productivity = (Increase in capacity ÷ current capacity) x 100

= 1/4 x 100

= 25%

Mfg. time for a product = 45days

Annual days = 300 working days

Increase in products = 6 products p.a.

Min. cost of product = 10lacs/product

Expectd earnings = 60,00,000 INR

6.5.2. For small size products:

Product of size = 0.5m x 0.4m x 0.3m

Max. no. of products = 250 (duration:60 days)

No. of products mfg. = 4 in a batch.

Thus, requires 63 batches.

With proposed layout,

No. of product expected = 5 in a batch.

Requires 50 batches.

Increase in productivity = (63-50) ÷ 63

=0.2063

=20.63%

No. of product mfg. = 1,250 per annum

Product to be mfg. =1,560 per annum

Min. cost of product =3000rs/product

Expectd earnings **= (1560-1250) x 3000**

= 9,30,000 INR

Total earning **= 60,00,000 + 9,30,000**

= 6,930,000 INR p.a.

The profits calculated are based on the selling price of the individual product. This does not include the material cost, labour cost and other additional costs.

Taking into consideration use of roll-out racks (since they are more expensive), thus, payback period is calculated so on:

Total Cost of roll-out racks = 930,000/- INR

Average earning per month = 6,930,000 ÷ 12

= 577,500/- INR

Pay-back period = 930,000 ÷ 577,500

= 1.610 months

Pay-back period = 2 months approximately.

6.6. Conclusion

In this chapter, two alternatives for material storage is proposed; their overall costing are calculated. Effective utilization of space is achieved and the increased area can be used to increase the production rate; the costing of racks is compared with total increased earning to calculate the payback period.

CHAPTER NO. 7

CONCLUSIONS AND RECOMMENDATIONS

CHAPTER NO. 7

CONCLUSIONS AND RECOMMENDATIONS

7.1 Introduction

The conclusions and recommendations are discussed in this chapter. This chapter includes the project summary, findings of the project and further recommendations for future improvement.

7.2 Project Summary

This case study is conducted at Otoklin Global Business Ltd. Located at Sakinaka near Chandivali junction. The objectives of this study are to improve the production floor layout, suggest material storage systems and to suggest improvement alternative using Systematic Layout Planning. Finally, is to evaluate this alternative to calculate increased earning by increasing production rates.

Layout improvement alternative have been proposed using Systematic Layout Planning (SLP). There are altogether 11 steps which have been discussed previously in chapter 5. This alternative is then evaluated based on total increased earning.

7.3 Findings

After completing analysis, it is found that the generated layout yields the best results for effective utilization of space, material storage system, decrease in overall handling of in-process inventories and increase in production rate.

On top of that no extra space is needed during the re-layout. This will enable smooth process of station transfers. The cost of the re-layout will be less, except for installation of material storage system.

7.4 Further Recommendation

After improving layout of the production, some performance measures such as resource utilization and total average WIP level could be reduced, as we can see from the results in chapter 6 total productivity can be increased of both small and big products. As for improvement in total average WIP level, factors such as low yield rate, machine breakdowns can be studied.

7.5 Conclusion

The Optimised plant layout was obtained with the application of SLP technique. The report focuses on the optimisation in two criteria which are capacity and productivity. Thus, taking in to consideration the sequence of the operations to be followed and space requirements, the capacity of the plant is increased. The storage system played an important role in saving space. Expected profits are in lakhs hence the expected payback period will be less.

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Paper Under Review

A case study on facility planning

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Abstract:

This case study is about implementation of SLP technique for optimisation of a plant layout for a firm which has its major manufacturing products as various types of filtration equipment for steel, power & fertilizer & for various core sectors. Nowadays, for any manufacturing firm it requires a flawless skeleton to stand in a competitive market. That supporting skeleton is a plant layout of an industry. The optimization process could be done either by increasing the productivity via focusing on the material flow or by increasing the capacity of plant in terms of space availability. However both approaches are not completely excluded with each other but we focused on both the aspects separately. The study of all the activities was done by observing the operations on periodic basis and collecting the required data from the firm. New layout was proposed with optimised spacing and increased capacity of the plant.

Keywords:

Layout, SLP, Optimization, Storage, Productivity, Capacity.