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Increasing Productivity through Facility Layout Improvement using Systematic Layout Planning Pattern Theory

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I. Introduction

Facility layout concerns with the optimum arrangement of departments with known dimensions in such a way that minimizes materials handling and ensure effective utilization of men, equipment and space. In the competitive world, demand is continuously increasing where resources are always limited. In industry sectors, it is important to manufacture the products which have good quality and meet customers demand. This action could be conducted under the existing resources like employees, machines and other facilities. For this reason, industrial factories need to increase their potentials in production and effectiveness to compete against their competitors. That is why; the production process needs to be set in a proper organized way that minimizes production cost with higher effectiveness. Therefore, the way of solving the problem of production is very important.

There are many techniques like quality control (QC), Pareto analysis, total quality management (TQM), control chart and plant layout are used to solve the problems concerning productivity. However, plant layout improvement could be one of the tools to response to industrial productivity improvement by the reduction of cost of manufacturing with a proper workflow in production route. For ensuring proper workflow departments are arranged in such a way that optimizes their relative placement. Sometimes, optimal placement means placing inter dependent traffic departments adjacent to one another. Knowing the nature of flow between departments and process of material flow is important.

Systematic layout planning pattern (SLP) theory is used to analyze the step-by-step of layout facility from raw material storage to finish product dispatched. This method helps to develop a new plant layout with improved process flow and effective utilization of space. On the Basis of production, designing a new layout may follow different ways such as product, process, mixed, fixed position and group layout. Since yarn is produced in mass production system with a limited variety on a steady demand, product layout is the matter of concern.

This paper is organized as follows. Section 2 gives an overview of relevant literature. In section 3 provides the methodology of SLP procedure. Analysis of original plant layout is shown in section 4. In section 5 original plant layout is analyzed by SLP theory. Proposed layout is shown in section 6. Comparison between proposed and existing layout is shown in section 7. Finally in section 8 shows the resells, conclusion & further work that can be done in this field.

II. Literature Review

Many researches have been done in facility planning area. Effective facility planning can reduce significantly the operational costs of a company by 10-30%. Proper analysis of facility layout design could result in the improvement of the performance of production line. This can be realized by optimizing the capacity of a bottleneck; minimizing material handling costs; reducing idle time; maximizing the utilization of labor, equipment and space.

Facility planning is an overall approach concerned with the design, layout and incorporation of people, machines and activities of a system. Huang emphasizes that facility layout design defines how to organize, locate, and distribute the equipment and support activities in a manufacturing facility to accomplish minimization of overall production time, maximization of operational efficiency, growth of revenue and maximization of factory output in conformance with production and strategic goals.

Wiyaratn and A. Watanapa study plant layout of iron manufacturing based on the systematic layout planning pattern theory (SLP) for increased productivity.

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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 billet cutting process until keeping in ware house.

R. Jayachitra and P. S. S. Prasad, study the suitability of a virtual cellular layout (VCL) along with an existing functional layout (FL) of an industry and a classical cellular layout (CL), if considered for implementation. A Genetic algorithm (GA) based intra-cell formation procedure is used in the cellular layout design. To identify the suitability of a particular layout in a given environment, a typical manufacturing system is modeled using the WITNESS 2006 simulation software. Design of experiments (DOE) is used to plan the simulation experiments.

Bozarth C. and P. M.Vilarinho (2006) discuss the impact of space utilization and production planning on the spacer requirement. It highlights the fact that layout is affected by all other activities. Chung S-H., W. L.Pearn and A. H. I. Lee (2006) provides some production performance measures on product mixes in semiconductor fabrication, which also clarifies the complexities involved in this environment. Pinto and Shayan (2007) applied several formal layout procedures to a real production environment demonstrating the advantages of formal methods over the ad hoc practices of the company. Although traditionally layout problems were mainly focusing on process layout scenarios, mathematical modeling of product based layout shave also been developed considerably.

III. Methodology

The data were collected and the number of tools & equipment for manufacturing were counted in terms of directional flow of raw materials and product. The operation process chart, flow of material and activity relationship chart have been used in analysis. The problem of the plant was determined and analyzed through SLP method to plan the relationship between the equipment's and the area. The framework of SLP is shown. Based on the data such as product, quantity, route, support, time and relationships between material flow from –to chart and activity relation chart are displayed. From the material flow and relationship activity in production, the relation between each operation unit can be observed. Muther's Systematic Layout planning include following steps-

a) Flow of materials.
b) Activity relationships.
c) Relationship diagram.
d) Space requirements & Space available.
e) Space relationship diagram.
f) Modifying considerations.
g) Practical limitations.
h) Develop layout alternatives.
i) Evaluation.

Above steps are used to analyze the existing layout and developed a new layout.

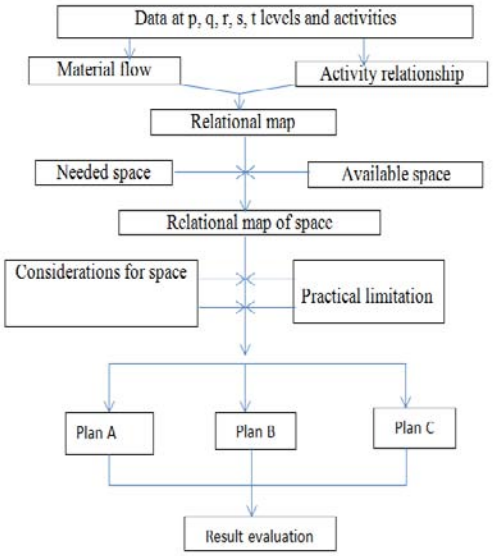


Fig. No. 1 : Systematic Layout planning

Operation flow process chart

Operation	symbol
Stores	
Emulsion	
Breaker card	
Finisher card	
Drawing	
Spinning	
Twisting	
Inspection	
Packaging	
Dispatch	

Symbol specification

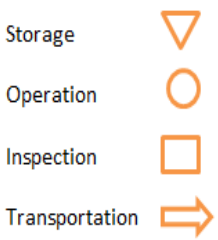


Fig. No. 2 : Operation flow process chart

IV. Analysis of Original Plant Layout

This case is based on the yarn production of jute industry. The original layout of company shown in

Fig.No.3 and the details of each section were described as follows:

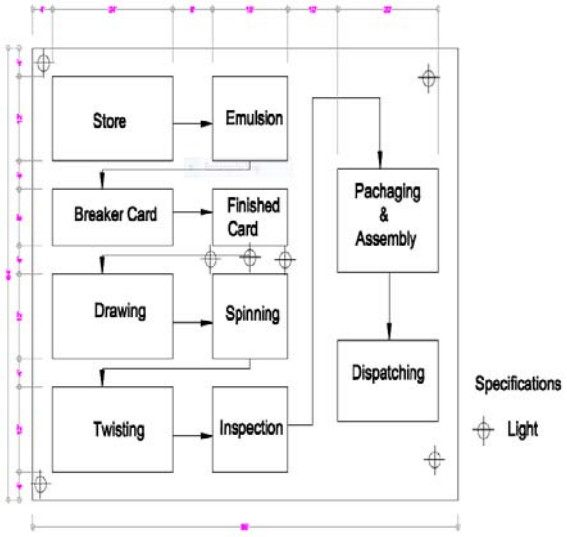


Fig. No. 3 : Existing layout

In this study, the yarn production of standard sizes is mostly analyzed. The operation process flow is shown in Fig. 2. The size of the equipment was relational to the area as shown in Table 1. According to the original plant layout, total working area, distance travelled of materials and unit flow cost and total cost could be discussed as follows:

Table No.1 : Relationship between equipment size and area

Department	Number of equipment	Equipment area (ft^2)	Total working area (ft^2)
Stores	-	-	180
Emulsion	1	140	180
Breaker card	2	160	192
Finisher card	1	240	288
Drawing	4	240	288
Spinning	2	160	180
Twisting	1	160	180
Inspection	4	100	120
Packaging	2	260	300
Dispatch	-	-	240

a) The Flow of Materials

Raw materials carrying are barely maintained in a sequential path that increases the waste of time, resulting in high cost as shown in Table No.2 that clearly show a relationship between distance with cost.

b) Utility of the Area

Total working area is more than equipment area because some spaces are required for the temporal storage of work in process inventory as well as free movement of worker.

c) The Amount and Sequence for Manufacturing

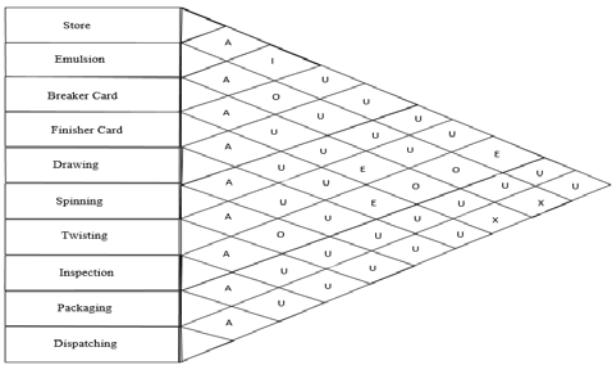
In a cycle of yarn production, there produced 100KG of final product. Total cost incurred with production is raw material cost, machining cost, transportation cost and wages. By applying the process of SLP costs related with transportation can be reduced. Statistics shows that per meter transportation cost is 6.75BDT. Our goal is to rearrange the department in such a way that will reduce both travelled distance and transportation cost.

Table No. 2 : Distance and cost incurred with present layout

From	To	Distance (ft.)	Unit cost (BDT)
Stores	Emulsion	23.5	158.625
Emulsion	Breaker card	37.5	253.125
Breaker card	Finisher card	23.5	158.625
Finisher card	Drawing	37.5	253.125
Drawing	Spinning	23.5	158.625
Spinning	Twisting	39.5	266.625
Twisting	Inspection	23.5	158.625
Inspection	Packaging	45.0	303.75
Packaging	Dispatch	17.5	118.125
	Total		1829.25

V. Analysis Plant Layout based on SLP

According to the study of the manufacturing process, it was found that the travelled distance should be reduced for moving raw materials and also the useless area should be reduced. It is done by applying SLP method on the existing plant lay out. The result is continuous work flow with a sequential departmental arrangement. Activity relationship chart is used to find the most dependent department based on sequential activity. The activity relationship chart is defined as follows. The reason behind most absolute essential department is continuous flow of material. Beside that sometimes they share common personnel, similar type of supervision, same space or equal opportunity of convenience.



Closeness Rating

Rating	Definition
A	Absolutely essential
E	Especially important
I	important
O	Ordinary closeness
U	Unimportant
X	Undesirable

Code	Reason
1	Flow of material
2	Type of supervision
3	Common personnel
4	Share same space
5	Convenience

Fig. No. 4 : Activity relationship chart

VI. Analysis of Proposed Layout

The proposed layout is based on the activity relationship chart and the theme of reducing travelled distance. Altering the positions between several departments will ensure smooth flow of materials as well as it will reduce total travelled distance throughout the production unit. The proposed layout are shown in Fig.No.5 with some ergonomic advantages over existing layout while Table No.3 shows the relationship between cost and distance of proposed layout.

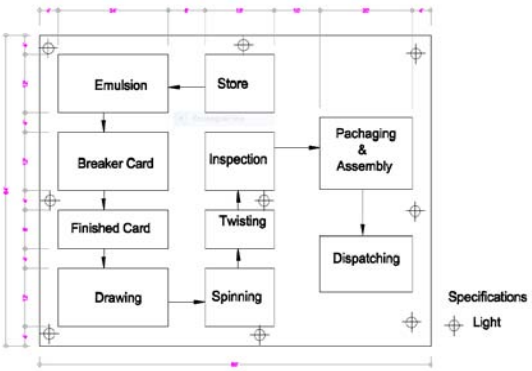


Fig. No. 5 : Proposed Layout

Table No. 3 : Distance and cost associated with present layout:

From	To	Distance (ft.)	Unit cost (BDT)
Stores	Emulsion	23.5	158.65
Emulsion	Breaker card	14.0	94.5
Breaker card	Finisher card	14.0	94.5
Finisher card	Drawing	16.0	108.0
Drawing	Spinning	23.5	158.65
Spinning	Twisting	16.0	108.0
Twisting	Inspection	14.0	94.5
Inspection	Packaging	27.5	185.625
Packaging	Dispatch	17.5	118.625
	Total		1120.5

VII. Result

After analyzing the existing layout it is shown that for a production of 100kg yarn total material handling costs are 1829.25BDT while it is reduced to 1120.5BDT for the modified layout. Implementation of newly developed layout can save 38.75% of total handling costs. It is due to the reduction of 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.

Conclusions & future study

In this paper per unit cost and distance are considered to improve existing layout but there are many other parameters to analyze the layout that may be worker number, 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 large comparative distance between several departments that's forced to travel long distance and impedes the smooth material flow and leads to higher cost.

In our proposed layout the position of various departments are altered with various others based on activity relationship chart.

The machines (Breaker card, Finisher card, Drawing, twisting) used in yarn production are highly weighted. The alternation of those machines are highly costly and time consuming. So, This proposed model will mostly be preferable while setting up a new plant.

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