International Conference on Mechanical and Industrial Engineering
ICMIE2022
November 15-17, 2022 Tripoli-Libya

Improvement of Factory Fayout for a Tissue Paper Factory using a Systematic Layout Planning Approach (SLP)

Zubeda A. Elkhoja
Engineering Management
Tripoli University
Zezekhoja@yahoo.com

Ahmed A. Abdelhafid
Mechanical Engineering
Tripoli University
a.abdelhafid@uot.edu.ly

Abulghassem M. Alshaikh
Mechanical Engineering
Tripoli University
Abulghassem@gmail.com

Abstract:
Because of the fierce competition in the global marketplace, facility planning is essentially considered a strategy, and it assists any organization in achieving supply chain excellence. Facility planning is based on the facility layout problem, which aims to improve the company's production operations by arranging and locating production units in any facility. Systematic layout planning (SLP) is a technique for creating factory layout plans. As a result, the (Afrah Shrayar) tissue paper factory in Tripoli, Libya, was chosen as a case study for this technology.
Travel times between plant departments and machines were reduced in this study to save space. Productivity increased as a result of using the pair-wise exchange approach. As a result, the material handling cost was reduced, resulting in a reduction in the overall cost and, thus, an increase in overall profit.
Key words (*Factory layout, Systematic Layout Planning facility planning, pair-wise exchange method).*

I. INTRODUCTION:

Facility design is now required for manufacturing systems. It explains how the tools used in a workshop increased output, reduced material handling, and made the best use of staff, supplies, and available space. Many businesses have multiple product lines and frequently switch between them; as a result, they require a functional layout to meet their requirements. Many researchers believe that the cost of material handling could account for up to 50% of the total cost of producing any given product. Therefore, work on reducing material handling costs depends mainly on developing an appropriate layout for the plant. However, Richard Muther proposed Systematic Layout Planning (SLP) in 1961, which has since been widely used by many companies to improve layouts based on space needs and material flow analyses.

The systematic layout planning approach is used here to enhance the layout of the (Afrah Shrayar) tissue paper factory, to create some alternatives, and then evaluate each alternative to choose the best one that provides the best economic layout.

Previous studies:

1. Jeff Mohr, Ciras**,** and Mike Willett (1999) investigated an eastern Iowa company that had encountered rapid expansion and planned to construct a new facility three times the size of their current one. After a sequence of adjustments and scorings, the team came to a final layout by selecting the best alternative.

2. Taho Yang (2000) proposed a paper that used Muther's systematic layout planning as a foundation to find a suitable solution to the factory layout design problem. The iterative optimization process is then suggested as a multiple decision-making guide to assessing the design alternatives.

3. Chee Ailing (2009) proposed a thesis to develop the production department floor layout and to assess the suggested alternative for MTA Factory located in Bayan Lepas, Penang.

The main issue that the company has fallen into is the transient high frequency between two buildings for E-Cal and Transceiver Subwavelength Dongle products.

Using Systematic Layout Planning, two different layouts are suggested, which include relocating the sections that have tight interrelationships.

4. Ajit Pal Singh (2013**)** submitted a paper about the cans factory that included an analysis of the floor layout of the factory's production shop floor. To solve the relevant layout problem, the author used a software-based (SLP) approach. The software is utilized to creating the two layout options for the production shop floor. In terms of time and cost of travel, as well as material flow distance, a performance comparison was made between the new layouts and the current layout. Based on their performance, it turns out that the two suggested alternative layouts are economically better than the current layout. As a result of

reduced travel time and cost, as well as material flow distance, productivity has increased.

5. Seyedeh and colleagues (2014) investigated an Iranian factory that manufactures cards and packets. For three different types of cards and packets, the manufacturing process is designed on two floors. Thus, the factory's total output is determined by the number of customer orders. As a result, manufacturing procedures are taken into account to meet customer demands by determining the total production. Accordingly, the SLP method was used to generate three alternative facility layouts, from which the best option was selected.

6. Mohamed, Riyad Hossain, and others proposed a study on juice manufacturing using the SLP approach to develop a new layout for the ongoing production process. As a consequence, the new layout resulted in a significant reduction in traveling distance and material flow cost. As a result, the overall cost was reduced, while the overall profit increased.

7. Wiyaratn and A. Watanapa (2014) conducted a study on steel rod manufacturing lines. The teamwork employed the SLP approach and was successful in producing two alternative layouts. The best alternative was chosen, resulting in a significant reduction in raw material traveling distance and, as a result, a reduction in material flow cost.

8. Herychanra (2014) proposed research on library layout. The author used the (SLP) approach to create a new layout that allows for an optimal arrangement of the library's facilities. The alternate layout demonstrated exceptional efficiency in library operations. As a result, the cost was reduced while productivity increased.

9. Pramod P. Shewale and colleagues (2017) proposed a study on a compressor manufacturing factory. The teamwork used the SLP approach to increase productivity by creating a new layout. The new layout reduced costs by shortening the material flow distance from stocks to dispatch.

10. Mohamed Ariful Islam (2016) proposed a study. Its objectives were to evaluate the production line's current layout, pinpoint its advantages and disadvantages, and apply the layout that the Systematic Layout Planning Technique determined to be the most efficient and effective. The findings demonstrated that the new suggested plant architecture makes better use of available space and boosts output.

11. Using Muther's systematic layout design process, Maina Eliud and others (2018) submitted a paper to examine and enhance the facility layout of a manufacturing organization (SLP). The produced alternatives are assessed using a multi-criteria decision-making technique and compared to the current configuration. The improved arrangement created by the SLP approach has a better material flow, makes better use of available space, and is versatile.

iii. METHODOLOGY

The approach taken in this study is to pinpoint the issues in several production areas. Data collection comes first, followed by an analysis of the connections between various activities. A material flow analysis graphic is created using the input data (From-to Chart). An analysis of the (From-to chart) and activity relationship chart results in the development of a relationship diagram. Templates are then created for each department in order to produce the space relationship diagram after determining the amount of space needed and allocating the available space to each activity. The following stage entails creating and analyzing several layout options based on practical constraints and modification considerations. The produced options are then assessed using the facility designers' criteria in order to choose an appropriate one. The figure shown below is SLP flowchart

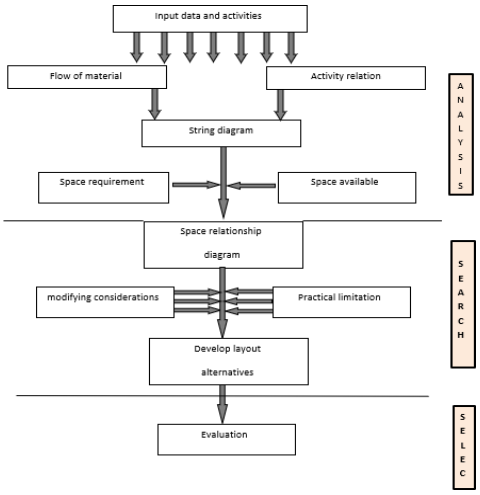

Fig. 1 Systematic Layout Planning [Muther2010]

The case under study in this paper is (AFRAH SAHRAYAR tissue paper factory). The factory is located in Tripoli, Libya.

It was established in 1981 and will be covered in detail by describing the existing situation in relation to layout and material flow.

Using Systematic Layout Planning (SLP) to create some theoretical alternatives will be suggested to improve the level of performance of the factory.

Overview of the Existing layout:

The figures (2), (3) depict the first and second floors of the factory's existing plant respectively. There are the following items included in it: a parking lot, a warehouse, a storage space, three manufacturing areas, two workshops, two restrooms, and two bathrooms. There are 22 individuals overall 13 manufacturing staff, 3 laborers, 1 manager, 1 secretary, 2 marketing, and 2 engineers for maintenance and

one shift (8 hours per day).
The reason for making it is to get a visual picture of the data gathered.

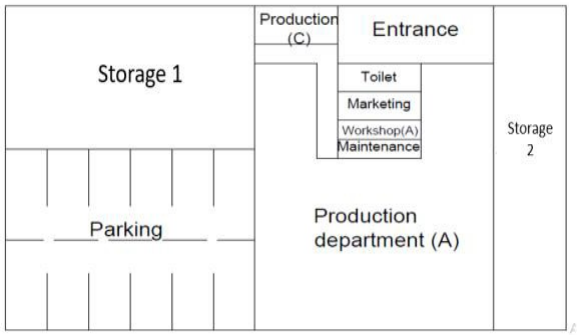

Fig. 2 First-floor plant

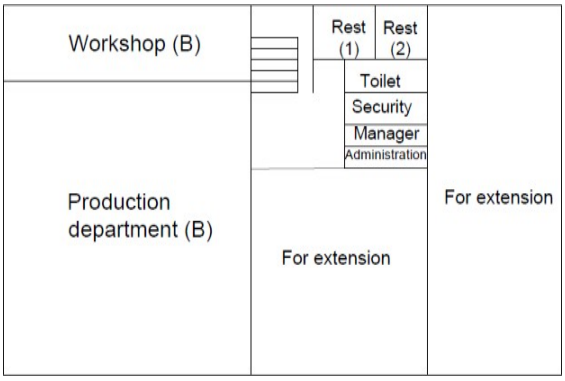

Fig.3 Second-floor plant

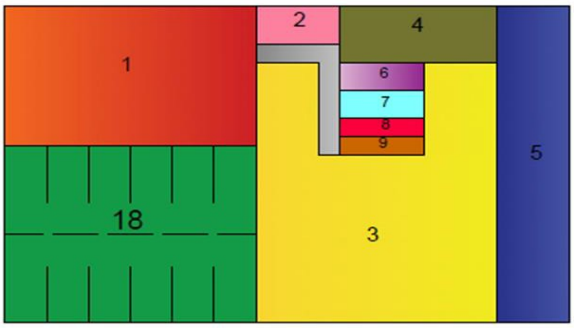

Fig.4 Current layout for the first floor

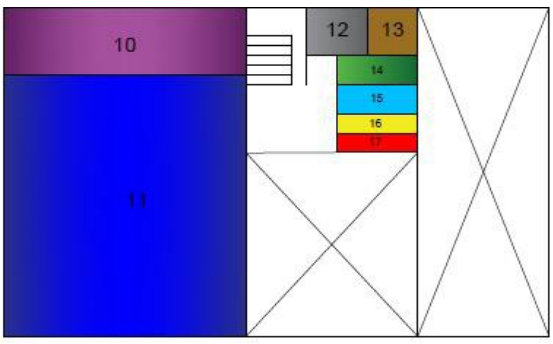

Fig.5 Current layout for the second floor

The first alternative (B): The production area (B) will be on the first floor instead of the second floor, as shown in the figure. The main goal with this layout is to have all production areas located as close together as possible instead of scattered like in the present layout. This will consequently lead to fewer errands between the departments.

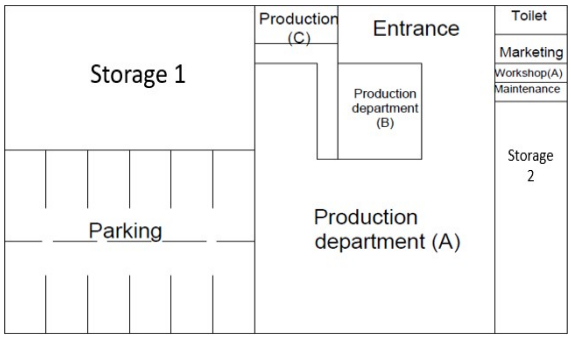

Fig.6 first alternative layout (B)

Second alternative (C): In this layout, both of production area (B) & workshop (B) will be moved to the first floor instead of the second floor, as shown in the figure, the main purpose with this layout is to have all production areas located as close together as possible and near to storage area, to make it easier for the workers to be able to alternate between the different workstations, and reduce traveling time between departments. This will consequently lead to less running about between the first and second floor.

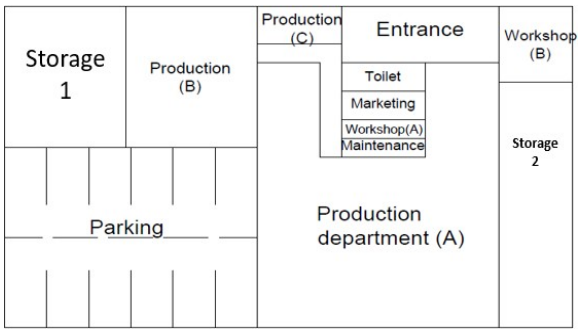

Fig.7 Second alternative layout (C)

The third alternative (D): - In this layout both of production area (B) & workshop (B) will be on the first floor instead of the second floor, in addition to that it is planned to build arraxt x eretxe and remove all the internal walls in the second floor to design it as a shopping mall for tissue paper, or take advantage of the space by renting it, new layout in this alternative is shown in the figure 8.

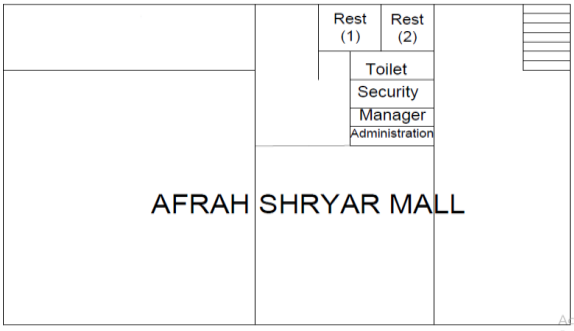

Fig.8 Third alternative layout (D)

Evaluation of the existing layout and alternatives

All of the factory's data have been gathered in this project. Manufacturing process flow, factory facilities, factory layout pattern, and product data are all relevant data. The figure depicts the shape and size of the existing facilities. The optimum layout of the factory was chosen based on the performance of proposed layouts in literature reviews as well as discussions with factory management. Consequently, the requirements are the cost of rearrangement and material handling, versatility, security, and material handling efficacy, flow efficacy, space utilization, and a comparison of alternatives to the current layout.

The cost of material handling was calculated using the pairwise exchange method (PEM), which is the most effective for layout.

The work done in this project was aimed at lowering the overall cost of material handling between all workstations in a facility.

The distance between workstations was measured from the centroid of one department to the centroid of another. Distance can be calculated using either rectilinear or Euclidean space. In this case, rectangular measurement was used. The material flow matrix was created using (from-to-chart). As a result, for each layout change, all material flow in the location of workstations is evaluated, and the change with the greatest reduction in total cost is chosen.

The alternatives were evaluated by comparing them to three factors as follows:

i. Cost of material handling (efficiency percentage ratio).

ii. Rearrangement cost

iii. Multiple-criteria decision-making (MCDM) Layout is the preferred option that the researcher chose after examining the data. Although it decreases material handling expenses, it has the greatest priority score in the MCDM evaluation and the fewest rearrangement costs.

Table 1. Shows summary of MCDM

Layout type	Material handling cost	Efficiency Ratio (RE)	Rearrangement cost (LD)	Requirement priority score	Extra income(LD)
Alternative layout(B)	16150	0.173913	10300	3.2	0
Alternative layout(C)	17000	0.130434	12200	2.8	0
Alternative layout(D)	17000	0.130434	26500	3	5000

iv. CONCLUSIONS:

Muther's (SLP) approach was used in this study to find a solution to a facility layout problem as well as to improve existing layouts.

When applying the model to the case company and after going through all of the models explained by Muther to improve the existing layout, three different alternatives were developed and evaluated using simple and objective multi-criteria evaluation.

Rearrangement costs, as well as MCDM theory, were both used to evaluate the factory's alternative layouts. Following an evaluation of the alternatives, the researcher chose the layout (B) as the best option.

In this layout, the production area (B) will move to the first floor instead of the second floor. In this layout, all of the production areas will be located on the first floor as close as possible, instead of scattered like in the present layout, as shown in figure (5-1). These changes will make it easier for the workers to alternate between the different workstations. To have the opportunity to work together with a substation. According to the analysis data, alternative (B) requires the least amount of rearrangement (10,300 LYD), despite a 17% reduction in material handling expenses. The alternative (B) achieved 3.2 as the greatest score in the MCDM evaluation.

Additionally, it enables flexibility, enhances the movement of products and people, and effectively utilizes available space. It also makes the company's current layout safer.

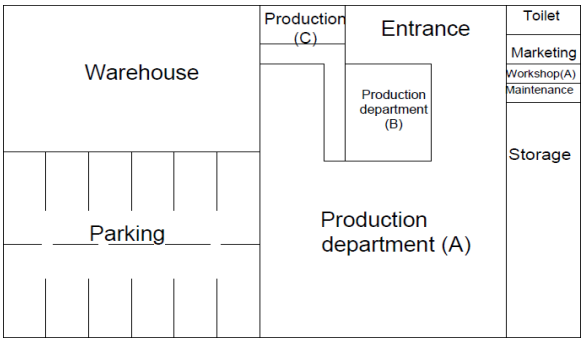

Fig.9 The best layout for the factory

v. REFERENCES:

[1] Adil baykasoglu, T.D. (2006). An ant colony algorithm for and unconstrained dynamic facility s eerxeteas-tesdarsolving layout problems. omega 34, pp 385-396.

[2] Amin Drira, Henri Pierreval, (facility layout problems: A survey). Elsevier, annual reviews in control 31(2007), pp 255-267.

[3] A- Andrew KUSIAK and Sunders S. HERAGU, (The Facility Layout problem), European Journal of Operational Research 29, North-Holland (1987), pp 229-251.

[4] Baraka, j, 2012 discrete event simulation modeling to improve productivity on an automotive production line.

[5] Dwijayanti K, Aoyama H ,2010. A proposed study on facility planning and design in the manufacturing process.

[6] Garcia, A, D, smith McG.2008 facility planning and design. Person International Edition. Prentice-Hall.

Huang, H .2003, facility layout using layout modules, Ph., D. thesis, the Ohio state university.

[7] Huang, H .2003, facility layout using layout modules, Ph., D. thesis, the Ohio state university.

[8] Maina Eliud C.1, Muchiri Peter N.2, and Keraita James N3, (2018) Improvement of Facility Layout Using Systematic Layout Planning.

[9] Maryam Hamedi, N.B(2012) Developing a Method to Generate Semi-Distributed Layouts by Genetic algorithm. International Journal of Industrial Engineering 18(5), pp 260-269.

[10] Murther, R, (1973). Systematic Layout Planning, Second Edition. Boston: Cahners book.

[11] Tompkins J, J (2010) Facilities Planning. Fourth Edition. New York: John Wiley & Sons, Inc.