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Research Methodology for Selection of Optimum Plant Layout

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ABSTRACT

This paper proposes an efficient and flexible research methodology for selection of plant layout for optimum utilization of resources and deal with future change. It consists of two steps, one for generating the layout alterative and other for selecting the optimum layout, generation of layout with the help of SLP (Systematic Layout Planning) and selection of optimum layout by using MCDM tools and technique by considering weight of each criteria. this research framework consists of define the problem, data collection, generation of alternative, selection of criteria & criteria score, MCDM tools & technique and selection & maintain. this methodology allows flexibility to be incorporated into the design of a new plant layout or provide improvement in exiting one.

Keyword: Plant layout, Criteria, SLP, Multi-criteria decision making (MCDM)

I. INTRODUCTION

A facilities layout, also called plant layout, consists of the production areas, production support areas like storage and personnel areas. Plant layout design is one of the strategic decisions that determine the long run efficiency of operation. (Alan Mühlemann, 1992) explained that the plant layout process is rather complex, "which cannot be set down with any finality, and one in which experience plays a great part" Facility layout determines the best locations for machine or departments within a manufacturing facility to reduce total material handling costs. In addition to material handling costs, a good layout can allow for cost savings in other categories such as reducing work-in-process inventory and increasing overall efficiency (Kim J., 2000). Plat layout is of extremely importance not only during new facility design but also in redesigns the exiting one. If a new layout can reduce material handling times and distance the conspicuous benefits are obvious. It is found that 15-70% of manufacturing costs can be attributed to material handling, which represents of 87% of all manufacturing time (Tompkins, 2010). This clearly indicates how important facility layout. The main objective of this paper is to provide a generic research framework for designing new layout or improvement in exiting one. Whether you are developing a new facility plan or an expansion plan,

without the correct tools, methodology, and knowledge, you may end up with a costly mistake. A lot of research has been dedicated to present the different approaches for the generation of layout Detailed review is provided by (Kusiak, 2011) (Meller R. D, 1996), (Sharma, 2006) and (Karray, 2000). When embarking on any facility planning project, we use a process called Systematic Layout Planning (SLP). This process developed by Richard Muther, is widely taught in universities and used by industrial engineers for facility planning projects. Following the SLP steps outlined in this article allows us to develop a facility plan that will meet your future needs and result in savings and add additional capacity.

II. RESEARCH METHODOLOGY

A. Road map for designing Research framework:

Figure 01 shows the research framework for plant layout design. Which consist of two section one for the generation and other for the Selection. In the generation section which analysis the data and generated the alternative plant layout with the help of SLP. After the generation of alternative layout selection section will start. Which include selection of criteria & criteria score, which is input for MCDM tool and technique. At this stage, the decision-maker prefers an optimal layout which satisfied all criteria value.

B. Define the Problem

For getting the answer question is necessary, similarly for getting solution statement of problem is necessary. This process is must, as a minimum, identify root causes, limiting assumptions, system and organizational boundaries and interfaces, and any stakeholder issues. The goal is to express the issue in a clear, one-sentence problem statement that describes both the initial conditions and the desired conditions. Of course, the one-sentence limit is often exceeded in the practice in case of complex decision problems. The problem statement must however be a concise and unambiguous written material agreed by all decision maker. Even if it can be sometimes a long iterative process to come to such an agreement, it is a crucial and necessary point before proceeding to the next step.

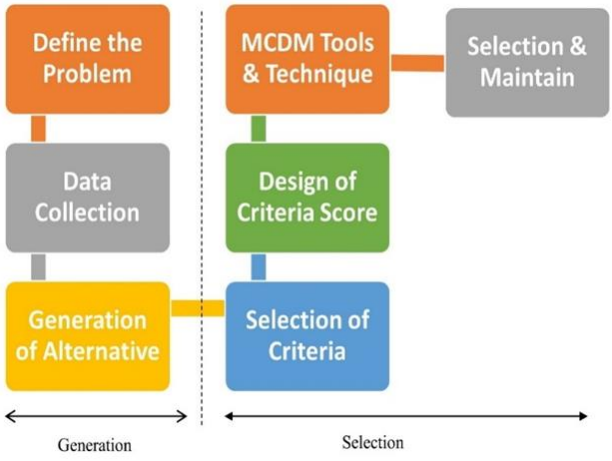

Figure 01 : Research framework for designing layout

C. Data Collection

The data were collected and the number of tools and equipment for production was counted in terms of the direction for 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 analysed through SLP method to plan the relationship between the machine or equipment and the area. 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 foundry production, the relation between each operation unit can be observed.

D. Generation of Alternative

SLP is a procedural layout design approach which its process is relatively straightforward but yet is proven a powerful tool in providing the layout design guideline [25]. A step-by-step planning

procedure of SLP uses to determine a reasonable production system layout scheme and develop a new plant layout with an improved process flow and an effective utilization of space. A workplace in a plant is arranged by locating two areas that contain high frequency and logical relationships close to each other. Readers are suggested reference [25] for detailed discussion and explanation of the SLP technique SLP is a procedural layout design approach which its process is relatively straightforward but yet is proven a powerful tool in providing the layout design guideline [25]. A step-by-step planning procedure of SLP uses to determine a reasonable production system layout scheme and develop a new plant layout with an improved process flow and an effective utilization of space. A workplace in a plant is arranged by locating two areas that contain high frequency and logical relationships close to each other. Readers are suggested reference [25] for detailed discussion and explanation of the SLP technique SLP is a procedural layout design approach which its process is relatively straightforward but yet is proven a powerful tool in providing the layout design guideline [25]. A step-by-step planning procedure of SLP uses to determine a reasonable production system layout scheme and develop a new plant layout with an improved process flow and an effective utilization of space. A workplace in a plant is arranged by locating two areas that contain high frequency and logical relationships close to each other. Readers are suggested reference [25] for detailed discussion and explanation of the SLP technique Generation of alternative layout by using SLP developed by Richard Muther in 1973 with 2 major purposes: high frequency and logical relationship. SLP is a procedural layout design approach which is candid and straightforward but yet is proven a powerful tool in generating the layout design. SLP uses a step-by-step planning procedure (figure 02) to determine a reasonable production system layout and develop a new plant layout alternative by considering objective. There are 6 main procedures as follows:

1) Making Relationship Chart and from-to chart: In this procedure, relationship of each pair of activities is determined and evaluated in relationship chart. A material Flow analysis is done in from-to chart.
2) Relationships Diagram: It is a diagram which symbols of proximity for all activities in the layout are shown how activities in each area are related to others.

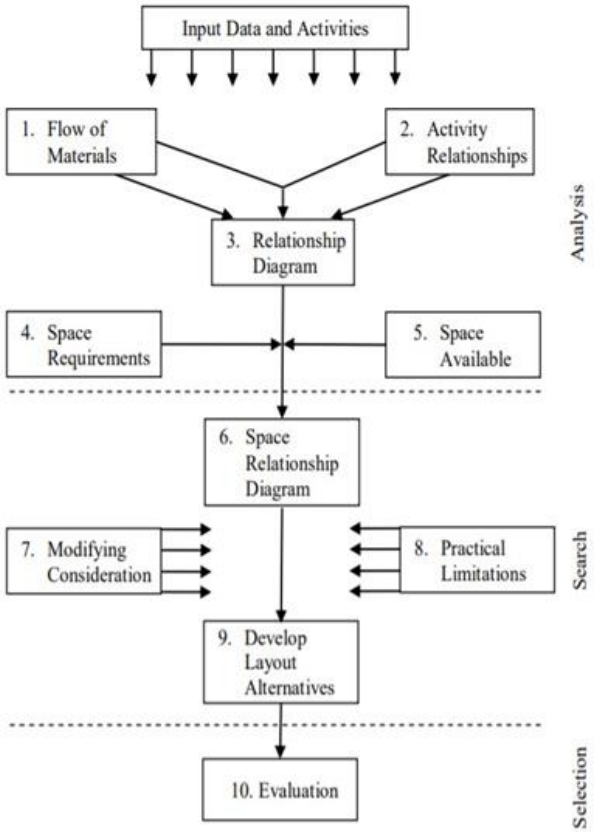

Figure 02 : SLP Procedure

3) Space Requirements and space available: Resulted from measuring the space of manufacturing process, machinery, and other manufacturing equipment's of current manufacturing plant and analysing space required.
4) Space Relationship diagram: Utilized as a guideline for design alternative layouts.

5) Alternative layouts Evaluation: Developed alternatives are evaluated based on specific criteria of each manufacturing plant.
6) Layout Selection and Installation: This final procedure is to select and to implement the most prefer alternative.

E. Selection of Criteria & Criteria Score

Selection of decision criteria, which will be segregated among alternatives, must be depend upon on the goals. It is necessary to define segregated criteria as objective measures of the goals to measure how well each alternative achieves the goals. every goal must generate at least one criteria but complex goals may be represented by several criteria. It can be helpful to group together criteria into a series of sets that relate to separate and distinguishable components of the overall objective for the decision. After selection of criteria a group of expert opinion survey is made for deriving the criteria score which indicate the importance of each criteria related to each other.

F. MCDM Tools & Technique

Decision making is the study of identifying and choosing alternatives based on the values and preferences of objective. Making a decision implies that there are alternative choices to be considered, and in such a case we want not only to identify as many of these alternatives as possible but to choose the one that best fits with our goals, objectives, desires and values. A MCDM used for selection of optimum Plant layout among all possible layout. Generally, factors (criteria) which influence on plant layout are considered in a MCDM. Which uses factors or criteria in the decision-making was discussed with the Expert. Information from the industrial personal are more importance while selecting a suitable criterion. It was necessary to assign a weight on each criteria to make the MCDM more accurate. A MCDM was made, as a first step, to evaluate which layout that is the most superior. Generally, the more aspects considered in a MCDM the better. Which factors to use in the decision-making was discussed between the expert and researchers. Information from the company was used as a major criterion when selecting suitable factors. Multi-criteria decision-making in general follows six steps including, (1) problem formulation, (2) identify the requirements, (3) set goals, (4) identify various alternatives, (5) develop criteria, and (6) identify and apply decision-making technique (Sabaei, Erkoyuncu, & Roy, 2015). Various mathematical techniques can be used for this process, some of them are Analytic Hierarchy Process (AHP), Technique for Order of Preference by Similarities to Ideal Solution (TOPSIS), Elimination Et Choix Traduisant la Realité (ELECTRE), Preference Ranking Organization Method for Enrichment of Evaluations (PROMETHEE), ViseKriterijumska Optimizcijai Kaompromisno Resenje (VIKOR), and Data Envelopment Analysis (DEA). AHP is based on mathematics and psychology. Rather than recommending the best alternative, AHP encourages decision makers to find a solution that better suits their goal and perception of the problem. It offers a comprehensive and rationally oriented context in which the decision problem can be organized, quantified, and evaluated. TOPSIS is a very useful MCDM method. This is an alternative approach that measures weights for each parameter, normalizes scores for each criterion, and determines the numerical difference for each alternative and the optimal alternative, which is the best score for every criteria. ELECTRE is another popular MCDM method used to eliminate any unacceptable alternatives. PROMETHEE is suitable when groups of people are working on complex issues, particularly those with various parameters that require several views and viewpoints that have long-term consequences in their decisions. The choice of techniques is made based on the nature of

the problem and the level of complexity assigned to the decision-making process.

G. Selection & Maintain

Evaluate the alternative designs both quantitatively and qualitatively and select the prefer optimum one by using MCDM tool & technique. Next phase is to implement the selected layout design. Once the layout is installed and running follow-up the results to maintain and accommodate the plan. When the new layout has been implemented it is recommended that the layout is examined periodically to ascertain the need for modifications and revisions. The utilization of space, equipment, personnel etc. the performance of the facility under current conditions; and the capacity of the facility to meet future requirements are to be assessed.

III. CONCLUSION AND DISCUSSION

This layout design methodology is an improvement over the existing traditional one methodology by overcoming the limitation of SLP. The study reported here attempts to present a new research methodology framework for plant layout design and provide an analysis tool to evaluate the plant layout alternatives. Which is used to create an initial new layout and improvement in exiting layout. The designed layouts of many existing layout design procedures don't have sufficient flexibility to meet the actual stochastic production requirements. Therefore, the new approach of layout design is necessary for manufacturing organizations to improve production operation and meet the industry requirement. This framework should give industry many practical advantages to remain competitive among the rivals.

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