Selection of Qualitative & Quantitative Criteria Weight for Selection of Plant Layout by Using Numerical Scale Method

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ABSTRACT

The aim of this paper is to design the criteria that affect the effectiveness of a Plant Layout. The design criteria can be classified into two categories which are qualitative and quantitative. The survey serves as a guide to those interested in how to evaluate and select the most appropriate criteria which can handle objective of good layout. This research give the clear idea about the selection of criteria and their importance (score) by using numerical scale method (NSM) These methods are particularly suitable to deal with complex situations, including various criteria and conflicting goals which need to be optimized simultaneously.

Keyword:Plant layout, Criteria, Multi-criteria decision making (MCDM), NSM (Numerical Scale Method)

I. INTRODUCTION

To operate production and service systems efficiently, systems should not only have to be operated with optimal planning and operational policies, but also have a plant layout that is well designed. The layout of a plant or facility is concerned with the physical placement of resources such as equipment and storage facilities, which should be designed to facilitate the efficient flow of customers or materials through the manufacturing or service system. The layout design is very important and should be taken very seriously as it can have a significant impact on the cost and efficiency of an operation and can involve substantial investment in time and money. The decisions taken with regards to the facility layout will have a direct influence on how efficiently workers will be able to carry out their jobs, how much and how fast goods can be produced, how difficult it is to automate a system, and how the system in place would be able to respond to any changes with regards to product or service design, product mix, or demand volume. So Optimal design of physical layout is an important issue in the early stage of system design and has a big influence on the long-term viability of the manufacturing system. A poorly designed layout will results in reduced productivity, increased work-in-process, increased manufacturing lead time, disordered material handling and so on. A lot of research has been dedicated to present the different approaches for the generation of layout. Detailed review is provided by (Kusiak and Heragu 1987), (Meller and Gau 1996), (Singh and Sharma 2006), (Drira et al 2007), and (Nordin and Lee 2016). However, no research has been found to survey the multi-criteria layout evaluation and selection approaches through a literature review since except (Lin and Sharp 1999). The aim of this proposed study is to present a survey about the criteria and the techniques considered by the decision makers for evaluating and selecting the most appropriate layout.

Muhlemann, Oakland and Lockyer (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". Design of good layout depend upon various criteria like Material Handling distance(Cost) which is measured (In meter) by the sum of the products of flow volume and rectilinear distance between the centroids of two departments.Which focused on reducing the Material Handling Cost (MHC). According to Chan, Chan, and Kwong (2004) Efficient facilities planning can reduce these costs by at least 10–30% another one is Flexibility which involves two aspects: the first is the capability to perform a variety of tasks under a variety of operating conditions; second is the flexibility of future expansion. Adjacency Score is the sum of all positive relationships between adjacent departments. Accessibility involves material handling and operator (Human) paths.Maintenance which involves the required spacefor maintenance engineers and tool movement. However, a literature survey has done on different criteria that are used by various author to evaluate different layouts are summarize in Table 01 where @ indicate criteria used by respective author and figure 01 show the criteria used by number of author.

Criteria / **Authors**	Shang (1993)	Abdul- Hamid et al	Yang et al (2000)	Yang and Kuo (2003)	Abdi (2005)	Ertay et al (2006)	Rahimi (2007)	Yang and Hung	Kuo et al(2008)	Abdi (2009)	Singh and Singh	Maniya and Bhatt	Shahin (2011)	Lateef-UR and	Shokri et al(2013)	Venchehet al.(2013)	Al-Hawari et al.	Ben cheikh et al	Ben cheikh et al	Wang et al. (2016)
Distance				@		@		@	@			@	@		@	@				@
Adjacency score				@		@		@	@			@	@		@	@				@
Shape ratio				@		@		@	@			@	@		@	@				@
Flexibility	@	@	@	@		@	@	@	@		@	@	@		@	@	@			@
Accessibili ty				@				@	@			@	@		@	@				@
Maintenan ce				@				@	@			@	@		@	@				@
Closeness gap value cluster																	@			
Process capacity			@																	
Reconfigur ation time																		@	@	
Productive area utilization																	@			
Quality					@	@	@			@										
Human issues clus	@									@	@						@		@	
Throughpu t time														@				@	@	
Products indicators														@				@	@	
Work in Process	@		@							@	@								@	

Machine utilization														@				@	@	
Number of machines and number of operators																			@	
Material handling vehicle utilization and handling cost						@														
Productivity		@	@				@													
Layout reconfigurability					@															
Cost		@			@					@										
Reliability					@					@										
Flow											@									

Table 01. A summary of evaluating criteria for facility layout evaluation and selection.

DATA COLLECTION:

The selection of criteria has to be made on the survey from a group of experts. The group consisting of peoples from academic as well as from industry.Thesurveyhas been done online throughGoogle form where 51 expert are participate where they giveimportance of all criteria on 5 scale factor (5 for extremely important and 1 for extremely unimportant) which is valuable information on plant layout selection criteria.

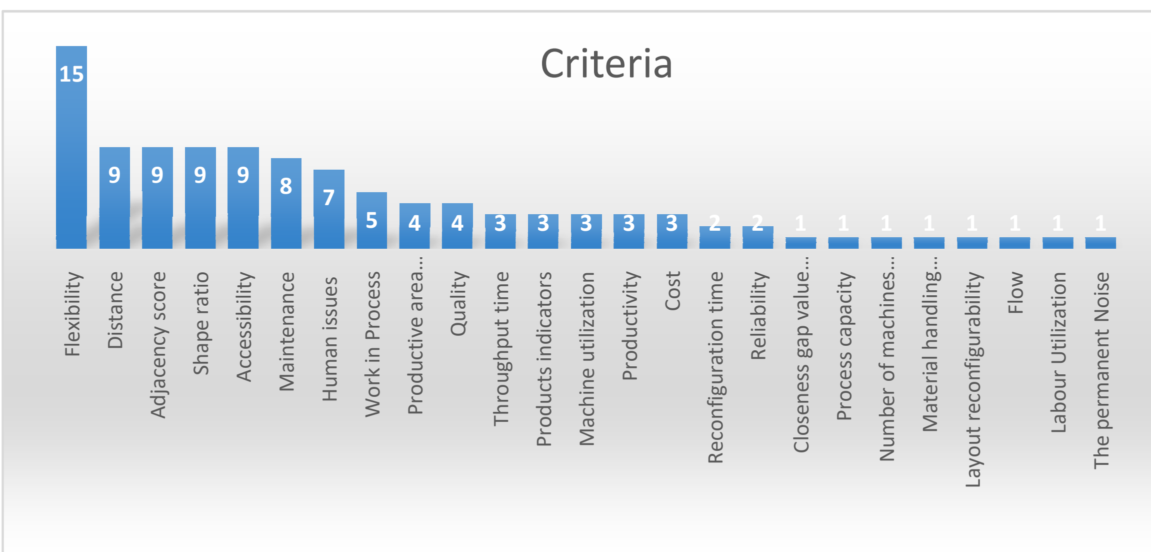

Figure 1: Criteria used by number of authors.

A preliminary survey led to three quantitative and three qualitative design attributes. The quantitative attributes included material handling distance (in 'meters'), adjacency score and shape ratio They are referred to as C1, C2, C3 respectively. For a layout design problem, we Endeavour to minimize the flow distance, while maximizing adjacency score there are three qualitative attributes—flexibility, accessibility, maintenance and safety. They are referred to as C4, C5, and C6 respectively. Flexibility involves two aspects: the first is the capability to perform a variety of tasks under a variety of operating conditions; second is the flexibility of future expansion. Accessibility involves material handling and operator paths. Finally, the maintenance issue involves the required space for maintenance engineers and tool movement.

II. ANALYSIS OF DATA

We adopt the numeric scale method proposed by ribeiro. It uses a five grade scale from "extremely important (the grade of 5)" to "extremely unimportant (the grade of 1)" The calculation algorithm is shown as Eq. 1):

$$Wj = \frac{Gradej}{\sum_{j=1}^{n} Gradej} \qquad j=1, 2, 3, 4 \dots n \qquad \dots.1$$

Where gradej is the grade scale for attribute Cj. According to experts' opinion, the grade scales for the six attributes are {5, 4, 2, 4, 3, 5}. We collected a pretty unanimous conclusion during the weight data collection process, and thus, do not feel the compelling need to develop a more sophisticated approach. Then, the resulting numeric scale weights using Eq. (1) are shown as Eq. (2).

W = {5/23, 4/23, 2/23, 4/23, 3/23, 5/23}

{0.22, 0.17, 0.09, 0.17, 0.13, 0.22} ….2

III. RESULT AND CONCLUSION

The large number of criteria that should typically be considered in selecting the best Layout, Using the structure of the six criteria as the base in current study dimension including material handling distance (in 'meters')(C1), adjacency score (C2), shape ratio (C3), flexibility (C4), accessibility (C5), maintenance and safety (C6) weights calculated by NSM is as 0.22, 0.17, 0.09, 0.17, 0.13, 0.22 are respectively. This research give the clear idea about the selection of criteria and their importance (score) by using numerical scale method (NSM). These methods are particularly suitable to deal with complex situations, including various criteria and conflicting goals which need to be optimized simultaneously

IV. REFERENCE

[1] Abdou, G. & Dutta, S.P. (1990). An integrated approach to facilities layout using expert systems. *International Journal of Production Research*, 28(4), 685-708.

[2] Aiello, G., Enea, M. & Galante, G. (2006). A multi-objective approach to facility layout problem by genetic search algorithm and Electre method. *Robotics & Computer-Integrated Manufacturing*, 22(3), 447-455.

[3] Chen, C.W. & Sha, D.Y. (2005). Heuristic approach for solving the multiobjective facility layout problem. *International Journal of Production Research*, 43(21), 4493-4507.

[4] Chu T.-C., (2002), "Selecting plant location via a fuzzy TOPSIS approach", International Journal of Advanced Manufacturing Technology, 20, 859-864.

[5] Evans, G.W., Wilhelm, M.R., Karwowski, W. (1987) "A Layout Design Heuristic Employing the Theory of Fuzzy Sets" International Journal Of Production Research 25, 1431–1450

[6] Ertay, T., Ruan, D. &Tuzkaya, U.R. (2006). Integrating data envelopment analysis and analytic hierarchy for thefacility layout design in manufacturing systems. *Information Sciences*, 176(3), 237-262.

[7] Gonzalez-Cruz, M.C. & Gomez-SenentMartınez, E. (2011). An entropy-based algorithm to solve the facility layout design problem. *Robotics & Computer-Integrated Manufacturing*, 27(1), 88-100.

[8] Grobelny J. On One Possibly (1987) “Fuzzy Approach To Facility Layout Problems.” International

[9] Journal of Production Research; 25:1123-41.

[10] Houshyar A., and White B., (1997), “Comparison of solution procedure to the facility location problem”, Computers and Industrial Engineering, 32, 77-87.

[11] Karray, F., Zaneldin, E., Hegazy, T., Shabeeb, A. And Elbeltagi, (2000), "Tools Of Soft Computing As Applied To The Problem Of Facilities Layout Planning." IEEE Transactions On Fuzzy Systems, Vol. 8, No. 4, Pp. 367-379.