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Analysis of layout alternatives to increased productivity

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ABSTRACT

In this research, proposed to improve process flow of production area by using Systematic Layout Planning (SLP) to design layout alternative and Multi-criteria decision making (MCDM) method was used to determine the appropriate plant layout alternatives by considering the factors for instance including material flow, convenience to transfer, coordinate, convenience for receiving material and convenience for operator operation. The result found that the best suitable layout is the layout No.1. This layout could reduce inefficiency of transportation and working process.

Keyword: Systematic Layout Planning, Analysis Hierarchy Process, MCDM

1. Introduction

Nowadays, industrial manufacturing are high competition and facing critical situation about economic. The occurred situation affecting Small and Medium Enterprise in Thailand some manufacturer have closed because of there were no profit in theirs operation. Therefore they have to enhance capacity of process by increase machine but it will affect in costing. Design of manufacturing process or handling facility will be provide a system that reduce waste in process and improve productivity. The case study showed that the main problem was inefficient processes so it should be eliminated. Pramod (Pramod P. Shewale 2012), W. Wiyaratn (W. Wiyaratn 2013) and Chandra Shekhar Tak (Yadav 2012) increased productivity by use Systematic Layout Planning (SLP). This method can be design layout alternatives and considered as selection criteria, which makes the selection process a multi-criteria decision making (MCDM) problem. Many researchers studied about tools used in decision-making process to ensure the most appropriate alternative. There are several fields were applied these methods to organizations for instance plant location selection (S. Meysam Mousavi 2013), (Tuncay ozcan 2011), investment alternatives (Caliskan 2006), (Ojala and Hallikas 2006), supply chain management (Cruz 2009),(Erturul 2009) etc. So this research aims to applied multi-criteria decision method in evaluation phase of Systematic Layout Planning procedure.

2. Theory

2.1 Systematic Layout Planning

Systematic Layout Planning (SLP) is an acronym of Systematic Layout Planning which is a technique established by Richard Muther. It is a step by step planning procedure allowing users to identify, visualize, and rate the various activities, relationships, and alternatives involved in a layout project. The three fundamental areas of the technique are relationships, space and adjustment. Five important elements of plant layout problems can be divided into five elements according to the SLP method. These five elements including P-product Q-quantity, R-route,S-supporting service and T-time.

The details of the relationship area are collection of input data, materials flow, relationship activities and relationship diagrams. The space areas are space requirements, space available and space relationship diagrams. The adjustment areas are modifying considerations, practical limitations and evaluation and final selection. The steps follow Systematic Layout Planning procedure in Figure 1

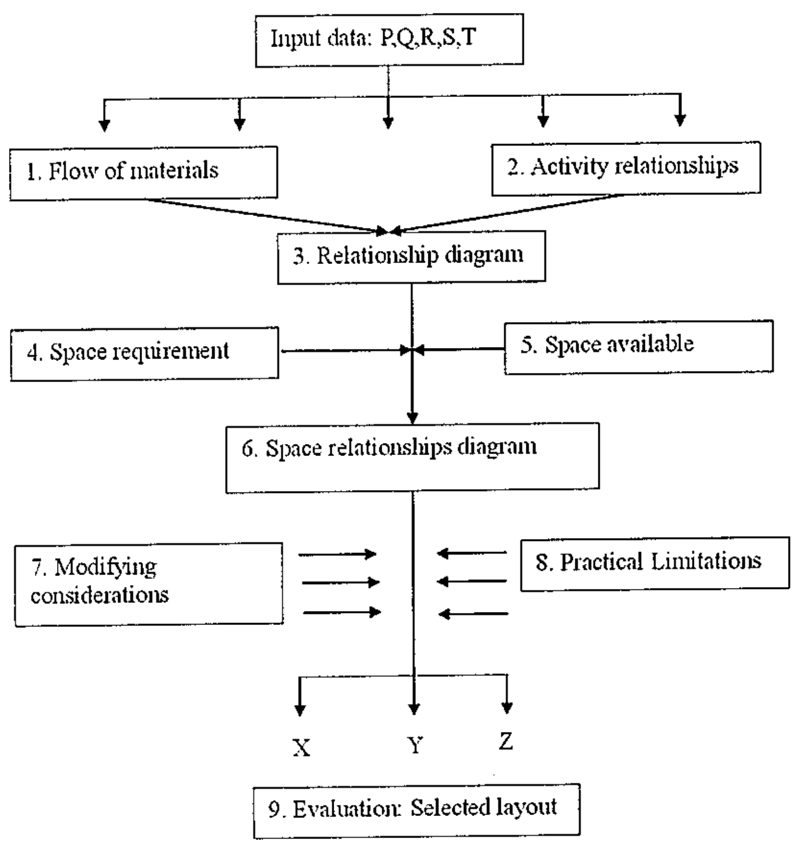

Figure 1 Systematic Layout Planning (SLP) pattern procedure

2.2 Group decision making

Group decision have two important factors are how to conclude final decision by group judgement and how to create group choice to single choice. It will be need to determine the method to be used to combine individual responses and construct procedure decision outcome by choose suitable method of selection. There are many several methods for instance consultation with a single decision, group average, voting, consensus, unanimous and multi-criteria decision analysis.

3. Research methodology

This research purposed to design layout and evaluate suitable layout for manufacturing by apply Systematic Layout Planning (SLP) in case study and use multi-criteria decision analysis in evaluation phase of Systematic Layout Planning procedure.

This section describes the detailed methodology which includes five steps to achieve research objective as the following;

Step 1: collect input data such as product type, product capacity, route, time, support service etc. for choose product for study.

Step 2: construct material flow process chart, relationship activity chart and relationship diagram.

Step 3: analysis relationship diagram between equipment and area available based on condition and design initial layout.

Step 4: modify initial layout by considering factors which might affect the implementation phase.

Step 5: Use multi-criteria decision making method to evaluate layout design.

4. Results

4.1 Case study

Case study is conducted at component part manufacturing. Checking ring product had been selected to study because it had most product demand and production line common with other products. Checking ring was part of injection machine see as figure 1.

Figure 1 Checking ring product

4.2 Construct flow chart and diagram

According to several tools could be define area of problem this research using the manufacturing flow process chart was graphically represent of sequence of all activities and record directly by observing the work. There were five symbols to represent activities including operation, transfer, delay, inspection and storage as in table 1. It was found that the long distance or non-valued process so could be reduced for moving raw materials and the problem about useless area. It could be see the overall picture of process by using flow process diagram in figure 2

Table 1 Flow process chart of checking ring

Flow Process chart		Material				
		Summary				
Name	AAA	Symbol		Present	Proposed	Saving
Checking ring process		Operation	●			
		Transfer	➡			
		Waiting	D			
		Inspection	■			
Present	Proposed	Storage	▼			
Recorder	Sompom	Distance (m)				
Analzer	Natthapon	Time (sec)				

Event description	Distance (m)	Time (sec)	Symbol ●	➡	D	■	▼	Remark
1.Material Preparation Process	-	300	•					
2.Material transfer to CNC room	10	120		•				
3.CNC Lahte process	-	2400	•					
4.Transfer to CNC milling room	3	60		•				
5.CNC milling process	-	1800	•					
6.Transfer to Grinding Machine	10	120		•				
7.Grinding Process	-	1800	•					
8.Transfer to Polishing Machine	40	180		•				
9.Polishing Process	-	1200	•					
10.Transfer to QA room	50	210		•				
11.QA- Inspection Process	-	300				•		
12.Transfer to Storage area	3	120		•				
13.Storage (Wait for Hardness process)	-	6000					•	
	116	14610	5	6	0	1	1	0

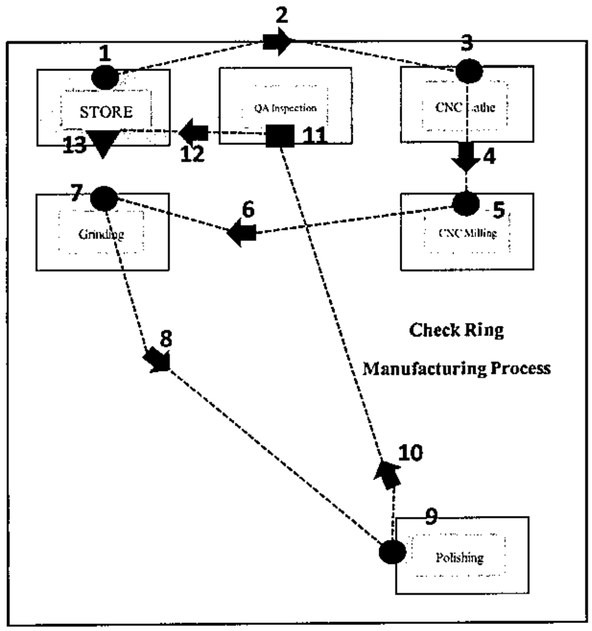

Figure 2 Flow process diagram of checking ring

4.3 Construct relationship activity chart and relationship diagram.

A relationship activity chart collects the qualitative information of proximity ratios which consist of a set of letters (A, E, I, O, U, X) and represents M(M-1)/2 symmetric qualitative relationships where $r_{ij} \in \{A, E, I, O, U\}$: Closeness Value (CV) between activities i and j; r_{ij} is an ordinal value. On process gave relation score which consider by each reason followed as table 2.

Table 2 Relationship number and reason

Code	Reason
1	Flow of materials
2	Same equipment
3	Easy to transfer
4	Convenience
5	Same operator

Relationship activity chart was created by person who concern in manufacturing. They were brainstorming and sharing idea with group. So a relationship activity chart as in figures 3.

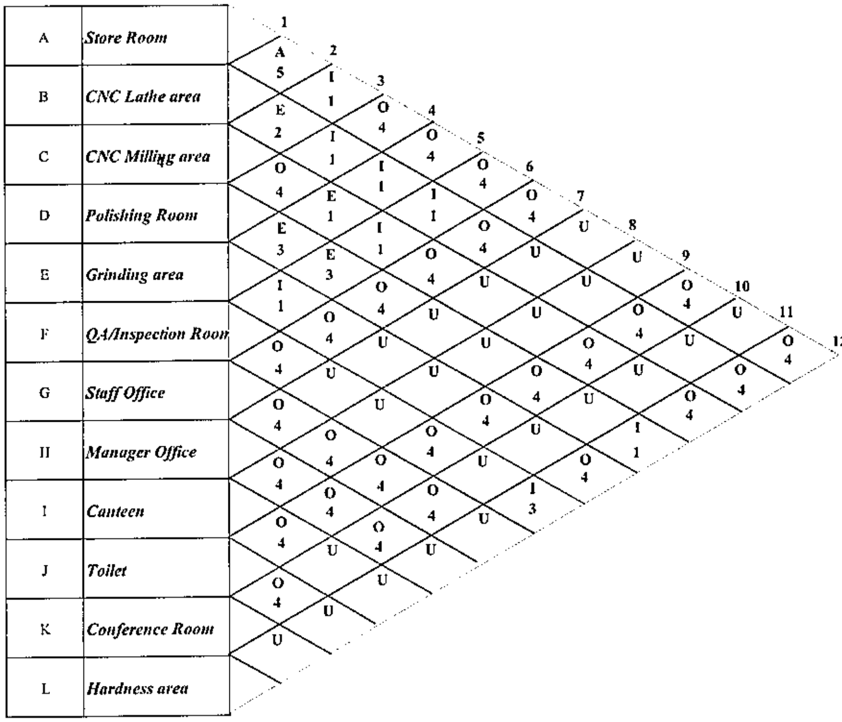

Figure 3 A relationship activity chart of checking ring

An activity relationship diagram is developed from information in the activity relation chart. Essentially the relationship diagram is a block diagram of the various areas to be placed into the layout. The departments were shown linked together by a number of lines in figure 4. For instance, A rating or four joining line indicate need to have two departments located close together whereas one line indicates a low priority and X rating indicate two departments not allowed to closed.

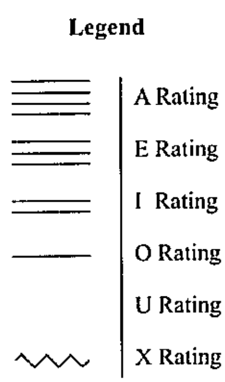

Figure 4 Relationship legend

For activity relationship diagram of manufacturing process divided into twelve areas for support all activities as figure 5.

Supporting	
A	*Store Room*
B	*CNC Lathe area*
C	*CNC Milling area*
D	*Polishing Room*
E	*Grinding area*
F	*QA/Inspection Room*
G	*Staff Office*
H	*Manager Office*
I	*Canteen*
J	*Toilet*
K	*Conference Room*
L	*Hardness area*

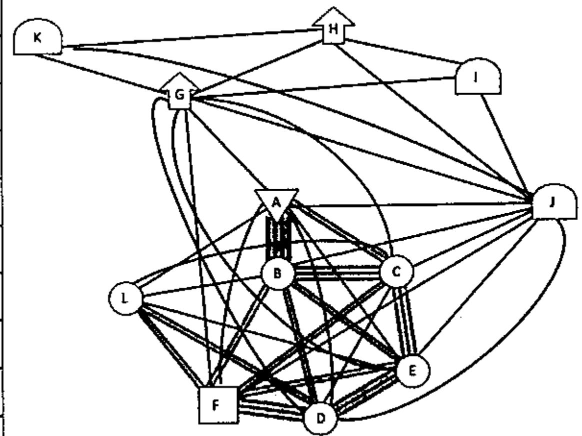

Figure 5 activity relationship diagram initial stage

4.4 Propose layout design

There are three layout were proposed when modified initial diagram and consider with process flow, space and limitation. Process flow was considered and designed.

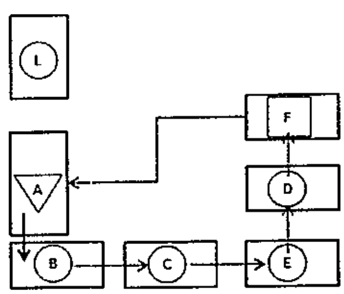

Figure 6 layout design 1

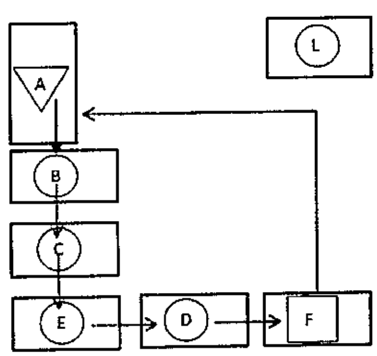

Figure 7 layout design 2

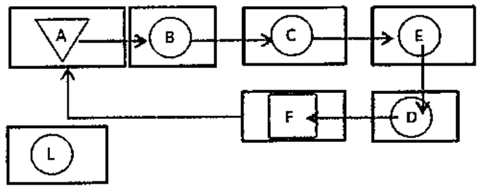

Figure 8 layout design 3

4.5 Evaluate layout design

This research demonstrates the flow of the MCDM methodology, a case study use multi-criteria decision making method to select best layout. All criteria were given by team including material flow (C1), convenience to transfer (C2), coordinate (C3), convenience for receiving material (C4) and convenience for operator operation (C5) and there are three layouts were selected.

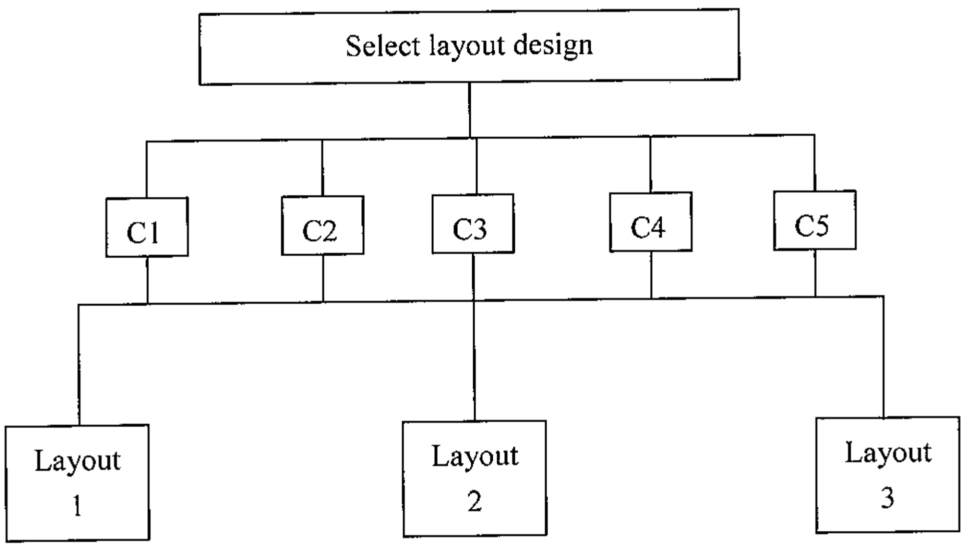

Figure 9 Decision Hierarchy

In this step, the weights of the criteria to be used in evaluation layout calculated by using AHP method and give rating score by team. The result weights of criteria and ranking layout were present in table 3 and table 4.

Table 3 the weights of criteria by AHP method

Criteria	Weight	λ_{max}	CI	RI	CR
C1	0.4642	5.3735	0.0934	1.12	0.083
C2	0.3198				
C3	0.0336				
C4	0.1182				
C5	0.0642				

Consistency ratio of the pair wise comparison matrix is calculated as 0.083 < 0.1. So the weights are shown to be consistent and they are used in layout selection process.

Table 4 the ranking layout by AHP method

Project	Weight	Rank
Layout 1	0.5426	1
Layout 2	0.1645	3
Layout 3	0.2929	2

5. Conclusion

This paper was followed Systematic Layout Planning (SLP) theory to improve process flow and use multi-criteria decision making to evaluate layout design which suitable in manufacturing. As the result of selection process multi-criteria decision method provides the systematic of group decision making that found layout 1 was selected by team. Next process manufacturing will be move refer layout 1 because it can be reduce distance and time of process.

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