

Sequencing of Dust Filter Production Process Using Design Structure Matrix (DSM)

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Abstract. Metal casting company produces machinery spare part for manufactures. One of the product produced is dust filter. Most of palm oil mill used this product. Since it is used in most of palm oil mill, company often have problems to address this product. One of problem is the disordered of production process. It carried out by the job sequencing. The important job that should be solved first, least implement, while less important job and could be completed later, implemented first. Design Structure Matrix (DSM) used to analyse and determine priorities in the production process. DSM analysis is sort of production process through dependency sequencing. The result of dependency sequences shows the sequence process according to the inter-process linkage considering before and after activities. Finally, it demonstrates their activities to the coupled activities for metal smelting, refining, grinding, cutting container castings, metal expenditure of molds, metal casting, coating processes, and manufacture of molds of sand.

1. Introduction

Competitiveness of market and product life cycles are getting shorter has become a threat to the company today. It is known that successful products are those that have the highest quality, lowest cost and shortest time to market [1]. Therefore, it needs a systematic and structured way to gain knowledge of product design and organization [2]. The company is engaged in manufacturing metal. One of the resulting product is a dust filter manufactured by metal casting. In meeting the demand, the company faced some problems. One of the problems facing the company is the irregularity of the production process carried out by the workers so that work is important and that should be solved first be ruled out, while the job is less important and which should be completed later implemented first. Based on the existing problems, the approach can be used to resolve such problems is a method Design Structure Matrix (DSM). DSM is a square matrix with columns and rows of identical [3]. Many researchers and practitioners have been using Design Structure Matrix (DSM) to represent and analyse models of complex systems [4]. DSM provides a simple and visualization for analysis and management of complex systems, especially to represent interactions and feedback dependencies between elements of the system [5]. Consequently, DSM is easy to comprehend and improves the efficiency in the late process of design for task such as management of development schedule, manufacturing, and parts. DSM approach along with tools and other methods can be widely used to solve different types of problems, such as the army, the Change Propagation Method (CPM), and Quality Function Deployment (QFD) [6] [7]. Previous research to determine the technical characteristics of the dust filter with Quality Function Deployment DSM has done. Furthermore, the



journal will be followed by determining the sequence of the production process dust filters using Design Structure Matrix (DSM). With QFD and DSM research that has been done on an information technology company in Taiwan to solve problems in making decisions crucial to determine priorities task. Problems contradictions on QFD solved using TRIZ, then the technical characteristics obtained are sorted by partitioning and tearing analysis in DSM method [8]. Another study conducted in Iran to determine the pattern of structural complexity of health and medicine, in Iran and accommodation needs of the recipients of treatment [9]. The use of DSM is very broad, it can even be used for the planning of integrated systems in the military system in the United States [10]. QFD translates customer needs into technology that helps the designer in manipulating the product design process to achieve optimum effectiveness of the process [11] [12]. This method produces a matrix that connects the technical characteristics of the product and consumers' desire for products. Then the Design Structure Matrix (DSM) is raised to make a priority of working against the elements that constitute the technical characteristics of the House of Quality (HOQ). Design Structure Matrix (DSM) consider the correlation factor between the technical characteristics that cannot be obtained in the study of Quality Function Deployment (QFD). The design process of the design structure matrix sort through sequencing analysis process and identify blocks of activity in the production process [13] [14].

2. Methods

Type of research is descriptive research which is a type of research that aims to describe in a systematic, factual and accurate about the facts and the nature of an object or a particular population. The research object observed in this paper is an attribute of the dust filter product.

In this paper, the method used is a combination of Quality Function Deployment (QFD) and Design Structure Matrix (DSM).

The term of DSM comes from the DSM function itself, using a matrix to model the design and structure of a system. Over the years, other terms that are often used in addition to the design structure matrix is a dependency structure matrix, dependency system models, deliverable source folder and others [20]. The Quality Function Deployment (QFD) has been discussed in previous research that produces quality house (House of Quality) which serve as inputs to the matrix DSM. Relations between the technical characteristics and performance measures in the House of Quality of Quality Function Deployment (QFD) as input for the establishment of a binary matrix at DSM. Furthermore, the sequencing models. The results of the model sequencing are the determination of the base sequence of process improvements made dust filter product design process.

Three methods are typically used to reorder rows and columns on the DSM are: clustering, partitioning, and tearing [15] [16]. Preparation of Design Structure Matrix (DSM) is divided into five key stages are as follows: [17] [18]

- a. Decomposition, break the system down into a form of more simple elements based on the level of the system hierarchy.
- b. Identification, Identify the relationships that occur between system elements.
- c. Analysis, Reconstitute the elements and relationships in the matrix to obtain a better understanding of the system.
- d. Display, make a representation of the model DSM, which aims to show the relationship that are important in a system.
- e. Improve, Improvising and improving on the result of improvements in the system resulting in continuous improvement.

3. Results and discussion

DSM is used to analyse and sort the processes of production of a product. The steps to create Process Architecture DSM namely:

1. Determination of boundary system using data from the technical characteristics.
2. Determination of the strength of the interaction between the production process.

Interaction strength value obtained from the rooftops of house of quality that is relationship between the quality of the technical characteristics. Interaction strength every technical characteristic can be seen in Figure 1.

Importance	Importance										
	Mix sand silica, bentonite, and water	Make sand mold	Coating process	Metal melting	Pour metal to sand mold	Release metal from mold	Cut cast container	Grinding	Smoothing	Painting	
	3	3	3	3	5	4	2	3	3	2	
Mix sand silica, bentonite, and water	3										
Make sand mold	3	4									
Coating process	3	4	3								
Metal melting	3										
Pour metal to sand mold	5	3	4	3	4						
Release metal from mold	4	3	2	3	3	1					
Cut cast container	2				3	3	3				
Grinding	3				3	3	4				
Smoothing	3				3	3	3		3		
Painting	2								3	4	

Figure 1. Interaction Strength

3. Determination of the model's granularity

Model's granularity is determined to obtain the sum value of the interests of a process. The calculation of the value in the model's granularity for sand mold making and coating process which is $3 \times 2 \times 2 = 12$. The model's overall granularity can be seen in Figure 2.

4. Identifying the interactions between processes by sequencing.

Sequencing is the most important stages in determining the optimum allocation of N component to the M sequence. The process of sequencing is done with the help of software DSM Matrix v1.3. Dependency sequences display on DSM Matrix v1.3 software can be seen in Figure 3.

	Mix sand silica, bentonite, and water	Make sand mold	Coating process	Metal melting	Pour metal to sand mold	Release metal from mold	Cut cast container	Grinding	Smoothing	Painting
Mix sand silica, bentonite and water										
Make sand mold	36									
Coating process	36	27								
Metal melting										
Pour metal to sand mold	45	60	45	60						
Release metal from mold	36	24	36	36	20					
Cut cast container				18	30	24				
Grinding				27	45	48				
Smoothing				27	45	36		27		
Painting								18	24	

Figure 2. Model's Granularity

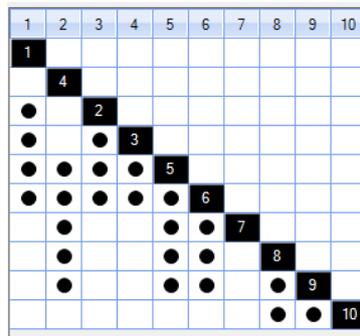


Figure 3. Dependency Sequence Display

Result of dependency sequence obtained by the process sequence based linkages between processes by considering the activity before and after. The results obtained from sequence dependencies change order process activities are shown in Table 1. The results indicate that the melt can be done prior to making sand molds. After the metal melted down, workers can make sand molds without disturbing the metal melting process itself because both activities can be done in parallel without disrupting the activity of each other.

Table 1. Activity Sequence Before and After Dependency Sequencing Analysis

Seq.		After Dependency Sequencing Analysis
1	Mix sand silica, <i>bentonite</i> , and water	Mix sand silica, <i>bentonite</i> , and water
2	Make sand mold	Metal melting
3	Coating process	Make sand mold
4	Metal melting	Coating process
5	Pour metal to sand mold	Pour metal to sand mold
6	Release metal from mold	Release metal from mold
7	Cut cast container	Cut cast container
8	Grinding	Grinding
9	Smoothing	Smoothing
10	Painting	Painting

Views clustering sequences on DSM Matrix v1.3 software can be seen in Figure 4.

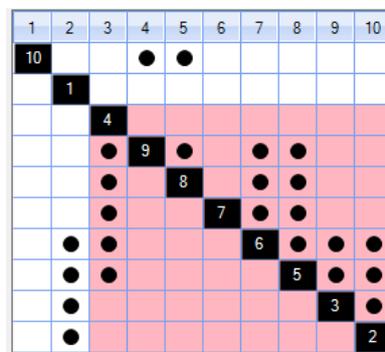


Figure 4. Clustering Sequence Display

Clustering sequences shows that there are coupled activities [17] for activity 4,9,8,7,6,5,3, and 2. In the coupled activities, each activity requires input from other activities so that their iterations to obtain a satisfactory solution. The execution of coupled activities should be prioritized because any activity related to each other.

4. Conclusion

The conclusion in the research using DSM is obtained by sequencing analysis. Where the result obtained from dependency sequence permutation process activity. Changing this sequence is possible to do by doing the parallel activity of the metal melting and mold making that can streamline production time. Clustering sequence shows coupled activities. Coupled activities related to one another only if each input coupled activities in activities derived from other activities so that each activity cannot stand alone. It can be concluded that the sequencing analysis can cluster coupled activities, that should be prioritized executed.

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