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Research paper

An Application of Cellular Manufacturing System for a Refrigerator Door Gaskets Processing Improvement: a Case Study

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Abstract

This paper aims to study the processing improvement on electrical industry in Thailand. The case study of manufacturer is an electrical part assembly factory. The main product of this manufacturer is a refrigerator door gasket. In the past several month, that factory had a high production cost and the productivity on the production line is quite down. Therefore, this paper applies the processing improvement approach that is cellular manufacturing system with the ECRS principal for the production line. The results illustrate that the propose improvement approach is more efficient for a refrigerator door gaskets production line.

Keywords: *cellular manufacturing system; ECRS principal; processing improvement; refrigerator door gaskets*

1. Introduction

In the past several years, a plenty of manufacturing industry have been a high competition in the industrial world. Such as marketing, production cost, transportation, etc. Especially in the world of industry4.0, many manufacturers are focus that how to improve the productivity of their factory. Because of the high or smart productivity is affected to rise up the level of each manufacturing. Likewise the electrical industry, each company aims to develop the production and manufacturing for increasing the productivity. Plant layout and facility design is one of the approaches to increase productivity for manufacturing. Many researchers investigated verities of improvement methods to apply in manufacturer. In the study of [1], the research demonstrated the lean manufacturing concept that cellular manufacturing system (CMS). Also [2] presents the implementation of cellular manufacturing for minimizing the non-value added. The results show that their method was more efficient to improve the productivity. According to [3], [4] and [5] also propose the application of cellular manufacturing system in a factory case study. Those researches propose how to use the CMS in manufacturing. As results of the studies, the CMS approach can improve productivity in the manufacturing. Also [6], [7], [8] and [9], those researches demonstrate the effectiveness of cellular manufacturing system that more efficiency in the real industry world. Therefore, the cellular manufacturing system is more important to improve the operation productivity.

This research studies on a refrigerator door gasket manufacturing. The cellular manufacturing system with the ECRS principal is applied to improve the processing productivity. Section 2 describes the theory of plant layout and facility design. In addition, the relational theories have been described. Section 3 demonstrates the implementation of CMS on a refrigerator door gasket manufacturing. Section 4 shows the improvement results. And the last section describes the conclusion of the efficiency of propose method.

2. Theory and literature reviews

2.1. Plant layout and design

Plant layout and design is the method to locate the man, machine, method and production facilities into manufacturing shop floor. The optimal/appropriated approach affects to economist, reduce transportation time and distance. Therefore, the optimal/appropriated approach for layout facilities is extremely necessary for manufacturing.

The common types of plant layout and facility design in manufacturing system are

2.1.1. Product layout

Product layout is the layout which located the machine and all the processing equipment according to the sequencing operations. This method demonstrates in Figure 1.

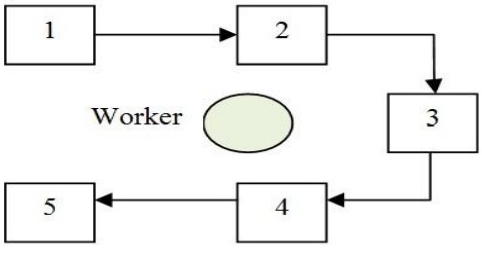


Fig. 1: Product layout

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2.1.2. Process layout

Process layout is the most common type of manufacturing layout. For the method, the machines are not arranged by the operations sequence but are arranged base on nature or type of the operations that shows in Figure 2.

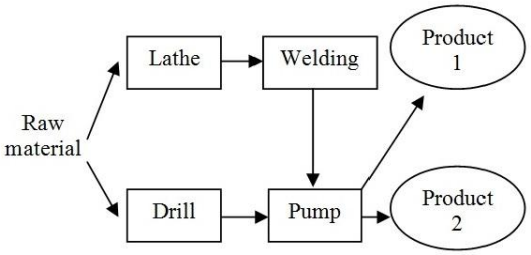


Fig. 2: Process layout

2.1.3. Fixed position layout

Fixed position layout is the method to operate product that locate all components, equipment or machines around the position of product. Figure 3 shows the characteristic of this method.

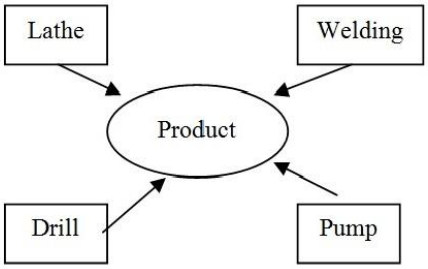


Fig. 3: Fixed position layout

2.1.4. Group or Cellular layout

Group or Cellular layout is the concept to locate the machine which has a similar function into same region/zone. The characteristic of this type illustrates in Figure 4 as follow:

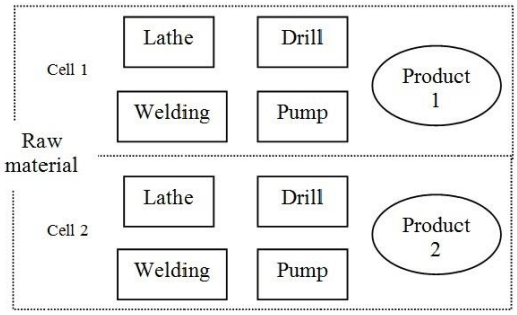


Fig. 4: Group or Cellular layout

2.2. Cellular manufacturing system

Cellular manufacturing system is the one of the facility layout located approach. The concept of this method bases on group technology. Namely, machine which has similar function is located in the same area/zone. The production line is operated consequently.

Advantages of cellular manufacturing compared to traditional manufacturing by efficient layout design are reduction in material flow distance, setup times, work in process, material flow distance, material handling cost and time, etc., also improvement in the quality, machine utilization of the production line.

2.3. The principle of ECRS

The ECRS is the method to improve productivity of the processing line. The concept of this method consists of elimination, combination, rearrangement and simplification that describe as follow;

a) Elimination is a procedure to eliminate the wastes that have occurred in the operation line.

b) Combination is a method to consider the unnecessary operation step on processing line that can be combined.

c) Rearrangement is the approach to rearrange the production flow line for movement reduction.

d) Simplification is the way to redesign the procedure to be a simplify method.

2.4. The 7 Wastes of lean manufacturing

The seven wastes of lean manufacturing are the non-value added losses in manufacturing.

The Seven Wastes of Lean Manufacturing are;

- Transport
- Inventory
- Motion
- Waiting
- Over-Processing
- Overproduction
- Defects

3. Implementation of cellular manufacturing on a refrigerator door gaskets processing

This paper studied on a refrigerator door gasket processing of electrical manufacturer that located in Thailand. This manufacturer produces the parts assembly for electrical industry. The main product of this factory is a refrigerator door gasket. For six month latest, the average product is 84,000 units per month approximately. Figure 5 illustrates the flow process chart of a refrigerator door gasket.

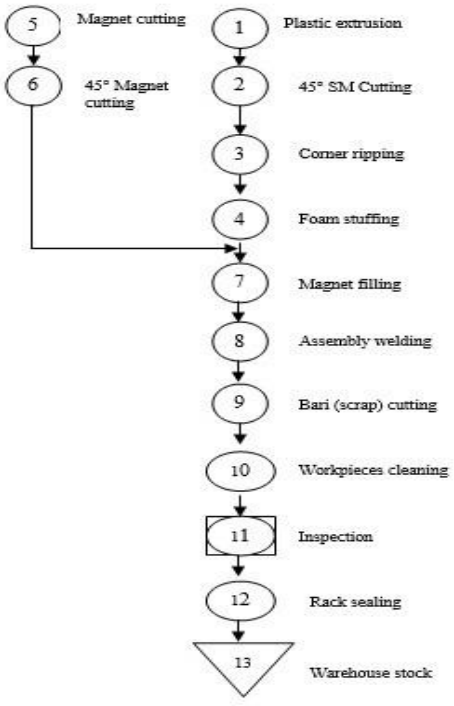


Fig. 5: Flow process chart of a refrigerator door gasket.

From the study, the wastes of the production line were occurred. The productivity of processing line was down that affect to be an uplifting cost. Therefore, we proposed the improving procedure to improve productivity of the operation line. For the method, the ECRS principal was adopt with the cellular manufacturing system concept. The ECRS principal was used to reduce wastes that have occurred in the line that illustrated in table 1. The cellular manufacturing concept had been applied to rearrange the position of machine in the shop floor. The machines which have similar function were group in the same zone. Figure 6 demonstrates the cellular layout in shop floor.

Table 1: The ECRS procedures on a refrigerator door gaskets processing

Current operations	The ECRS	Improvement concept
1.Workers convey workpieces into cutting mahine	-	
2. Workers set up mold	-	
3. Workers cut 45° SM	-	
4. Workers hold workpieces on rip corner workpiece table	S	reduce the table size for walk step reduction
5. Workers cut magnet	-	
6. Workers convey rip corner workpiece to the magnet assembly table	R	rearrange the position of the worker
7. Workers rip corner of workpiece	-	
8. Workers stuff a foam into workpiece	-	
9. Workers assembly magnet into workpiece	-	
10. Workers transport the workpiece to the welding table	R	rearrange position of magnet table closed to the welding area
11.Workers hold on the workpiece for welding	E	reduce the walking distance
12. Workers transport the workpiece to the bari(scrap) cutting area	R	rearrange the workpiece buffer close to welding area
13. Workers cut bari of the workpiece	-	
14. Workers transport the workpiece to the clean the product area	C	combine the operation steps for only one worker
15. Workers clean the gasket product		
16. Workers hang on the product on the rack		
17.QC staff inspect product at QC area		
18. Workers seal the product		
19. Workers transport the product to finished good zone	-	
20. Workers transport product to warehouse area for delivery	-	

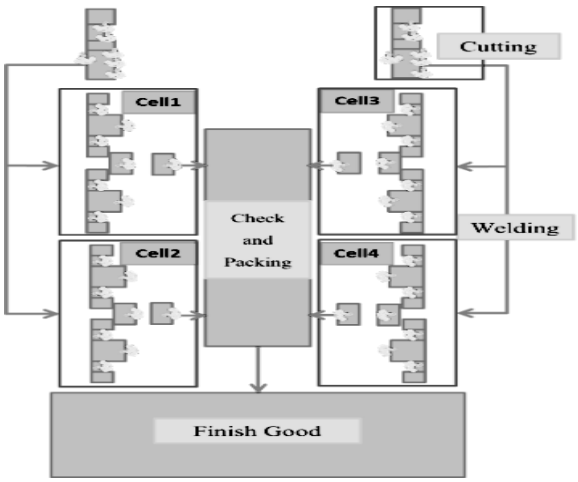


Fig. 6: Cellular manufacturing layout in shop floor

From the proposed methods that demonstrate in table 1 and fig. 6, the number the operation step have reduced by the ECRS principal and the transportation distance was reduced by CMS approach.

4. Performance measurement

This paper proposed the improvement approach for a refrigerator door gasket manufacturing. To evaluate the performance of the method, the 4 months before and after improvement data had been compared. The results show in table 2 in term of average value.

Table 2: A comparison results between before and after improvements

Performance measurement factor	Before Improvement	After Improvement	Percentage of differentiation
1.Transportation time(second)	239.18	187.46	21.62
2. Transportation distance(meter)	143.26	34.66	75.81
3.Production time (second)	865.8	795.3	8.14
4. No. of WIP (pieces per month)	147	130	11.56
5. No. of product unit(pieces per month)	84,144	93,625	11.27

As the results, cellular manufacturing system with the ECRS principal is more efficient for a refrigerator door gasket processing improvement. Namely, transportation time and distance were reduced as 21.62% and 75.81%, respectively. The production time of this product was also reduced as 8.14%. Also the number of work in process in the processing line, it was reduced. Furthermore, the high productivity can affect to the number of product unit increased as 11.27%.

5. Conclusion

This research proposed the cellular manufacturing system (CMS) and the principal of ECRS to improve the productivity of a refrigerator door gasket, a case study of electrical industry in Thailand. In the past several months, that manufacturer has a high cost and low productivity in a refrigerator door gasket production process. Since the propose method was applied, the productivity of production line becomes higher. Therefore, cellular manufacturing system with the ECRS principal is effectiveness for processing line improvement.

Acknowledgement

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