IMPROVING QUALITY OF LIGHT COMMERCIAL VEHICLE USING PDCA APPROACH

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ABSTRACT: Good quality coating in painting process of light commercial vehicle is important to reduce cost and concurrently achieve customer satisfaction. The PDCA-cycle approach is utilized to reduce the defects in the electrodeposition process. In this study the bits defect on the electrodeposited body is investigated. A systematic quality improvement plan and optimization are performed. The application of the PDCA-cycle improved 65% of bits and reduced 34% of sanding man hour.

KEYWORDS: *Electrodeposition; Defect; Quality Improvement; PDCA*

1.0 INTRODUCTION

Quality improvement is about finding out how to do things better [1]. The efficient way to do this is by using the scientific method. Modern quality improvement extends the domain of scientific method over users, over areas of human endeavor, over time, and over causative factors [2]. Quality improvement methods focus on reducing, defects or errors by eliminating variation in both manufacturing and service operations; hence, quality tools are often used to investigate problems and develop appropriate solutions to address these problems [3].

Most of the highly active automotive companies are implementing the leadership attributes in Lean Manufacturing and Total Quality Management [4]. Researchers have introduced a number of methodologies for quality improvement including PDCA, Six sigma, Total Quality Management (TQM) and Statistical Process Control (SPC). The common approach between all the mentioned methodologies is scientific problem solving technique. The PDCA-cycle is a dynamic model and an integral part of the process management which is designed to be used as a dynamic model because one cycle represents one complete step of improvement [5]. The circle is presented in four quadrants of plan-do-check-action [6]. PDCA cycle is widely applied in QM and achieved good results [7]. The PDCA-cycle has successfully improved the FTT- rate in RMG sector [8].

Painting process is critical in the manufacturing process of light commercial vehicle to provide both protection and decorative elements. Good quality coating is important to reduce cost and concurrently achieve customer satisfaction. The electrodeposition (ED) in the light commercial vehicle is a special coating method where the ED paint that is dispersed in water is electrically deposited on the substrate to form a uniform and water-insoluble. The main purposes of the coating are to protect the substrate from the corrosive attack and to provide it with a good appearance [9]. The primary process for ED is electrolysis [10 - 11]. The fundamental aspect of ED is reported by Beck [12]. This paper focuses on the systematic application of PDCA-cycle in an automotive manufacturing plant to improve the quality of painting process in order to reduce the operational cost and time.

2.0 METHODOLOGY

It is commonly known in the painting process of an automobile industry that, many surface defects arise from the poorly cleaned surface after the ED process. As a solution, the defected surface on the body is required to be removed by sanding process before proceeding to next coating process which is the primer coating. Since the process of sanding is costly, it is very important to provide a good quality surface of the electrodeposited body. The good quality of the electrodeposited surface can be achieved by reducing the defects during the ED process. The common defects of the electrodeposited surface are bits, pinhole, cissing, sludge, grind mark and line mark.

Due to the criticalness of having the defects, many literature studies had been conducted on the applications of reducing defects in automotive painting process. One of the major defects from ED process is the bits. Accumulation of remaining particles within dipping tank is the root cause for producing the bits. In order to coordinate the continuous improvement effort, the PDCA-cycle is utilized. The PDCA-cycle methodology is illustrated in Figure 1.

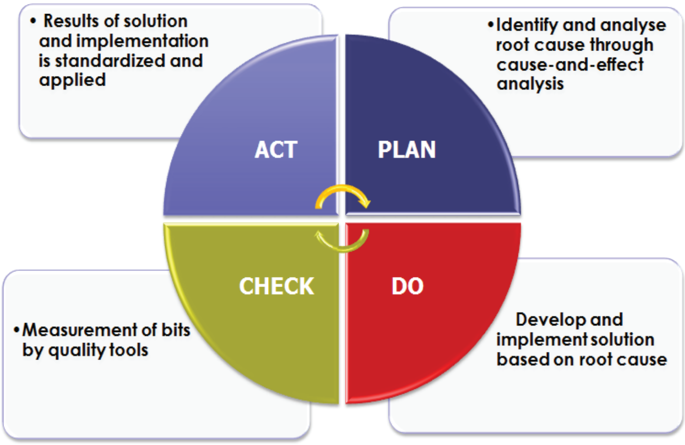

Figure 1: The PDCA-Cycle Methodology

In the plan-stage, the problem is identified using Pareto-chart and subsequently the root because is analyzed through cause and effect diagram. The Pareto-chart is used to separate the “vital few” from “the trivial many” [13]. The cause and effect diagram is a tool used to identify and isolate causes of a problem [14]. A brainstorming session is conducted to identify the main root cause item. Following to that, in the do-stage the implementation of solution, there will be measurement on the quality results of the implementation in the check-stage. Finally in the act-stage, the results of the implementation is standardized and applied and the PDCA-cycle is restarted again to sustain and improve process further.

3.0 RESULTS AND DISCUSSION

In the plan-stage the major problems are analyzed based on the collected data on defects occurred after the ED process, where these defects are detected on the coated surface after the baking process through visual inspection. In more details, the bright lights and the associate reflections measured through visual inspection are used for locating and evaluating any defects. Some of the defects found are bits, grind mark, rough surface, line mark, and sludge, pinhole, mapping mark and sanding mark. As a method to identify the main problem, the defects are plotted in a Pareto-chart as depicted in Figure 2.

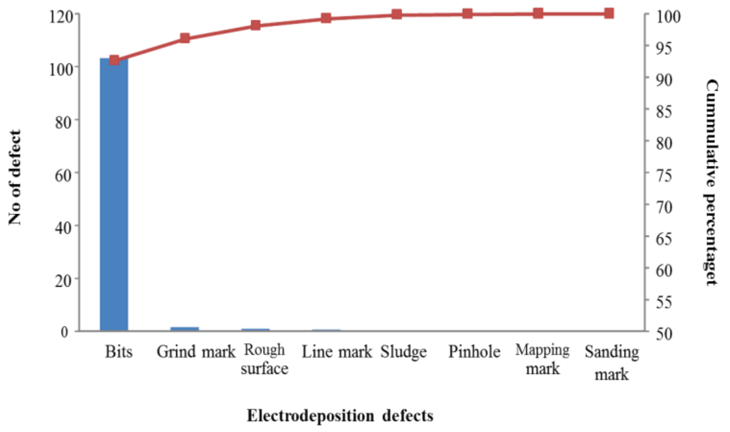

Figure 2: The Electrodeposition Defects

Based on the chart, it can be observed that the main problem is the bits that accounts for 93% of the overall defects. Therefore, bits are selected as the main defect that critically requires a solution. Bits are basically foreign materials that are found to be sticking on the coated surface. The root cause of bits is analyzed by using Ishikawa diagram as shown in Figure 3. The analysis is divided in four main factors, namely man, method, machine and material.

In the do-stage, the countermeasure solution is implemented after the brainstorming session. The team elaborated an action plan covering a set of corrective action, the designated responsibilities and a time frame available for completion, behind each item. The planning of improvement activities are elaborated in Table 1. In the check-stage, the quantity of the bits on the coated surface is counted after the improvement. The amounts of bits that can be seen and felt by hand are counted in a 100 millimeters square outside of the coated body. The measurement is taken at the three surface areas, namely roof surface, bonnet surface and door surface. The bits count after the improvement are recorded and presented as depicted in Figure 4.

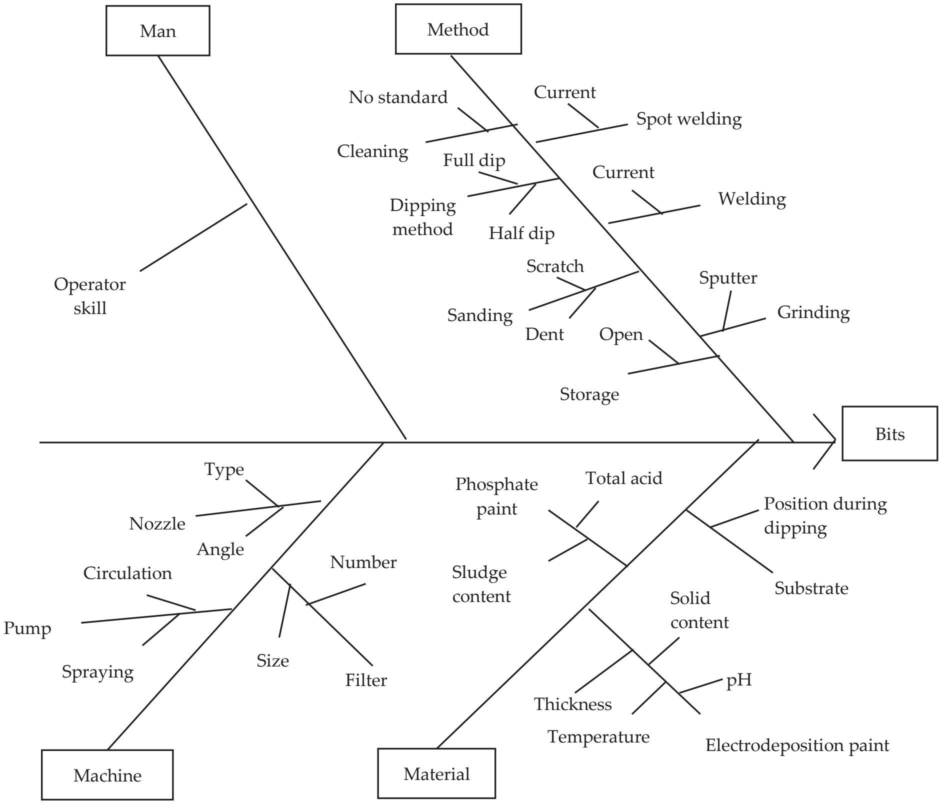

Figure 3: Bits root cause analysis

Table 1: The planning of improvement activities

Item	Root cause item	Countermeasure	Responsible	Timing
Operator skill	Skill during welding and spot welding	Training and certified person	Production	1 Quarter
Spot welding	Current	Periodical check	Maintenance	1 Quarter
Welding	Current	Periodical check	Maintenance	1 Quarter
Grinding	Sputter	Control defect to reduce grinding	Production, Engineering	1 Quarter
Sanding	Scratch	Control defect to reduce scratch	Production, Engineering	1 Quarter
	Dent	Control defect to reduce dent	Production, Engineering	1 Quarter
Dipping method	Full dip	Convert Tank 1 from full dip to half dip	Engineering	4 Quarter

Storage	Open	Put cover for body if storage over than 3 days	Production	1 Quarter
		Control min and maximum of white body storage	Production	1 Quarter
Cleaning	No standard	Establish standard	Engineering	1 Quarter
Pump	Circulation	Repair pump	Maintenance	2 Quarter
	Spraying	Repair pump	Maintenance	2 Quarter
Nozzle	Type	Change to flat type nozzle	Engineering	2 Quarter
	Angle	Repair relay and reset spraying angle	Maintenance, Production	2 Quarter
Filter	Size	Change to finer size of 25 and 50 and change from polyester to nylon	Engineering	2 Quarter
		Additional filter for body washer spray	Engineering	2 Quarter
	Number	Additional filter for Tank 7	Engineering	2 Quarter
Phosphat e paint	Sludge content	Change new filter	Engineering	3 Quarter
Substrate	Position during dipping	Increase length of bonnet stopper	Engineering	1 Quarter

The bits counts on the roof surface, bonnet surface and door surface before improvement are 58, 45, and 7, respectively. After the improvement, the bits count on the roof surface improved 67%, the bonnet surface improved 71% and the door surface improved 57%. There was improvement of bits count, however still not achieved the target of 3 bits on roof and bonnet surface.

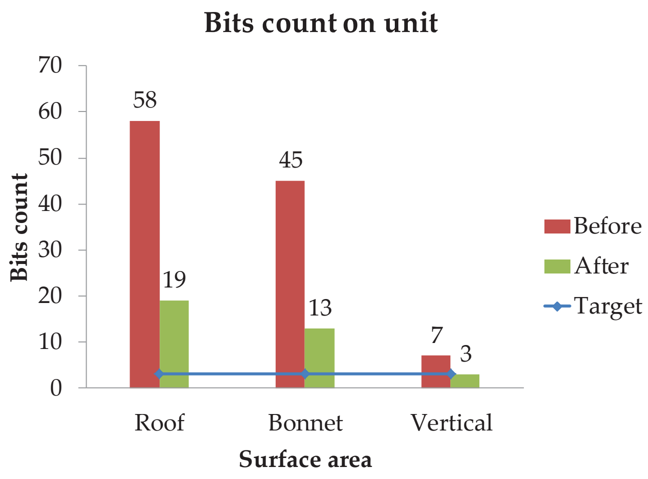

Figure 4: Comparison of bits counts before and after improvement

For the completion of the first cycle, in the act-stage, the improvement activities were set up as a standard procedure to sustain the improvement. However, the filter size standard cannot be standardized due to the high blockage frequency. The bits count will be further improved by restarting the PDCA-cycle.

By applying PDCA-cycle for quality improvement, the rework activity of sanding on the surface area has been reduced. Therefore, the man hour, manpower and sanding disc consumption are reduced. The reduced items are discussed in Table 2. The man hour is reduced from 0.45 to 0.30, while the manpower is reduced from 8 persons to 5 persons. The sanding disc consumption for sanding consumption for sanding activity is also reduced from 8 to 4 pieces per unit. By translating these figures into cost, this activity contributes to the saving of RM 4.000 on sanding disc consumption and RM 36.00 on man hour cost.

Table 2: The reduced items before and after the improvement

Item	Before	After
Manpower	8 persons	5 persons
Man hour	0.45	0.30
Sanding disc consumption	8 pieces	4 pieces

4.0 CONCLUSION

The main defect of the electrodeposited body was generation of bits. The systematic application of PDCA-cycle improved the generation of the bits. The average number of bits reduced was by 65%. In the perspective of the operational expenditure, the sanding man hour used to improve the electrodeposited body is reduced by 33% with a total saving of RM39.00 per unit.

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