QUALITY IMPROVEMENT IN ELECTRODEPOSITION PROCESS OF COMMERCIAL VEHICLE USING PDCA APPROACH

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Master of Science

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SUPERVISOR'S DECLARATION

We hereby declare that we have checked this thesis and in our opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Master of Science in Manufacturing Engineering

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I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

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LIST OF SYMBOLS

μm	micrometres
mm	millimetres
m^3	cubic meters

LIST OF ABBREVIATIONS

ED	Electrodeposition
PDCA	Plan-Do-Check-Act
NEP	Not enough paint
TQM	Total Quality Management
SPC	Statistical Process Control
SQC	Statistical Quality Control
SPQC	Statistical Process Quality Control
DPU	Defect per unit
5W2H	What,when,who,where,why,how,how much
GUT	Gravity, Urgency and Tendency
2K	2 Komponent
BIW	Body in White
PVC	Polyvinyl Chloride
Ti	Titanium
DI	Deionised
PP	Polypropylene
CKD	Complete knock down
JIA	Joint inspection area
SEM	Scanning Electron Microscope
SEM/EDX	X-ray spectrometer
MIG	Metal inert gas
TPM	Total Productive Maintenance
AM	Autonomous Maintenance

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ABSTRAK

Dalam dunia yang kompetitif, matlamat utama merupakan kualiti terbaik, masa pengeluaran terpendek dan kos terendah. Isu utama untuk memenuhi ketiga-tiga aspek ialah mengurangkan kos dan meningkatkan kualiti. Dalam kajian ini, kajian kes mengggunakan pendekatan dan aplikasi secara sistematik dan teknik pengurusan yang canggih dilaksanakan di kilang automotif sebenar untuk meningkatkan kualiti proses mengecat. Masalah yang timbul dalam proses pembuatan kenderaan komersial ialah kualiti rendah pada badan kenderaan yang dicat. Sebuah pengeluar kenderaan komersial ringan menghadapi masalah kualiti di permukaan deposisi elektro pada produk yang dihasilkan. Permukaan badan kenderaan yang dicat dicemari kecacatan yang tinggi semasa proses deposisi elektro. Permukaan yang mempunyai kecacatan boleh disingkirkan melalui proses pemasiran yang berkos tinggi dan memakan masa pengeluaran. Objektif kajian ini untuk mengenalpasti dan menganalisis faktor-faktor yang mempengaruhi kualiti proses deposisi elektro dan mengurangkan kos operasi. Kajian ini memberi tumpuan kepada pengurangan kecacatan deposisi elektro dalam proses mengecat untuk meningkatkan kualiti dan mengurangkan proses pemasiran daripada major kepada minor. Pendekatan yang dicadangkan ialah dengan menggunakan kitaran PDCA untuk mengurangkan kecacatan deposisi elektro pada badan kenderaan. Pendekatan tersebut dicadangkan kerana memenuhi budaya organisasi yang mengadaptasi aspek pengurusan pembuatan Jepun. Kecacatan utama pada badan kenderaan yang telah dideposisi elektro dikenal pasti oleh carta Pareto. Kecacatan bit pada deposisi elektro badan kenderaan disiasat dalam kajian ini. Punca utama bit adalah 80% dari besi dan 20% dari fosfat. Habuk besi terhasil dari proses pemasangan badan kenderaan yang dijalankan di bahagian pemasangan badan kenderaan, kekal di dalam badan kenderaan dan dibawa masuk ke proses pengecatan. Pencemaran fosfat dihasilkan akibat kesan tindak balas kimia antara besi badan kenderaan dan bahan kimia zink fosfat. Punca utama masalah bit telah dikenalpasti menggunakan kaedah berkualiti seperti brainstorming, rajah sebab dan kesan dan penyiasatan genba. Melalui analisis Graviti, Urgency, dan Tendency (analisis GUT), penyebab utama diutamakan dan aktiviti penambahbaikan dirancang dengan menggunakan alat 5W2H. Kaedah terbaik untuk mencegah kecacatan bit ialah dengan mengeluarkan atau mengurangkan pencemaran besi dan fosfat di bahagian pemasangan dan pengecatan badan kenderaan. Kawalan proses, penapisan dan kaedah penyemburan yang berkesan, pemisahan magnetik dan proses pelarasan permukaan badan kenderaan adalah disyorkan untuk memperbaiki kecacatan bit. Pelaksanaan kitaran PDCA mengurangkan kecacatan bit daripada 103 ke 21 kecacatan bit per unit dan menyumbang kepada pengurangan kos operasi sebanyak 49%. Jumlah pengurangan operasi itu bersamaan dengan gaji tujuh (7) orang pekerja di kawasan pemasiran elektro deposi selama setahun. Hasil daripada kajian ini telah memberi gambaran tentang penggunaan kitaran PDCA yang berjaya melalui penggunaan pendekatan dan aplikasi secara sistematik dan alat pengurusan kualiti asas dan teknik canggih sebagai rangka kerja penyelesaian untuk menyelesaikan masalah industri sebenar seperti masalah bahagian pengecatan automotif.

ABSTRACT

In a competitive world, the goals are best quality, shortest production time, and lowest cost. The main issues in meeting these three aspects are reducing cost and improving quality. In this research, a case study using a systematic approach and an application of basic and advanced tools and techniques was carried out in an actual automotive plant to improve the quality of the painting process. In the manufacturing of commercial vehicles, the problem faced was low quality of the painted body. A light commercial vehicle company was facing a low-quality problem on the electrodeposited surface of their product. The surface of the painted body was contaminated with defects during the electrodeposition process. The defect surface can be removed through the process of sanding but it is high in cost and requires extensive production time. The objectives of this study are to identify and analyse factors affecting the quality of electrodeposition process and reduce the operational cost. The study focused on reducing defects in the electrodeposition process of painting process to improve the quality and replacing the major sanding process with light sanding process. The PDCA cycle approach was utilised to reduce the defects in the electrodeposited body. The approach was proposed as it fitted the organisation culture adapted from the Japanese manufacturing management system. The major defect in the electrodeposited automobile bodies was identified by Pareto chart. The main defect of bits was investigated in this study. The major contribution of the bits was 80% from iron and 20% from phosphate. The iron filings from the metal assembly process carried out in the body assembly shop remained on the body during the painting process in the paintshop. The phosphate sludge was generated due to the effect of the chemical reaction with the metal and zinc phosphate chemical. Using quality tools like brainstorming, cause-and-effect diagram, and genba investigation, the root causes of the bit problem were identified. Through the Gravity, Urgency, and Tendency (GUT) analysis, the root causes were prioritised and the improvement activities were planned using 5W2H tools. The best method to prevent the bit defects was by removing or reducing the iron filing and phosphate sludge at the body assembly and painting departments. The process control, efficient filtration and spraying method, magnetic separation, and surface adjustment process were recommended to improve the bit defects. The application of PDCA cycle succeeded in helping the company to minimise from 103 to less than 21 bits per unit and contributed to a total of 49% operational cost reduction. The amount is equivalent to the salary of seven (7) operators at electrodeposition sanding line for one year. The results from the study have provided an insight on the successful deployment of PDCA cycle through the application of basic and advanced tools and techniques as the systematic problem-solving framework on solving actual industrial issues such as automotive painting problem.

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