MATHEMATICAL MODEL OF PRODUCTIVITY PERFORMANCE OF A PLASTIC CELL PHONE HOUSING

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ABSTRACT

This research was conducted in the injection molding production department and it makes a significant contribution in the areas of injection molding industry and academic work. The research is an attempt to find ways to achieve high productivity performance by applying mathematical modelling and statistical methods to develop an integrated solution by combining technical and human factors in the injection molding industry. This is accomplished through a case study carried out in two phases. The aim of phase 1 is to determine the optimal injection molding process parameters setting by Design of Experimental (DOE) based methods that could be set to maintain the dimensions of the length and width of a cell phone housing as close to the target values of length (93.49 mm) and width (45.93 mm) as possible. The quality control tools were used to identify the critical injection molding process parameters, namely, mould temperature, injection pressure and screw rotation speed which can minimize the shrinkage defect. The statistical results and analysis are used to provide better interpretation of the experiments. The significant factors affecting the responses were identified by using ANOVA. Subsequently, the mathematical model equations were developed for predicted responses. The optimal process parameters setting was found to be: mould temperature at 90°C, injection pressure at 2331 kg/cm^2 and screw rotation speed at 123 mm/sec, by using response surfaces and contour plots. Verification and confirmation runs were carried out to ensure the achievability and stability of the determined optimal process parameters setting against the target dimensions of the length and width. The aim of phase 2 is to improve the daily productivity performance by evaluating three performance indicators, namely, production capacity, reject rate and process yield of the injection molding department, especially before and after the payday, and during working days in long holiday periods. The daily production data collected from injection molding production floor was used to obtain the daily productivity performance indicators. Subsequently, the One-Sample t-test was applied as a statistical tool to evaluate the daily productivity performance indicators. The appropriate payday was identified as every fourth Monday of the month. It was also found that all the daily productivity performance indicators did not reach the "Normal" level during working days in long holiday periods.

ABSTRAK

MODEL MATHEMATIK BAGI MENILAIKAN PRESTASI PRODUKTIVITI SEBUAH PENUTUP PLASTIK TELEFON BIMBIT

Kajian ini telah dijalankan di jabatan pengeluaran pengacuan suntikan dan ia memberikan sumbangan penting kepada industri acuan suntikan dan akademik. Kajian ini adalah satu usaha untuk menentukan cara-cara untuk mencapai prestasi produktiviti yang tinggi dengan menggunakan pemodelan mathematik dan kaedah statistik untuk membangunkan satu penyelesaian bersepadu dengan menggabungkan faktor-faktor teknikal dan manusia dalam industri acuan suntikan. Ini dapat dicapai melalui satu kajian kes yang dijalankan dalam dua fasa. Tujuan fasa 1 adalah untuk menentukan suntikan penetapan parameter-parameter proses optima dengan menggunakan kaedah berasaskan rekabentik ujikaji eksperimen yang boleh mengekalkan dimensi panjang dan lebar sebuah penutup telefon bimbit menghampiri dengan nilai sasaran panjang (93.49 mm) dan lebar (45.93 mm) yang mungkin. Alat-alat kawalan kualiti telah digunakan untuk mengenal pasti parameter-parameter yang kritikal dalam proses suntikan, iaitu, suhu acuan, tekanan suntikan dan kelajuan putaran skru yang boleh mengurangkan kecacatan pengecutan. Analisis dan keputusan statistik digunakan untuk memberi tafsiran yang lebih baik berdasarkan eksperimen-eksperimen yang telah dijalankan. Faktor-faktor penting yang mempengaruhi keputusan eksperimen telah dikenal pasti dengan menggunakan kaedah ANOVA. Selepas itu, persamaan-persamaan model matematik telah dibangunkan. Penetapan parameter-parameter proses optima telah ditentukan, iaitu, suhu acuan pada 90°C, tekanan suntikan pada 2331 kg/cm^2 dan kelajuan putaran skru pada 123 mm/s, dengan menggunakan plot permukaan sambutan dan plot kontur. Pengesahan telah dijalankan untuk memastikan pencapaian dan kestabilan panjang dan lebar dengan menetapkan parameter-parameter proses optima. Tujuan fasa 2 adalah untuk meningkatkan prestasi produktiviti harian dengan menilai tiga petunjuk prestasi iaitu, kapasiti pengeluaran, kadar penolakan dan kadar hasil proses, di jabatan pengeluaran pengacuan suntikan, terutama sebelum dan selepas gaji bulanan dibayar, dan pada hari bekerja dalam tempoh cuti panjang. Data pengeluaran harian dari jabatan pengeluaran pengacuan suntikan telah digunakan untuk mendapatkan petunjuk prestasi produktiviti harian. Selepas itu, ujian-t satu-sampel telah digunakan sebagai alat statistik untuk menilai petunjuk prestasi produktiviti harian. Hari yang sesuai untuk membayar gaji bulanan telah dikenal pasti sebagai hari Isnin yang keempat setiap bulan. Disamping itu petunjuk prestasi produktiviti harian tidak mencapai tahap "normal" pada hari bekerja dalam tempoh cuti panjang.

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2FI	Two factor interaction
ABS	Acrylonitrile Butadiene Styrene
ANN	Artificial Neural Networks
ANOVA	Analysis of variance
BC-DC	Back cover of a digital camera
BC-HP	Back cover of a hand phone
BPNN	Back Propagation Neural Network
CAE	Computer Aided Engineering
CBR	Case Based Reasoning
CCCD	Circumscribed Central Composite Design
CCD	Central Composite Design
CNY	Chinese New Year
CP	Center Points
DFP	Davidon-Fletcher-Powell
DOE	Design of Experiment
E & E	Electrical and electronic appliances
FCCD	Faced Central Composite Design
FC-HP	Front cover of a hand phone
FEA	Finite element analysis
FEM	Finite Element Method
FFD	Full Factorial Design
GA	Genetic Algotithm
GRNN	General Regression Neural Network
HDPE	High Density Polyethylene
HR	Hari Raya
LCL	Lower control limit
MIDA	Malaysian Investment Development Authority
MITI	Ministry of International Trade and Industry Malaysia
MLN	Multiple Layer Networks

OFAT	One-factor-at-a-time
PBT	Polyester
PC	Polycarbonate
PC/ABS	Polycarbonate/Acrylonitrile Butadiene Styrene
PE	Polyethylene
PMMA	Acrylic
POM	Acetal
PP	Polypropylene
PPO	Polyphenylene Oxide
PRESS	Predicted Residual Sum of Squares
PS	Polystyrene
PTFE	Polytetrafluoroethylene
QC	Quality control
RBNN	Radial Basis Neural Network
RSM	Response Surface Methodology
SA	Simulated Annealing
SGF	Short Glass Fiber
SLN	Single Layer Network
SMI	Small Medium Industries
SOP	Standard Operating Procedure
SQP	Sequential Quadratic Programming
TL	Target limit
UCL	Upper control limit
UK	United Kingdom
V/P	Velocity/pressure switch-over position