THE APPLICATION OF FULL FACTORIAL DESIGN AND RANDOM FOREST FOR PREDICTING THE WELDING PARAMETER SETTING

UNDERGRADUATE FINAL PROJECT

Submitted as one of the requirements to obtain Sarjana Teknik (S.T)

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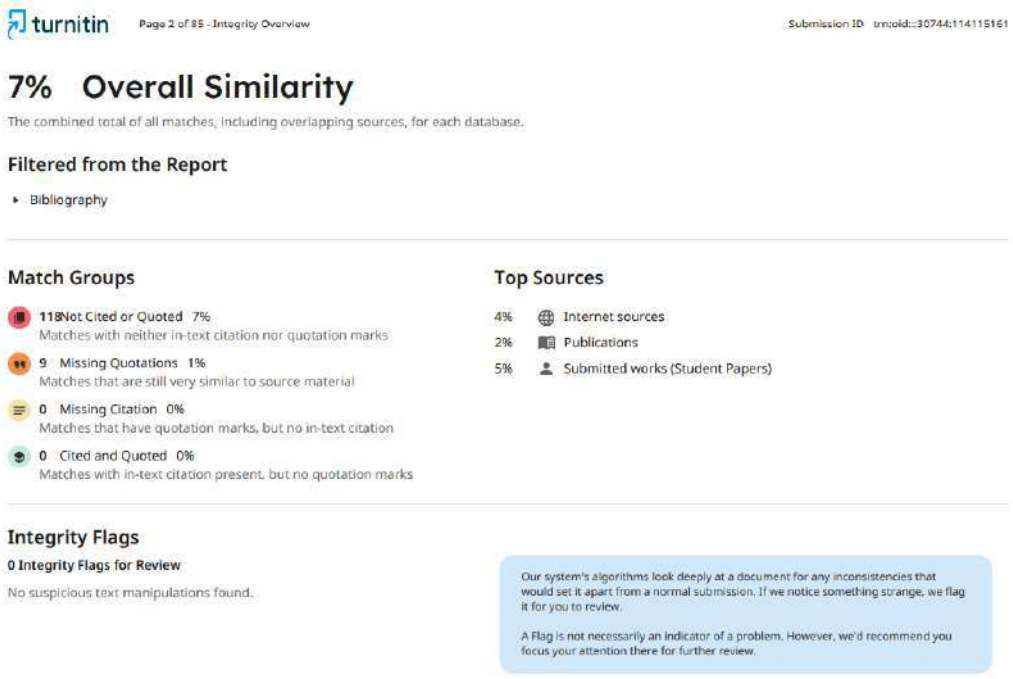
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ABSTRACT

This research was conducted in multinational doll manufacturing company, to address high defect rates in blister accessory packaging. The main problem identified was detached blisters, which accounted for nearly 40% of packaging defects during drop tests. Root cause analysis using Pareto charts and fishbone diagrams confirmed that unstandardized ultrasonic welding parameters were the dominant cause. To address this, a Design of Experiments with a full factorial design was applied to evaluate the effects of welding time, cooling time, and amplitude. Random Forest machine learning was then used to enhance prediction accuracy and validate parameter importance. This study measures weld quality as the primary response variable, defined as the proportion of blister accessories that remain attached during standardized drop testing. A defect occurs when blister accessories detach from the cardboard insert, compromising product integrity and customer satisfaction. Results showed that welding time and cooling time were the most influential factors, with amplitude playing a smaller but supporting role. The optimum parameter range was identified as welding time of 1.0–1.2 seconds, cooling time of 1.4-1.5 seconds, and amplitude of 50–64%, which reduced defects from 40% to 13%, or reduced by 22%, equivalent to avoiding 545 defectives in a 2,400-unit run. This research demonstrates that combining DOE with machine learning provides both statistical evidence and predictive capability, offering a practical framework to improve packaging quality and efficiency in manufacturing.

Keywords: Blister Packaging, Defect Reduction, Design of Experiments, Full Factorial Design, Random Forest, Sonic Spot Welding.

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