



SUPERVISOR'S DECLARATION

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Master of Science in Industrial 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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PATH TOWARDS AN ATTAINABLE QUALITY: THE EFFECT OF
TOOLING DESIGN ON THE PRODUCT COMPETENCY
AND PROCESS EFFICIENCY

TAMILARASI ARASU

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ABSTRAK

Pada masa kini, kebergantungan kepada penggunaan alatan elektronik seperti komputer, telefon bimbit dan sebagainya menunjukkan kadar peningkatan. Tambahan pula, peningkatan penggunaan terutamanya komputer riba dilihat agak ketara semenjak amalan bekerja dari rumah diperkenalkan sejak bermulanya penularan wabak Covid19 yang melanda seluruh dunia. Maka daripada implikasi kronologi tersebut, permintaan terhadap produk elektronik semakin bertambah secara drastik. Panghasilan produk tersebut diperbuat daripada gabungan beberapa litar bersepadu (integrated circuit) di mana ia akan melalui beberapa proses sebelum menjadi produk yang boleh berfungsi dengan baik dan menguntungkan pelbagai pihak terutamanya pengguna.

Oleh yang demikian, terdapat beberapa isu yang perlu ditangani untuk menghasilkan produk yang berkualiti. Antara isu yang diketengahkan dalam kajian ini adalah peningkatan kadar kerosakan serta penurunan hasil di stesen yang memproses pemasangan barangan mekanikal. Selain itu, pemasangan barangan mekanikal secara manual serta penggunaan alat yang tidak mengikut keperluan spesifikasi litar bersepadu menyebabkan penurunan ukuran koordinat produk tersebut. Akibatnya, masa yang diambil untuk menyelesaikan proses pemasangan meningkat secara mendadak.

Objektif kajian ini adalah untuk menyelidik kaedah teknikal bagi menyiasat kejadian kerosakan dan mengklasifikasikan puncanya secara sistematik menggunakan kitaran defek (defect cycle) dan analisis pokok kesalahan (fault tree analysis) bagi menghasilkan produk yang bermutu tinggi. Di samping itu, kajian ini juga menghuraikan kaedah untuk mereka bentuk peralatan menggunakan garis panduan yang lebih berstruktur iaitu "*Verein Deutscher Ingenieure 2221*" (VDI 2221) bagi membantu memudahkan kaedah pemprosesan. Hasilnya, masa pemprosesan produk dapat dikurangkan pada kadar yang optimum seterusnya membantu dalam meningkatkan kadar keluaran dan tahap kepuasan pelanggan.

Data untuk kajian ini dikumpul melalui pelbagai saluran seperti data sistem, pemerhatian, temu bual separa berstruktur dalam kalangan operator, perbincangan dan eksperimen. Secara keseluruhan, kajian ini telah membantu untuk mengurangkan kadar kerosakan yang berkaitan dengan pemasangan mekanikal sepenuhnya iaitu sebanyak 81.3%, dan pengurangan kadar pembaziran bahan kepada 57% dengan penjimatan USD 5920, sekaligus pengurangan masa pemprosesan kepada 28.57% iaitu penjimatan sebanyak USD 419.

Penemuan daripada kajian ini berjaya mencadangkan serta mendedahkan tahap kritikal sebenar dalam mencari dan memahami kaedah pengesanan kerosakan yang tepat dan mengenalpasti punca kerosakan dengan lebih tertib. Selain daripada itu, melalui kajian ini, kaedah generik mereka bentuk alatan yang teratur telah dikenal pasti. Tambahan juga, kajian ini diharapkan dapat menawarkan beberapa teknik yang boleh diamalkan untuk meningkatkan kualiti keluaran dengan penggunaan masa yang lebih singkat.

ABSTRACT

People gradually started to rely on electronic devices such as computers, smartphones, and so on as their lives became increasingly dependent on them. These products are made up of several Integrated Circuits (IC) which are connected among themselves with copper traces and undergo numerous processes before becoming a finished product.

Due to its importance, it is vital to produce printed circuit board assemblies that are high in quality and low in the probability of malfunctioning. Therefore, certain issues need to be carefully resolved to ensure the reliability of the products. In addition, several problems have been identified during this study. A large yield drop and high rejects have been observed at specific stations where operators perform mechanical assembly of printed circuit boards. In addition, the lack of a clear understanding of the process of the operators has led to defects at the station. Aside from that, operators manually assemble the mechanical part using poorly designed tooling that is not designed for printed circuit board assembly. Since it is highly error-prone due to human error, this technique is known to have a high rejection rate. As a result of high rejects and unfit tooling used, the cycle time of producing the product has been increasing abruptly.

To produce defect-free products, this study will explore a technical method to explore defect occurrences and classify their root causes by using existing quality tools, such as defect cycle analysis and fault tree analysis (FTA). Additionally, this study examines the possibilities of designing tooling using more structured guidelines such as "*Verein Deutscher Ingenieure 2221*" (VDI 2221), which makes the process simpler and allows for the evaluation of each task taken in designing and its significant impact. Eventually, the processing time of the products is brought down to optimal, which maximizes productivity and increases customer satisfaction.

The data for this study were collected through various channels such as system data, observations, semi-structured interviews among the operators, discussion and brainstorming, and finally real-time experiments and trials. In sum, this study helped eliminate all defects related to mechanical assembly, which resulted in a reduction of overall defects by 81.3%, a reduction of scrap by 57% (total saving of USD 5920), and a reduction of the cycle time by 28.57% (saving of USD 419 in two quarters).

Based on these results, it is crucial to identify the correct method of defect detection, the point of occurrence, and the root cause of the defect. Through this study, a well-organized generic method of designing tooling has been developed as well. Nonetheless, this study hopes to offer a few techniques that are being practiced to increase quality with a lesser time used.

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