UNIVERSITI PUTRA MALAYSIA

DEVELOPMENT AND VERIFICATION OF PREDICTIVE MAINTENANCE SYSTEM IN A SOLAR CELL MANUFACTURING INDUSTRY

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By

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Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfillment of the Requirements for the Degree of Master of Science

January 2013

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the degree of Master of Science

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Chairman : Mohd Khairol Anuar Mohd Ariffin, PhD.

Faculty : Engineering

Manufacturing industries need to find the best preventive maintenance strategy during their planning and scheduling. When a machine is taken down for maintenance, it does not produce a product for the company which means production is interrupted thus incurring loss to the company. Therefore, downtime for services needs to be minimized. Preventive Maintenance is a service being done by qualified personnel to ensure that the equipment is always in a good and safe operating condition.

Preventive Maintenance is a set of activities taken based on a planned schedule either by time or a condition to prevent permanent or lengthy breakdowns. Example of a Preventive Maintenance are like changing lead screw bearing every year or servicing filter at every 50,000 running hours. Usually preventive maintenance is scheduled based on equipment vendor's recommendation. Through experience running the equipment, engineers will be knowledgeable to adjust their schedule based on the nearest actual lifetime which is based on the history or record.

Solar Cell manufacturing is facing high unscheduled downtime. The aim of this

project was to develop a Predictive Maintenance System in a solar cell manufacturing environment. A Predictive Maintenance System in a solar cell manufacturing industry should reduce its equipment unscheduled downtime because not all types of problems can be prevented by using a scheduled maintenance alone. The machine operation involves process parameters and human interventions. Thus the preventive actions need to be taken before its breakdown. Nevertheless, having a scheduled preventive maintenance is the least a management should implement to reduce the machine breakdown if there is no form of other solution.

This research had proposed to use a Continuous Improvement Program method by Vannest and Wassenhove which was developed in 1995 which aims to reduce downtime. This research then, had proposed a streamline and comprehensive tools for this continuous improvement program which are the use of Pareto Analysis and FMEA before starting any improvement activity. This research had also developed an improvised diagnostic method of Predictive Maintenance System that was from Groba et al. in year 2007. The Predictive Maintenance System that was developed from this research had used diagnostic method through use of failure limit(s) and its threshold limit(s).

This Predictive Maintenance System was then developed and tested in one of solar cell manufacturing company in Peninsular Malaysia which had just operated in less than 5 years. It was verified that this Predictive Maintenance System had cause a reduction of unscheduled downtime of more than 23% for Deposition and Diffusion equipments in one Solar Cell manufacturing company. This research had

successfully developed a streamline and comprehensive tools for Continuous Improvement Program which integrates with Predictive Maintenance System using threshold Limit(s) and failure Limit(s).

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk Ijazah Master Sains

PEMBENTUKAN DAN PENGESAHAN SISTEM PENYELENGGARAAN JANGKAAN DI INDUSTRI PEMBUATAN SEL SURIA.

Oleh

NURHAIZA SHAHRIR

Januari 2013

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Fakulti : Kejuruteraan

Industri pembuatan perlu mencari strategi penyelenggaraan pencegahan yang terbaik. Apabila sebuah mesin diambil untuk penyelenggaraan pencegahan, ia tidak menghasilkan produk bagi sesebuah syarikat dan ini bermakna ia tidak menghasilkan wang, oleh itu masa yang diambil untuk menjalankan perkhidmatan penyelenggaraan pencegahan perlu menjadi lebih bermakna dan memberi manfaat kepada syarikat. Penyelenggaraan pencegahan adalah perkhidmatan yang dilakukan oleh kakitangan yang terlatih untuk memastikan peralatan itu dikekalkan dalam keadaan yang memuaskan.

Penyelenggaraan pencegahan adalah satu tindakan pencegahan diambil berdasarkan jadual yang dirancang sama ada berdasarkan masa atau pada kaunter tertentu untuk menghalang terjadinya kerosakan yang kekal. Contoh Penyelenggaraan Pencegahan adalah seperti menukar bearing pada setiap tahun atau servis penapis udara pada

setiap 50,000 jam mesin operasi. Penyelenggaraan berjadual biasanya berdasarkan saranan vendor peralatan, dan melalui pengalaman selama mengendalikan peralatan ini. Jurutera-jurutera akan mengubahsuai jadual berdasarkan jangka hayat terdekat sebenar yang diperolehi dari sejarah mesin tersebut.

Pembuatan sel suria menghadapi masalah mesin rosak yg tidak dijangka yang tinggi. Tujuan projek ini adalah untuk membina Penyelenggaraan Jangkaan dengan menggunakan Pemantauan Kondisi dalam mesin pembuatan sel suria kerana tidak semua jenis masalah boleh diselesaikan atau dicegah dengan sistem penyelenggaraan berjadual. Mesin mempunyai pelbagai faktor penyebab seperti parameter proses yang terlibat dan juga faktor campur tangan manusia. Tindakan pencegahan perlu dilakukan sebelum mesin itu rosak. Walau bagaimanapun, penyelenggaraan pencegahan yang berjadual adalah sekurang-kurangnya perkara yang perlu untuk mengurangkan kerosakan mesin jika tiada penyelesaian yang lain.

Kajian ini telah mencadangkan untuk menggunakan kaedah Program Penambahbaikan Berterusan oleh Vannest dan Wassenhove yang dibina pada tahun 1995 yang bertujuan untuk mengurangkan masalah mesin. Kajian ini telah mencadangkan garis arus dan alat yang menyeluruh untuk program penambahbaikan yang berterusan ini dengan penggunaan Analisis Pareto dan FMEA sebelum memulakan aktiviti peningkatan. Kajian ini juga telah membangunkan satu kaedah spontan diagnostik Penyelenggaraan Sistem Jangkaan yang telah dibangunkan Groba et al. pada tahun 2007. Ini Penyelenggaraan Sistem Jangkaan telah dibangunkan menggunakan kaedah diagnostik melalui penggunaan had-had kegagalan dan had-had ambang.

Penyelenggaraan Sistem Jangkaan ini telah dibangunkan dan diuji di sebuah syarikat pembuatan sel solar di Semenanjung Malaysia yang baru sahaja beroperasi dalam tempoh kurang dari 5 tahun. Ia telah disahkan bahawa Penyenggaraan Sistem Jangkaan ini telah menyebabkan pengurangan masalah mesin lebih daripada 23% untuk mesin-mesin Pemendapan dan mesin-mesin Resapan di dalam sebuah syarikat pengilangan Sel Suria. Kajian ini telah berjaya menghasilkan garis arus dan alat yang menyeluruh untuk program Penambahbaikan yang Berterusan ini yang digabungkan dengan pembentukan Penyelenggaraan Sistem Jangkaan yang menggunakan had-had kegagalan dan had-had ambang.

I certify that an Examination Committee has met on January 16, 2013 to conduct the final examination of Nurhaiza Shahrir on her Master of Science thesis entitled "Development and Verification of Predictive Maintenance System in a Solar Cell Manufacturing Industry." in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the student be awarded the relevant degree.

Member of the Examination Committee were as follows:

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This thesis was submitted to the senate of Universiti Putra Malaysia and has been accepted as fulfillment of the requirement for the degree of Master of Science. The members of the supervisory committee were as follow:

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DECLARATION

I declare that this thesis is 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 Putra Malaysia or other institutions.

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NURHAIZA SHAHRIR

Date: 16 January 2013

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