UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Faculty of Manufacturing Engineering

PERFORMANCE ANALYSIS OF INDUSTRIAL ROBOTS IN HANDLING HARD DISK DRIVE

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Master of Manufacturing Engineering (Manufacturing System Engineering)

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A thesis submitted

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APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of UTeM as a partial fulfilment of the requirements for the degree of Master in Manufacturing Engineering (Manufacturing System Engineering). The member of the supervisory committee is as follow:

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DEDICATION

For my beloved wife

ABSTRACT

Data storage device such as hard disk drive (HDD) has evolved tremendously in the market today. The demanding capacity output from the biggest player of this core business mainly comes from the Western Digital Malaysia Sdn Bhd.(WDM). WDM production continues to improve it utilizations from the investment on the several types of industrial robots with diverse capabilities, facilities and specification. Identically, three types of robot are critically used. They are selective compliance assembly robots arm (SCARA), Cartesian coordinates robot and articulated robot. In order to meet the world class manufacturing standards, the performance analysis of these robots has become an important criterion to be considered. This paper presents the application of an overall equipment efficiency (OEE) as a method to compare all the three types of robots performance analysis. Systems reporting through the automation logs are being revised to suit the OEE requirement. The data collection for the system reporting are developed using the software dispatcher and system database. The analysis tools for the result is expressed using the Microsoft excel. Based on overall selected criterion, the obtained result shows that the six joint articulated robot is ranked as the robot with the best performance. Second place goes to SCARA and the lowest is Cartesian coordinates robot.

ABSTRAK

Pengeluaran Pemacu cakera keras semakin berkembang pesat seiring dengan kemajuan teknologi penyimpanan data terkini. Western Digital Malaysia Sdn Bhd (WDM) merupakan pengeluar yang terbesar di dalam bidang ini. Permintaan yang tinggi memerlukan pembaharuan dari segi penigkatan kapasiti terhadap pengeluaran produk. Ini secara tidak langsung merujuk kepada kepengunaan robot-robot dalam automasi. Tiga jenis robot telah digunapakai untuk mempertingkatkan produktiviti pengeluaran. Robot terdiri daripada *articulated robot, cartesian coordination robot* dan *Scara robot*. Dalam usaha untuk memenuhi standard pembuatan bertaraf dunia, analisis prestasi robot telah menjadi satu kriteria penting yang perlu dipertimbangkan. Kajian ini memberi tumpuan kepada pengunaan kaedah *overall equipment Efficiency (OEE), overall input efficiency (OIE), total equipment efficiency (TEE)* dan *analytical hierarchy process (AHP)*. Data analisis diolah mengikut perkiraan yang diguna pakai dalam analisis OEE. Pengumpulan data dibangunkan menggunakans sejenis perisian dipanggil *dispatcher* dan sistem pengkalan data. Selain TEE, terdapat beberapa kriteria yang lain telah diambil kira dalam menentukan prestasi robot. Ini dilakukan melalui keserasian dan kesefahaman bersama dan kemudahan dari segi kajian dan pembangunuan. Ia akan dipilih dan dibandingkan dengan analisa TEE. Berdasarkan kriteria yang telah dipilih, keseluruhan keputusan menunjukkan bahawa c*artesian coordinate robot* mempunyai nilai prestai yang tertinggi diikuti dengan *SCARA robot*. A*rticulated robot* mempunyai nilai prestasi yang paling rendah.

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SCARA	-	Selective Compliance Assembly Robot Arm (SCARA)
AHP	-	Analytical Hierarchy Process
CIM	-	Computer Integrated Manufacturing
DT	-	Downtime
HDD	-	Hard disk Drive
IFR	-	International Federal of Robotics
MITEC	-	Manufacturing Information Technology Execution Control Systems
MTBF	-	Mean Time Before Failure
OEE	-	Overall Equipment Efficiency
PPC	-	Production Planning and Control
RSA	-	Rack Storage Availability
SCARA	-	Selective Compliance Assembly Robot Arm
TPM	-	Total Preventive maintenance
TQM	-	Total Quality Management
WD	-	Western Digital

WDM	-	Western Digital Malaysia Sdn. Bhd
FMS	-	Flexible Manufacturing system (FMS)
AGVs	-	Automatic Guided Vehicles
JIT	-	Just in Time
GB	-	Gigabytes
SATA	-	Serial ATA
USB	-	Universal Serial Bus
kg	-	kilogram
OEE	-	Overall Equipment Effectiveness
MTBF	-	Mean Time Between Failure
MTTR	-	Mean Time To Repair
AI	-	Artificial Intelligent
CIM	-	Computer Integrated Manufacturing
MITEC	-	Manufacturing Information Technology Execution Control Systems
OOC	-	out-of-control
CBA	-	Cost Benefits Analysis
OEE	-	Overall Equipment Efficiency
OIE	-	Input Equipment Efficiency

TEE	-	Total Equipment Efficiency
AHP	-	Analytical Hierarchy Process
QFD	-	Quality Function Deployment
TOPSIS	-	Technique for Order Preference by Similarity to Ideal Solution
TQM	-	Total Quality Management
R.S.A	-	Rack Storage Availability
IE	-	Industrial Engineering
DT	-	downtime
CR	-	consistency ratio
R & D	-	Research and Development

CHAPTER 1

INTRODUCTION

1.1 Background

Industrial robotics are closely related to the technology of automation in the modern practice of manufacturing. The basic applications of industrial robot include painting, welding, assembly and it is most widely used for picking and placing in material handling activities. All robots features require high endurance, speed, and precision. Today, robots population is increasing at a significant rate. It is predicted that their total worldwide population will be increasing by million by the year 2015 and over half of them are being used in Japan (Aleem 2012). At the end of 2013, market data for the first three quarters show a further increase in comparison to the same period in 2012. Robotic industry shows promising progresses even in the current uncertain economic situation (http://www.ifr.org/home/).

The growth in the robotic demand situation requires feasible strategic planning in terms of cost and overall system performances. In developing countries, such as Malaysia, robots are used only if they are attractive compared to the labors intensive. Furthermore, the

knowledge and skills for the high end robot technology is yet not established compared to many developed countries like Japan, United States and Germany.

In Malaysia, one of the multinational companies that use industrial robot is the Western Digital Malaysia Sdn Bhd (WDM). WDM is one of the world largest hard disk drives (HDD) manufacturers. The manufacturing plants are in Malaysia, Thailand, Philippines and China. Malaysia's production plant is able to deliver an average of 200,000 of HDD daily. This requires high end automation equipment that can handle a big capacity of pick and place operations. The material handling involves the types and sizes of HDD devices that mainly comes from 2.5 inch and 3.5 inch.

Assembly production processes in WDM are divided into two main categories which are "front end" and "back end". "Front end" is a process of assembling a HDD. The assembled HDD will be fully tested and labels. This process is called as "back end". Industrial robotic is mostly used in the "back end" process. The process involves "pick" and "place" of HDD device and then the device will be loaded into the rack storage compartment for testing (known as the dynamic test). This process conducts the final testing verification before the HDD proceed to the packaging process.

Identically, there are three types of robots; Selective Compliance Assembly Robot Arm (SCARA), Articulated Robot Arm and Cartesian Coordinates Robot. All three types of robots are shown in Figures 1.1 to Figures 1.3. Each type has the advantages and disadvantages that require careful justification in terms of financing, maintenance and machines reliability.

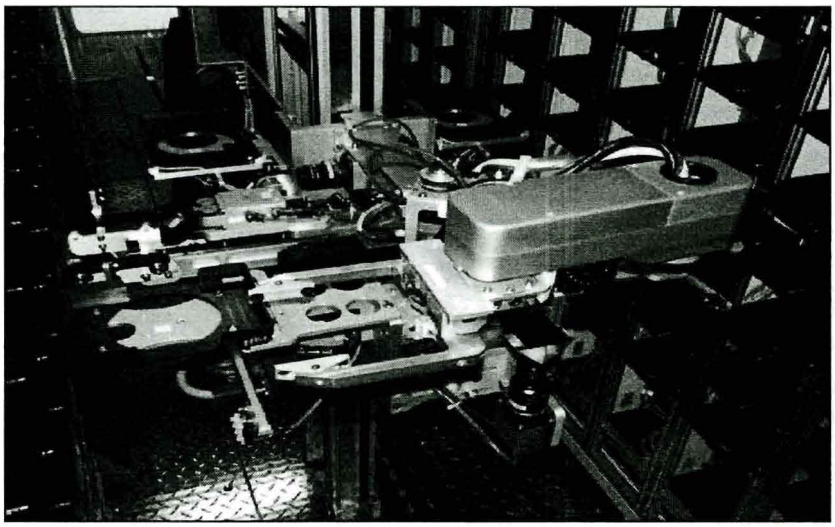

Figure 1.1: SCARA Robot

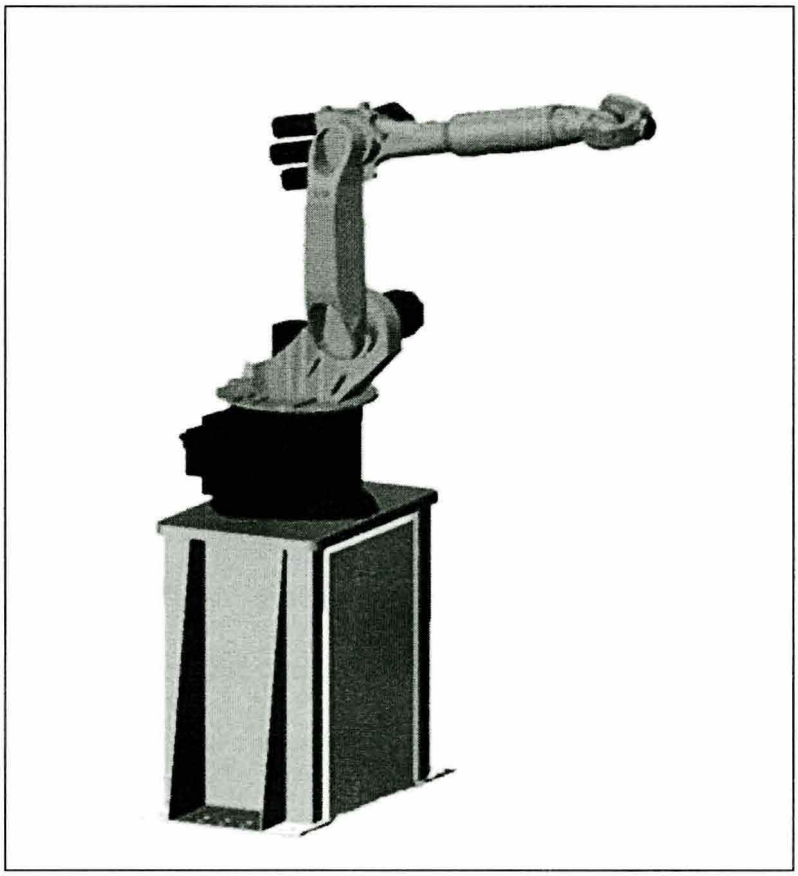

Figure 1.2 : 6-joint articulated robot

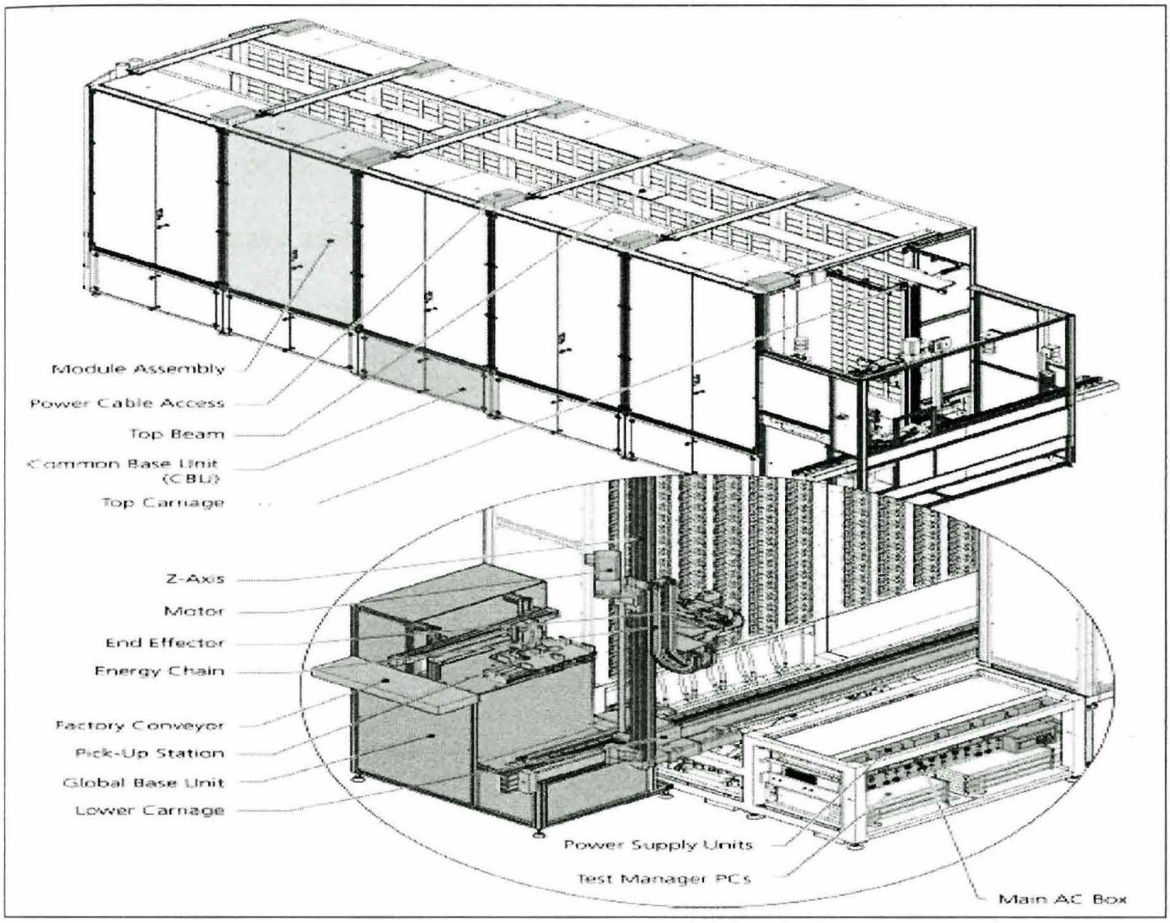

Figure 1.3: Cartesian coordinates robot

1.2 Problem statements

Production planning and control (PPC) is the department responsible to manage the strategy for good product finishing depending on the volume of the customers demand. The bottleneck can be found occurring during the "back end" process. The process occupies longer cycle time to produce an output compared to the "front end" process. This will then gives the impact to the overall production flow.

Automated system using robotic offers the best alternatives for the "back end" process so that the demand can be met. The management decided to purchase several types of robotic