A STUDY OF FUTURE OF MANUFACTURING IN THE CONTEXT OF DEVELOPING COUNTRIES

This report is submitted in accordance with requirement of the University Teknikal Malaysia Melaka (UTeM) for Bachelor Degree of Manufacturing Engineering (Manufacturing Management) (Hons.)

by

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I hereby, declared this report entitled “A Study of Future of Manufacturing in the Context of Developing Countries” is the result of my own research except as cited in references.

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Date : 16 June 2017

APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of Universiti Teknikal Malaysia Melaka as a partial fulfilment of the requirement for Degree of Manufacturing Engineering (Manufacturing Management) (Hons). The members of the supervisory committee are as follow:

…….....

(DR. ZUHRIAH BINTI EBRAHIM)

ABSTRAK

Projek ini membincangkan mengenai masa depan pembuatan dalam konteks negara-negara membangun. Tujuan kajian ini adalah untuk memberi kefahaman mengenai bagaimana negara-negara membangun boleh mengaplikasikan konsep pembuatan masa depan dan apakah cabaran ke arah itu. Projek ini dibina daripada kajian literatur dan analisis yang kritikal seperti jurnal, artikel, laporan dan laman web rasmi. Negara-negara membangun di rantau Asia Tenggara yang merangkumi Malaysia, Indonesia, Thailand, Vietnam dan Filipina telah dipilih sebagai skop projek. Kaedah kajian ini bermula dengan memahami konsep pembuatan masa depan. Kajian ini diteruskan dengan mengenalpasti keperluan utama ke arah pembuatan masa depan. Cabaran yang dihadapi oleh negara-negara membangun ke arah pembuatan masa depan juga dijelaskan dalam kajian ini. Sebagai langkah terakhir, ilustrasi gambar rajah pembuatan masa depan dilakarkan bagi mengkongklusi keseluruhan projek ini. Hasil daripada kajian ini, keperluan utama (iaitu teknologi, kemahiran pekerja dan "Internet of Things (IoT)") dan keperluan kecil (iaitu dasar perindustrian) telah dikenalpasti. Cabaran yang dihadapi oleh negara-negara membangun ke arah masa depan pembuatan dari segi teknologi adalah cabaran sederhana, kemahiran pekerja adalah cabaran kecil dan "Internet of Things (IoT)"adalah cabaran kecil. Lakaran gambar rajah konklusinya dapat memberikan pemahaman dalam masa yang singkat mengenai pembuatan masa depan dalam konteks negara-negara membangun.

ABSTRACT

This project discusses about future of manufacturing in context of developing countries. The purpose of this study is to provide understanding on how developing countries can implement future of manufacturing concept and what are the challenges towards it. This project is built from literature study and critical analysis on journals, articles, reports and formal websites. Developing countries in Southeast Asia region that includes Malaysia, Indonesia, Thailand, Vietnam and Philippines were selected as scope of the project. The methodology starts with understanding the future of manufacturing concept. The study proceeds by identifying major requirements of future of manufacturing. Challenges faced by developing countries towards future of manufacturing also clarified in this study. As a final step, illustration diagrams of future of manufacturing are illustrated to conclude the overview of this project. As a result, major requirements (i.e. technology, employee skill and Internet of Things (IoT)) and minor requirement (i.e. industrial policy) were identified. Challenges faced by developing countries towards future of manufacturing in term of technology, employee skill and Internet of Things (IoT) are moderate challenge, slight challenge and slight challenge respectively. The illustration diagram purposely provides a quick understanding about future of manufacturing in context of developing countries.

DEDICATION

This report is dedicated to my beloved family, supervisor and friends. Thank you for your guidance and support.

ACKNOWLEDGEMENT

First and foremost, I would like to thank to Allah, the most gracious with the highest praise for lending me this opportunity to complete my project with ease. A special gratitude for my project supervisor, Dr. Zuhriah Binti Ebrahim, who is committed in contributing suggestion and encouragement throughout the entire project hence, helped me to organize and complete my project successfully.

I would also like to acknowledge with much gratefulness to my parents who keep supporting from the beginning of the project until submission of the project report. Thank you to all friends for your help and motivation to complete this report.

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LIST OF ABBREVIATIONS

3D	-	Three Dimension
CAD	-	Computer Aided Design
CAM	-	Computer Aided Manufacturing
CIM	-	Computer Integrated Manufacturing
CPS	-	Cyber Physical System
GDP	-	Gross Domestic Product
GNI	-	Gross National Income
GPS	-	Global Positioning System
HDI	-	Human Development Index
ICT	-	Information and Communications Technology
IoT	-	Internet of Things
NFC	-	Near Field Communication
PSM	-	Projek Sarjana Muda
R&D	-	Research and Development
RFID	-	Radio Frequency Identification
STEM	-	Science, Technology, Engineering and Mathematical
UTeM	-	Universiti Teknikal Malaysia
UTM	-	Universiti Teknologi Malaysia
UiTM	-	Universiti Teknologi MARA
UK	-	United Kingdom
USA	-	United States of America
UNDP	-	United Nations Development Programme
WLAN	-	Wireless Local Area Network

CHAPTER 1
INTRODUCTION

1.0 Preliminary

This chapter explain brief introduction in project background about future of manufacturing in context of developing countries. In addition, project motivation, objectives, scope and thesis outline also included to get further information about the case study.

1.1 Project Background

The future of manufacturing always addressed to Industry 4.0 which is the current trend of automation and fast data exchange in manufacturing technologies. The Industry 4.0 briefly works with high-end technologies, high-level employee skills and high-speed internet connection to get a real-time data or it can be a context-aware communication. According to Penner and Sun (2016), better situational awareness leads to better operations. They both who are from University of British Columbia adds, “Every machine must communicate with one another. Machines must be very intelligent, self-adjusting, self-optimizing. This is the internet of things”.

The project explains the question in which areas related to future of manufacturing, developing countries will have to be competitive in five to ten years from now to meet customer demand. In action to answer the question, integration of adequate research effort from various literature studies including journals, articles, reports and formal websites concluded in one formal report.

Requirements to future of manufacturing are identified in this project as a guideline for developing countries to move forward and apply future of manufacturing concept in industrial floor. These requirements will be analysed to establish major requirements in purpose to identify which requirements are prior or critical in manufacturing system. The prioritised requirements are the requirements that manufacturing firms in developing countries need to resolve or fulfil first compared to other requirements.

Challenges of developing countries towards future of manufacturing can be classified into critical challenge, moderate challenge and slight challenge to understand aspects that dragged-down these developing countries to engage with future of manufacturing requirements. Reasons to these challenges also can be established on why developing countries cannot reach same height of accomplishment in term of manufacturing development compared to developed countries that already on the right track towards future of manufacturing concept.

1.2 Project Motivation

This project research is built by a collection of literature materials and supported by critical analysis to distinguish preparation and challenges developing countries towards future of manufacturing. The information also gathered in purpose to expand awareness among developing countries to engage with future of manufacturing concept or also known as Industry 4.0.

Up to this date, there are no compilation report has been done in the context of future of manufacturing for developing countries. This effort encourages researcher to dig down deeper about future of manufacturing in developing countries especially in Asia region.

This project extinguish major requirements of future of manufacturing to be developed for competitive purpose in incoming challenging manufacturing business arena. Study of these requirements can narrow down the most critical effort of manufacturing firms towards future of manufacturing concept to sustain in future of market industry.

This project also built to identify critical challenges among developing countries to cope with future of manufacturing concept. These challenges can exaggerate awareness among manufacturing-based researcher to solve or eliminate causes that prevent developing countries to engage with future of manufacturing concept.

1.3 Project Objectives

The main objectives of this project research are:

i. To understand the concept of future of manufacturing.
ii. To identify the major requirements of future of manufacturing.
iii. To clarify critical challenges of developing countries towards future of manufacturing.
iv. To provide illustration diagrams in concluding the overview of future of manufacturing in context of developing countries.

1.4 Scope of project

The project is based on literature study and analysis to study about requirement of future of manufacturing and challenges of developing countries towards it. The study covered at least sixty literature study including journals, articles, reports and formal websites. This research study of future of manufacturing limited to five developing countries in Southeast Asia region:

i. Malaysia
ii. Indonesia
iii. Thailand
iv. Vietnam
v. Philippines

These developing Southeast Asia countries were selected based on Gross Domestic Product (GDP) tabulation data. The countries were selected based on the top four countries with closest GDP to Malaysia. The list of GDP tabulation data can be referred at Appendix A.

1.5 Expected Outcome

The expected outcome of the project can be listed as:

i. Description about future of manufacturing
ii. Major requirements of future of manufacturing
iii. Critical challenges of developing countries towards future of manufacturing
iv. Illustration diagram of future of manufacturing in context of developing countries

1.6 Thesis Outline

The content of this project has been organised as follows;

Chapter 1: This chapter consists of project background, project motivation, project objectives, scope and expected outcome of the study.

Chapter 2: This chapter consists of explanation and discussion of collected data, critical definition, current technologies and impact of the study.

Chapter 3: This chapter consists of methodology used to conduct this study. This chapter includes planning and activities, data collection and data analysis of each objective.

Chapter 4: This chapter consists of data analysis collected from literature study onwards discussion on the results of the study.

Chapter 5: This chapter consists of presentation conclusion of the whole study and recommendation.

CHAPTER 2
LITERATURE REVIEW

2.0 Preliminary

This chapter provides critical definition of manufacturing, manufacturing industry, future of manufacturing and developing countries. These definitions are supported with components or elements in detail to achieve sufficient understanding about manufacturing industry, future of manufacturing and developing countries. As a result, understanding of future of manufacturing in context of developing countries is established.

2.1 Manufacturing Industry

Manufacturing is a conversion process of raw materials or components into finished product using machines, tools and labour that meet customer demand and specification. While, manufacturing industry refers to the businesses involve in manufacturing and it can be divided into two categories which are primary manufacturing industry and secondary manufacturing industry (Darrel, 2012). Table 2.1 shows the manufacturing industry categories.

Table 2.1: Manufacturing industry categories (InsideView, 2016)

Manufacturing industry categories	Description
Primary Manufacturing Industry	Primary manufacturing industry involved in extraction and collection of natural resources and turns the natural resources into products. This industry includes mining, agriculture and forestry.
Secondary Manufacturing Industry	Secondary manufacturing industry links to improvement of quality, shape or function of primary industry product to become more likely consumed by individuals. This industry includes textile, clothing and furniture.

2.1.1 Manufacturing Industry Supply Chain

Primary and secondary manufacturing industries are related to each other. Primary manufacturing industry collects and extracts natural resources. Secondary manufacturing industry adds value to primary manufacturing industry product as finished goods to become more likely consumed by individuals. Figure 2.1.1 shows supply chain or connection between primary and secondary manufacturing industries.

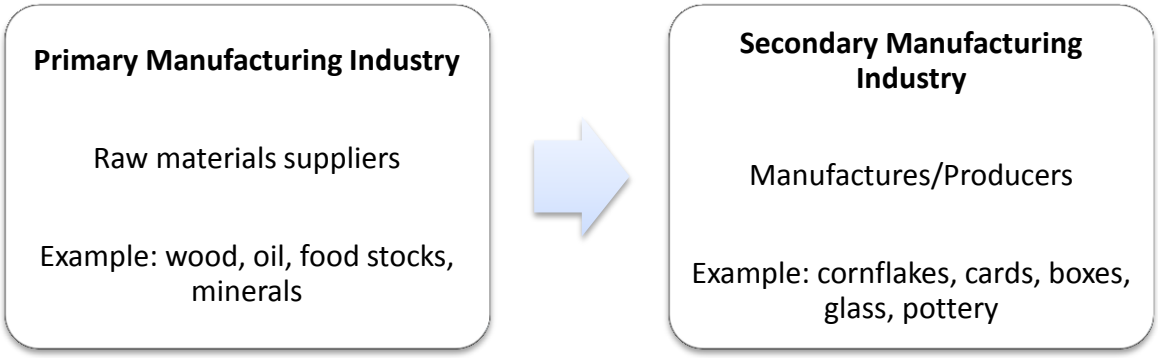

Figure 2.1: Manufacturing industry supply chain

2.1.2 Example of Manufacturing Industries

Darrel (2012) from his article of "Types of manufacturing industry" shows example of manufacturing industries;

i. Metallurgical industry

As a "heavy" manufacturing industry, the metallurgical industry is concerned with refining, alloying and fabrication of metals. The iron and steel industry is the most important, since many projects require several thousand tons of iron and steel as raw materials. Other metallurgical industries that are prominent in manufacturing include those that smelt, refine and process metals excluding iron.

ii. Engineering industry

Engineering is a heavy industry that relies heavily on the output of the metallurgical industries. Like many other industries, engineering has several branches. The major ones include: transport equipment (shipbuilding, automobile, aircraft and railway) ; electrical (heavy and light) and industrial machinery.

iii. Chemicals industry

The chemicals industry is a very significant one in the modern era, since chemicals are required for a myriad of economic activity. The chemical industry is subdivided into three broad categories: heavy chemicals (using mineral deposits or by-products), pharmaceuticals (drugs and medicines) and petrochemicals (chemicals derived from fuel sources).

iv. Textile industry

The clothing and textile industry is one of the oldest manufacturing industries, although it now relies heavily on mechanized textile manufacture. Whereas other industries are confined to certain areas, the production of textile is widespread due to a number of factors, including demand and availability of raw materials.

v. Food processing industry

Food processing is an example of a light industry, although food processing can take place on a large scale. It involves the processing of raw materials (e.g. wheat) into foodstuffs (e.g. flour), food preservation and food packaging.

vi. Hitech industry

In the age of knowledge workers and advanced technology, the high-tech industry relies heavily on research and development and is capital intensive. This is a form of secondary industry, since it involves production. It can overlap with other types of manufacturing industries – such as transport and energy for example.

2.2 What is Future of manufacturing?

Future of manufacturing always matched with Industry 4.0 by formal journal or article authors. It is because the elements and concept of both future of manufacturing and Industry 4.0 is same. Future of manufacturing is predicted to be applied by year 2020 where the time of new era of manufacturing begins (Wilson and Hogarth, 2013). Table 2.2 shows the future of manufacturing description from five different literature materials.

Table 2.2: Future of manufacturing description

Year	Author	Title	Description on Future of manufacturing
2016	Siemens Global Website	Future of Manufacturing: Digitalization as an Opportunity	Siemens company confidently saying that the **future of manufacturing is digital**. Digitalization guarantees **lower costs, improve production quality, flexible and efficient, shorter reaction time** to client requests and market demands. It also opens up innovative business area.
2016	World Economic Forum	Manufacturing Our Future	Evolvement of manufacturing due to global economic dynamics as well as manufacturing technologies to produce diverse and sophisticated product. **Higher skill level and great convergence of skill** is needed for future of manufacturing. Capability of understanding in manufacturing changes will enable economics and at the same time establish **capabilities to innovate** and set new development opportunities including multiplying effects on wages.
2016	Lisa De Propris	How the fourth industrial revolution is powering the rise of smart manufacturing	Industry 4.0 is including think of the **internet, nanotechnology, bioscience, electronics, photonics, advanced materials and renewable energies**.
2013	Sir Mark Walport and Sir Richard Lapthorne	Future of manufacturing: a new era of opportunity and challenge for the UK	Future of manufacturing is a manufacturing in the future with capability of **rapid adapting of their industrial physical and intellectual infrastructures** in effort to **exploit changes in technology**. The **speed of manufacturing is increasing** rapidly and **better interaction between customer and manufacturing industry** due to high-speed respond in order to change global market and closer to customers.
2012	McKinsey and Company	Manufacturing the future: The next era of global growth and innovation	The future of manufacturing will be marked by highly **agile, networked enterprises** that use information and analytical data. They will **employ talent and machinery** to produce products and services to diverse global markets.

From literature collection above, future of manufacturing can be described as manufacturing in the future that works with networked autonomous robotics, high-end technologies, high-level employee skills to reduce cycle time, reduce cost, improve production quality, encourage innovation and better interaction between customer and manufacturing industry.

2.3 The Technologies in Future of Manufacturing

One of the huge impacts of future of manufacturing application is emerging technologies in manufacturing. According to Baily and Bosworth (2014), industrial robots and automation in manufacturing have potential to increase precision and raise productivity. These advanced technologies also can reduce labour cost by reducing the number of workers required.

2.3.1 Additive Manufacturing

Additive manufacturing that refers to 3D printing which builds up objects from small particles can improve flexibility, cut development costs and time, reduce material waste, eliminate tooling costs and simplify production runs. In the future, companies will sell designs of certain product on the web, instead of selling products directly. Companies will provide 3D printing services for product-printing-service or customers are able to print out the desired product for themselves. As the technology improves further, customisation of products are available in the market for specific demand of individual customers (Baily and Bosworth, 2014).

2.3.2 Computer Power and Software

Improvement of computer power and advances in software are leading to another level of advanced design that enhance companies in ability to develop prototypes and execute much more testing in digital model before building a physical prototype. This effort can improve quality of product and reduce probability of failure to happen at certain product (Baily and Bosworth, 2014). McKinsey Global Institute (2013) quoted that there will be 20-50 percent reduction in research and development costs as well as reduction in time to market.