



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

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

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

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ABSTRAK

Baru-baru ini, kemunculan masa depan pembuatan melalui dinamik ekonomi global serta teknologi maju telah membawa kepada penghasilan produk yang pelbagai di pasaran dunia. Masa depan pembuatan berkonsepkan Industri 4.0 adalah untuk merevolusikan industri pembuatan dengan mengintegrasikan teknologi maju ke dalam sistem pengeluaran. Walau bagaimanapun, masih belum ada kajian mengenai kriteria yang diperlukan oleh masa depan pembuatan dalam konteks negara maju. Oleh itu, kajian ini bertujuan untuk mengenalpasti kriteria yang perlu dalam membentuk masa depan pembuatan bagi negara maju. Untuk ini, kajian dilakukan terhadap keperluan masa depan pembuatan dan cabaran dalam masa depan pembuatan yang akan dihadapi oleh negara maju. Justeru itu, terdapat empat objektif telah ditetapkan untuk kajian ini iaitu; (i) Untuk memahami konsep masa depan pembuatan; (ii) Menentukan keperluan kritikal masa depan pembuatan untuk negara maju, (iii) Menentukan cabaran kritikal yang akan dihadapi oleh masa depan pembuatan bagi negara maju dan (iv) Menyediakan gambarajah ilustrasi masa depan pembuatan bagi negara maju berdasarkan kriteria keperluan dan cabaran. Keputusan kajian ini untuk negara maju berdasarkan kriteria keperluan dan cabaran. Selain itu, keperluan dan cabaran masa depan pembuatan telah ditentukan melalui analisis yang teliti daripada laporan tahunan, buku, jurnal dan beberapa laman web rasmi yang berkaitan dengan negara maju iaitu Australia, Kanada, Amerika Syarikat, Jepun dan Eropah (Ireland, Denmark, Jerman dan UK). Seterusnya, tahap keperluan dan cabaran kritikal masa depan pembuatan juga telah ditentukan berdasarkan peraturan Minor-Major. Untuk model masa depan pembuatan, gambarajah ilustrasi telah disediakan untuk memuktamadkan gambaran keseluruhan masa depan pembuatan bagi negara maju berdasarkan keperluan kritikal dan cabaran kritikal. Dengan cara ini, model berkenaan boleh digunakan sebagai panduan kepada negara maju untuk mendapatkan pemahaman yang lebih baik tentang masa depan pembuatan mereka dan juga membantu mereka untuk bersedia menghadapi cabaran masa depan dalam sektor industri pembuatan

ABSTRACT

Recently, emerging of the future manufacturing through global economic dynamics as well as advanced technologies has led to produce more diverse products in the world. Future manufacturing which is based on the concept of Industry 4.0 is to revolutionise the manufacturing industry by integrating advanced technologies into the heart of production system. However, there is still lack of study on identifying the criteria of the future manufacturing in the context of developed countries. Therefore, this study aims to determine the criteria which are necessary in shaping the future manufacturing for the developed countries. Thus, requirements of future manufacturing and the challenges in future manufacturing have been studied in the context of developed countries. Hence, there are four objectives have been set for this study which are; (i) To understand the concept of future manufacturing; (ii) To determine the critical requirements of future manufacturing for developed countries, (iii) To determine the critical challenges face by the future manufacturing for developed countries and (iv) To provide an illustration diagram of future manufacturing for developed countries based on requirements and challenges. The results of this study show that the concept of future manufacturing was understood through the literature study. Besides that, the requirements and challenges of future manufacturing were also determined through a thorough analysis of annual reports, books, journals and some formal websites of the relevant developed countries such as Australia, Canada, USA, Japan and Europe (i.e. Ireland, Denmark, Germany and UK). Thus, the critical requirements and challenges of future manufacturing have also been determined based on the Minor-Major rule. An illustration diagram has been constructed in order to conclude the overview of future manufacturing based on the critical requirements and challenges. In this way, it is believed that the findings from this study can be used as a guideline for the developed countries to get better understanding about their future manufacturing in the aspects of requirements and challenges.

DEDICATION

Only

my beloved father, Tan Keng Chwee

my appreciated mother, Ng Bee Lian

my adored sisters, Tan Ximin and Tan Xiying

for giving me moral support, money, cooperation, encouragement and also understandings

Thank You So Much & Love You All Forever

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TABLE OF CONTENT

Abstrak	I
Abstract	ii
Dedication	iii
Acknowledgement	iv
Table of Content	v
List of Tables	ix
List of Figures	x
List of Abbreviations	xi
CHAPTER 1: INTRODUCTION	1
1.0 Preliminary	1
1.1 Background of Study	1
1.2 Motivation of Study	2
1.3 Objectives of Study	3
1.4 Scope of Study	3
1.5 Significance of Study	4
1.6 Expected Outcomes	4
1.7 Thesis Content	4
CHAPTER 2: LITERATURE REVIEW	6
2.0 Preliminary	6
2.1 What is Future Manufacturing?	6
2.2 Industrial Revolution	10
2.3 Industry 4.0	17
2.3.1 Intelligent Factory	20
2.3.2 Intelligent Manufacturing	23
2.3.3 Technologies in Industry 4.0	25
2.3.3.1 Cyber Physical System (CPS)	25
2.3.3.2 Internet of Things (IoT)	28

2.3.3.3	Cloud Computing	30
2.3.3.4	Big Data	31
2.3.3.5	3D Printing	33
2.3.3.6	Autonomous Robots	35
2.3.4	Benefits of Industry 4.0	37
2.4	Developed Country/Developed Nation	39
2.5	Summary	43
CHAPTER 3: METHODOLOGY		46
3.0	Preliminary	46
3.1	Planning and Activities	46
3.2	Methodology	48
3.2.1	Stage 1: To understand the concept of future manufacturing	48
3.2.2	Stage 2: To determine the critical requirements of future manufacturing for developed countries	50
3.2.3	Stage 3: To determine the critical challenges face by the future manufacturing for developed countries	53
3.2.4	Stage 4: To provide an illustration diagram of future manufacturing for developed countries based on requirements and challenges	55
3.3	Summary	56
CHAPTER 4: RESULT AND DISCUSSION		57
4.0	Preliminary	57
4.1	To Understand the Concept of Future Manufacturing (Objective 1)	58
4.1.1	Analysis	58
4.1.2	Result and Discussion	65
4.2	To Determine the Critical Requirements of Future Manufacturing for Developed Countries (Objective 2)	71
4.2.1	Data Collection	71
4.2.2	Analysis	76
4.2.3	Result and Discussion	78
4.2.3.1	Critical requirements	78
4.2.3.2	Common requirements	82

4.3	To Determine the Critical Challenges Face by the Future Manufacturing for Developed Countries (Objective 3)	83
4.3.1	Data Collection	83
4.3.2	Analysis	86
4.3.3	Result and Discussion	88
	4.3.3.1 Critical challenges	88
	4.3.3.2 Common challenges	93
4.4	To Provide an Illustration Diagram of Future Manufacturing for Developed Countries based on Requirements and Challenges (Objective 4)	96
4.4.1	Data Collection	96
4.4.2	Analysis	97
4.4.3	Result and Discussion	99
4.5	Summary	101
CHAPTER 5: CONCLUSION AND RECOMMENDATION		102
5.0	Preliminary	102
5.1	Conclusion	102
5.2	Sustainable Development	106
5.3	Complexity of the Study	107
5.4	Recommendation	107
REFERENCES		108
APPENDICES		121
A	Gantt Chart of FYP 1 (2016)	122
	Gantt Chart of FYP 2 (2017)	123
B	Requirements of future manufacturing for the five developed countries	124
	Table 4.5 (a) Workforce with technical skills	124
	Table 4.5 (b) Technology/innovation	125
	Table 4.5 (c) Education	127
	Table 4.5 (d) Investment (i.e. technology, education, infrastructure)	128
	Table 4.5 (e) Policy and trade regulation	129
	Table 4.5 (f) Industrial based infrastructure	129
	Table 4.5 (g) Global market	130

	Table 4.5 (h) Global competencies	131
C	Challenges of future manufacturing for the five developed countries	132
	Table 4.7 (a) Workforce with technical skills	132
	Table 4.7 (b) Technology/innovation	134
	Table 4.7 (c) Education	136
	Table 4.7 (d) Investment (i.e. technology, education, infrastructure)	137
	Table 4.7 (e) Policy and trade regulation	138
	Table 4.7 (f) Industrial based infrastructure	139
	Table 4.7 (g) Global market	139
	Table 4.7 (h) Global competencies	140

LIST OF TABLES

4.1	Future Manufacturing	59
4.2	Industrial Revolutions	60
4.3	Industry 4.0	61
4.4	Definition and characteristic of developed countries	63
4.5	Requirements of future manufacturing for the five developed countries	75
4.6	Analysis of critical requirements of future manufacturing for the five developed countries	77
4.7	Challenges of future manufacturing for the five developed countries	85
4.8	Analysis of critical challenges of future manufacturing for the five developed countries	87
4.9	Overall results of critical and common requirements and challenges for the five developed countries	97
5.1	Summary of the findings of future manufacturing for developed countries	104

LIST OF FIGURES

2.1	Three phases in the shift to sustainable manufacturing	8
2.2	Four stages of industrial revolution	17
2.3	Framework of intelligent factory	21
2.4	Assembly system of electronic control unit	26
2.5	3D model-driven remote assembly system	27
2.6	Human-robot assembly system	27
2.7	Manufacturing cyber physical system	28
2.8	IoT components	29
2.9	Cloud technology is used to support industrial transformation	30
2.10	The three main characteristics of the big data	32
2.11	3D printed organs of human such as kidney, ears and finger bones	34
2.12	Autonomous robots in welding operation line	36
3.1	The process flow of the study	47
3.2	Flow chart of the objective 1	49
3.3	Flow chart of the objective 2	52
3.4	Flow chart of the objective 3	54
3.5	Flow chart of the objective 4	56
4.1	Interrelationship among the technologies	68
4.2	Initial diagram of future manufacturing	98
4.3	Refined diagram of future manufacturing	100

LIST OF ABBREVIATIONS

AGV	-	Automated Guided System
AM	-	Additive Manufacturing
CETA	-	Canada-European Union Comprehensive Economic and Trade Agreement
CIM	-	Computer Integrated Manufacturing
CPPs	-	Cyber Physical Production system
CPS	-	Cyber Physical System
FYP	-	Final Year Project
GDP	-	Gross Domestic Product
GPS	-	Global Positioning System
HDI	-	Human Development Index
IaaS	-	Infrastructure as a Service
ICT	-	Information and Communications Technology
IoS	-	Internet of Services
IoT	-	Internet of Things
IP	-	Intellectual Property
IT	-	Information Technology
M2M	-	Machine to Machine
PaaS	-	Platform as a Service
PC	-	Personal Computer
R&D	-	Research and Development
RFID	-	Radio-Frequency Identification
ROA	-	Return on Assets
ROI	-	Return on Investment
SaaS	-	Software as a Service
STEM	-	Science, Technology, Engineering and Maths
USA	-	United States of America
3D	-	3Dimensional

CHAPTER 1

INTRODUCTION

1.0 Preliminary

This chapter presents the overall review of the study, including the background, motivation, objectives and scope of study. All of that is explained in greater details later on. The expected outcome is explained in the last section of this chapter.

1.1 Background of Study

In a decade into the 21st century, the role of the manufacturing is getting important and crucial to the global economy. It continues to evolve from now till the future. The manufacturing is a main engine of the economies of both the developed and developing countries. This is because the manufacturing sector provides the foundational employment that help economic development in all countries around the world. Hence, it can be said that manufacturing is essential for long term economic growth and economic resilience in all the countries especially the developed countries.

Manufacturing, usually covering from the products and services, to process, companies and related business models, is the backbone of one country economy. Besides that, the future of manufacturing will also be marked by highly agile, network enterprises that use the information and analytics as skilfully as they employ talent and machinery to deliver products and services to diverse global market (James et al., 2012). Hence, manufacturing is indeed the foundation for building the economic prosperity in industrialized nations.

However, manufacturing industries will also going through a period of significant change and uncertainty. So, it is important for the countries around the world to know the challenges of future manufacturing competitiveness and also the requirements that contribute to the significant change of the future manufacturing.

According to Juergen (2016), Industrial 4.0 or the Fourth Industrial Revolution have the same concept as the future manufacturing which is to revolutionise the manufacturing and production industry by integrating the Internet of Things (IoT), cloud computing, data integration and other technological advances into the heart of production and manufacturing systems. In this regard, it can be viewed that the concept by integrating the IoT to the manufacturing systems in Industry 4.0 is same as the concept of shaping the future manufacturing by use the IoT based technology. However, this study focus on the critical requirements and the critical challenges of the future manufacturing in the context of developed countries. Critical requirements in this study can be defined as the requirements that are important and must have for the growth of future manufacturing. Whereas, critical challenges in this study is defined as something that needs a lot of skill, energy, and determination to deal with or achieve in the future manufacturing.

1.2 Motivation of Study

Nowadays, manufacturing is a tool to improve the standards of living either in the developed or developing countries. It can be a tool to support the national development goals by the pipeline of providing the better and cheaper products which produced by advance manufacturing technology, lower unemployment and a better quality of life. Today's manufacturing evolves through global economic dynamics as well as advanced technologies in order to produce more diverse and latest products. Hence, the manufacturing opens the door for employment of high skilled workforce in order to meet the global demand. Moreover, manufacturing will continue to grow when there is a demand from the customers. As long as the customer's demand exist, the manufacturing sector will pursue to increase their production. In the long run, the global market will growing fast and progressive. As a result, it will bring for the long term economic growth for a country. Hence, in order to maintain the long term economic growth, the countries in the world must have well prepared for any challenges in future manufacturing faced by them in coming decades.

Up to this date, there has not yet a study done on identifying the criteria of the future manufacturing in developed countries. Therefore, this study focus to investigate the criteria that necessary in shaping the future manufacturing in the developed countries. The criteria will be discussed in this study include the requirements of the future manufacturing and also the challenges in the manufacturing which will be faced by the developed countries in the future.

The study is choose to focus on the developed countries due to the reason that although the developed countries already have a strong and advance manufacturing background, but it is also quite difficult for them to maintain the growth of the manufacturing in the future as the global change rapidly. Hence, the results of this study can be used as a road map for developed countries to get better understanding the shaping of future manufacturing and also help them to prepare for the future challenges in the manufacturing sector.

1.3 Objectives of Study

There are four objectives of this study:

- i. To understand the concept of future manufacturing.
- ii. To determine the critical requirements of future manufacturing for developed countries.
- iii. To determine the critical challenges face by the future manufacturing for developed countries.
- iv. To provide an illustration diagram of future manufacturing for developed countries based on requirements and challenges.

1.4 Scope of Study

The scope of the study will only focus on analyse the future manufacturing of the developed countries which are:

- i. Europe (i.e. Ireland, Denmark, Germany, United Kingdom)

- ii. Canada
- iii. Australia
- iv. USA
- v. Japan

The reasons of choosing these five countries are most of them has established the reports of future manufacturing. Furthermore, the number of journals, articles and books that are relevant to the future manufacturing of these developed countries are more available to reach.

1.5 Significance of Study

The findings from this study that are requirements and challenges are classify from the minor-major rule can be used as a guideline for developed countries for their future manufacturing. This is because the findings are from thorough analysis from the literature study among the developed countries such as Canada, Australia, USA, Japan and Europe (i.e. Ireland, Denmark, Germany, United Kingdom).

1.6 Expected Outcomes

The expected outcome in this study is to provide a concluded overview on the future manufacturing of developed countries in the aspects of critical requirements and critical challenges.

1.7 Thesis Content

The content of this final year project thesis have been organized as follows:

Chapter 1: Introduction of the background of study, motivation of study, objectives, scope and expected outcome of the study.

Chapter 2: Explanation and discussion based on the data collection on the future manufacturing in terms of definition and characteristics. Industry Revolution and Industry 4.0 will also discuss in this chapter. Then the last part is about the explanation of what is the developed country and the differences between developed and developing countries.

Chapter 3: Representation of the methodology used to conduct this study. This chapter includes the planning and activities, flow chart, data collection and data analysis for every objective.

Chapter 4: Presentation of analysis the data collected from journals, reports, articles, books and formal website on the issue of future manufacturing's concept, requirements and challenges onwards discussion on the results of the study.

Chapter 5: Presentation of the conclusion of the whole study of future manufacturing in developed countries.

CHAPTER 2

LITERATURE REVIEW

2.0 Preliminary

In this chapter it will presents the literature review on future manufacturing and developed countries. General overview of future manufacturing will be presented in the first section. Besides that, in this section it contains the definition and characteristic of future manufacturing from several opinions that gather through the literature study. The second section presents the issues about the industrial revolution. The historical background of industry revolution and each stage of industrial revolution such as First Industrial Revolution, Second Industrial Revolution and Third Industrial Revolution will be discussed in this section. Next, the third section will present the Fourth Industrial Revolution. In this section, it will include the definition, characteristics, objectives, technologies and advantages of Industry 4.0 which are determined from literature study. Whereas the last section will present about the developed countries. The general definition and characteristics of developed countries and also the differences between developed and developing countries will be discussed in this section. In the end of this chapter, the summary will be provided in order to describe the overview of the whole literature review.

2.1 What is Future Manufacturing?

According to James et al. (2012), the future manufacturing is defined as the new stage of manufacturing which will be remarkable by the energetic, consist of the network enterprise that make use of the information as tactfully as they engage talent and also machinery in order to deliver the products and services to the markets. It can be said that the

future manufacturing brings the meaning of the next stage of innovation and global growth that will contribute to the global economy in the coming decade.

In the coming future, the manufacturing industries will play an important role in driving the global economic growth and also help in rising the living standards in both developed and developing countries. Hence, in order to improve the incomes of the citizens in the country, building an advanced manufacturing sector in the future is still an essential step in the nationwide development.

Besides that, when the manufacturing is entering a dynamic new phase it will provide substantial opportunities for the countries around the world. Based on Richard and Mark (2013), below are the four key future characteristics of manufacturing which are determined by the Foresight Project 2013:

i. Rapid, more responsive and close to customer.

In the future manufacturing, technology will play a crucial role in driving the changes. By applying the technologies such as additive manufacturing, new forms of materials, biotechnology, and computer-controlled tools, they can produce the mass personalisation of low cost products which meet the customer demand. This is because all these advanced technologies will lead to a new form of product personalisation. Besides, companies can increasingly produce the cheap cost and shorter cycle-time products due to the direct customer input to the design.

ii. Exposed to new market opportunities.

Richard and Mark (2013) claimed that in the future the products are dependent on the process-driven innovation, such as some electronics application and nanotech materials will get the benefit from the co-location of different parts of their production system. So with co-location of R&D, the products will continually be improved and later will win export markets when they truly deliver the valuable and rare products. These co-location of R&D products are exposed to new market opportunities and bring benefit of economic growth.

iii. More sustainable.

In the future, demand for the basic things such as water, materials, land and energy will be increased due to the faster growing of the population. As a results, most of the natural resources will face the challenges because of the disruptions in their supply. Hence, the nations should learn how to manufacture their products to become the more sustainable products which make use with fewer materials and low energy in order to cope with those effects. Below are the three phases which show the shifting to sustainable manufacturing. Figure 2.1 shows the three phases in the shift to sustainable manufacturing.

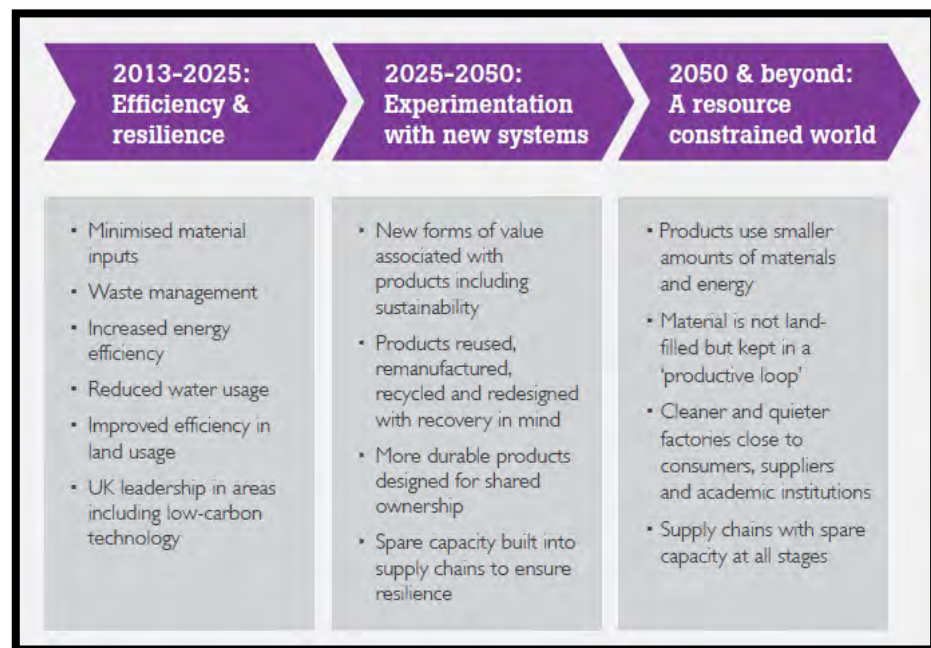


Figure 2.1: Three phases in the shift to sustainable manufacturing (Richard and Mark, 2013)

iv. Demand on the highly skilled workers are increasing.

Due to the future manufacturing is largely based on technology and high skilled work, so the future workers must equip with the qualification in STEM (Science, Technology, Engineering and Maths). It can be said that, overall many jobs in the future manufacturing will require certain degree and also STEM qualifications. Hence, by having the skilled workforce, the future demand of customer can be meet undoubtedly.

Moreover Canadian Business (2015) claimed that the future manufacturing is look like a smart factory. It becomes parts of Internet of Things (IoT) where a network links every component in the plant and products being manufactured can communicate. The smart factory is like having the virtual production system, where even the products are being designed, the manufacturing system are being designed at the same time. In smart factory, the manufacturing process will definitely become more intelligent, dynamic and flexible when compared to current models. Future manufacturing in other words is doing more with less, reordering the world to create more compact products and re-aligning enterprise strategies to provide more value (Muthukumar, 2016).

On the other hand, the future manufacturing is refer to the transformation of a tangible, material products into something that are more complex and useful. According to Jim (2016), before transform to more complex and useful products, the tangible products will undergo three stages of production. The primary stage of production is to collect or harvest the necessary raw materials from nature, the secondary stage is manufacture. This secondary stage of production is the most important among the three stages because it is an important and essential link in the chain of value added activity. While the tertiary stage of production is the inputs of services to ensure that the manufactured products are functional and useful. The one of the future manufacturing product is smart products.

Hence, in overview of the future manufacturing it look like a full cycle of activities from R&D, through design, production, logistic and services to the end of life management (NSW Business Chamber, 2011). In addition, because of the economics of production and distribution change along with the development of the 'smart' products and also shifting in the customer demand, manufacturers are given a chance to explore the new ways in creating and capturing value (John et al., 2015).

Overall, it can be concluded that there are four keys characteristics of future manufacturing. Firstly, technologies are faster, more responsive and dynamics and also close to the customer. Second, products which are based on the process driven innovation are exposed to the new market opportunities. Third, the future manufactured products are more sustainable. Fourth, the highly skills workers such as robot programmer, machine maintenance workers, assembly line workers in automotive industry and mobile service