MALAYSIAN SMART MANUFACTURING ECOSYSTEM READINESS ASSESSMENT FOR INDUSTRY 4.0

NURUL ATHIRAH BINTI ZAKARIA

This Thesis Is Submitted in Partial
Fulfilment Of The Requirements For The Award Of Bachelor Of Technology Management (Technology Innovation) With Honours

Faculty of Technology Management and Technopreneurship
UNIVERSITI TEKNIKAL MALAYSIA MELAKA

JANUARY 2023

MALAYSIAN SMART MANUFACTURING ECOSYSTEM READINESS ASSESSMENT FOR INDUSTRY 4.0

NURUL ATHIRAH BINTI ZAKARIA

Bachelor Of Technology Management (Technology Innovation) With Honours

Faculty of Technology Management and Technopreneurship
(UTeM) Malaysia Melaka Teknikal Universiti

APPROVAL

‘I hereby declare that I have read and go through this dissertation/report/thesis and certify that, this dissertation/report/thesis is satisfactory in the sense of scope and quality as a partial fulfilment the requirements for the award of Bachelor of Technology Management (Innovation) with Honours and will submitted to the Universiti Teknikal Malaysia Melaka.’

SUPERVISOR’S SIGNATURE	:	
SUPERVISOR NAME	:	Mrs. Nor Ratna Binti Masrom
DATE	:	10 January 2023

PANEL’S SIGNATURE	:	
PANEL NAME	:	Dr. Nurulizwa Binti Abdul Rashid
DATE	:	10 January 2023

DECLARATION

‘I have hereby stated that my
dissertation/report/thesis entitled,
“MALAYSIAN SMART MANUFACTURING ECOSYSTEM READINESS ASSESSMENT FOR INDUSTRY 4.0”
is the result of my personal study except with the explanations or information from other research as cited in the references clearly. The thesis has not been accepted for any degree and is not concurrently submitted in the candidature of any other degree.’

SIGNATURE : *athir*

NAME : Nurul Athirah Binti Zakaria

DATE : 10 January 2023

DEDICATION

I would like to express my deepest appreciation to my precious family members who have always aided and inspired me all the time in various spiritual, economical, and motivational ways. In addition, I would also like to devote my sincere gratitude to my beloved supervisor, Mrs. Nor Ratna Binti Masrom, who are willing to spend much time and patiently guided me in the whole process of this research and my classmates/friends who share their knowledge during the study. Without their blessing and support, this study is difficult to complete.

ACKNOWLEDGEMENT

I would like to take this opportunity to express my sincere gratitude to my beloved supervisor, Mrs. Nor Ratna Binti Masrom, for her guidance and advice. Thank you for sharing useful information and experiences that always inspired me to work hard towards the completion of the project. I would also like to thank my committee Dr. Nurulizwa Binti Abdul Rashid, who provided valuable comments and recommendations for my project, my deepest appreciation. Also, I would not forget to thank my family members, classmates, and friends who are always willing to help me and encourage me along the way to complete my thesis. Without their motivation and support, I would not have been able to successfully complete this thesis.

ABSTRACT

The Smart Manufacturing Ecosystem (SME) plays an important role in achieving the company's goal towards industry 4.0 (I4.0). Industry 4.0 revolves around “a network of manufacturing resources (manufacturing machines, robots, conveyors and warehousing systems and production facilities) that are autonomous, able to control themselves in response to different situations, self-configuring, knowledge-based, sensor-equipped and spatially distributed and which also incorporates related planning and management systems". Therefore, this research is to examine the readiness assessment of Malaysia's smart manufacturing ecosystem for industry 4.0 and aims to determine the relationship between the independent variables. This study was conducted using quantitative methods. This research will focus on employees working in manufacturing firms in Malaysia who are in positions at the executive level and above because they are more responsible in making decisions. In conducting the study of this research project, a quantitative method was chosen for data collection, and the Statistical Package for Social Sciences (SPSS) version 26 was used for data analysis. The constructed questionnaire was distributed to 120 of the target subjects via a URL or Google Form link via email and other network-based applications. Therefore, the results cross tabulation shows that the three variables in this. In conclusion, through this research, it is hoped to provide guidelines to Malaysian manufacturing firms for them to know the criteria required for companies to apply and use the smart manufacturing ecosystem (SME) for industry 4.0 (I4.0) in their work that can produce effective ways and efficient business.

Keyword – *Smart Manufacturing Ecosystem, Industry 4.0, SPSS.*

ABSTRAK

Ekosistem Pembuatan Pintar (SME) memainkan peranan penting dalam mencapai sasaran syarikat kearah industry 4.0 (I4.0). Industri 4.0 berkisar tentang "rangkaian sumber pembuatan (mesin pembuatan, robot, penghantar dan sistem pergudangan dan kemudahan pengeluaran) yang berautonomi, mampu mengawal diri mereka dalam tindak balas kepada situasi yang berbeza, konfigurasi diri, berasaskan pengetahuan, dilengkapi sensor dan tersebar secara spatial dan yang turut menggabungkan sistem perancangan dan pengurusan yang berkaitan". Oleh itu, penyelidikan ini adalah untuk mengkaji penilaian kesediaan ekosistem pembuatan pintar Malaysia untuk industry 4.0 dan bertujuan untuk menentukan hubungan antara pembolehubah bebas. Kajian ini dijalankan dengan menggunakan kaedah kuantitatif. Penyelidikan ini akan memberi tumpuan kepada pekerja yang bekerja di syarikat PKS di Malaysia yang berada dalam jawatan di peringkat eksekutif dan ke atas kerana mereka lebih bertanggungjawab dalam membuat keputusan. Dalam menjalankan kajian projek penyelidikan ini, kaedah kuantitatif telah dipilih untuk pengumpulan data, dan Pakej Statistik daripada Sains Sosial (SPSS) versi 26 digunakan untuk analisis data. Soal selidik yang dibina diedarkan kepada 120 daripada subjek sasaran melalui URL atau pautan Borang Google melalui email dan aplikasi berasaskan rangkaian lain. Oleh itu, hasil daripada penjadualan silang menunjukkan ketiga-tiga pembolehubah dalam kajian Kesimpulannya, melalui penyelidikan ini, diharapkan dapat memberi garis panduan kepada firma pembuatan Malaysia untuk mereka mengetahui kriteria yang diperlukan untuk syarikat mengaplikasi dan menggunakan ekosistem pembuatan pintar (SME) untuk industri 4.0 (I4.0) dalam kerja mereka yang boleh menghasilkan cara yang berkesan dan cekap menjalankan perniagaan.

Kata kunci – *Ekosistem Pembuatan Pintar, Industri 4.0, PKS, SPSS.*

TABLE OF CONTEXT

LIST OF TABLES

LIST OF RIGURES

LIST OF ABBREVIATIONS

I4.0	Industry 4.0
NIST	National Institute of Standards and Technology
IoT	Internet Of Things
RBV	Resource-Based View
SP	Smart Product
SF	Smart Factory
DDS	Data Driven Services
PLC	Programmable Logic Controllers
SMS	Short Production System
MESA	Manufacturing Enterprise Solutions Association
ICT	Information And Communications Technology
CPS	Cyber-Physical System
IT	Information Technology

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1. Introduction

This chapter explains about background of the study, research problem, research question, research objectives, significant of the study, limitation of the study and operational definitions. To complete a Bachelor's Degree Dissertation (Projek Sarjana Muda (PSM)) in Faculty of Technology Management and Technopreneurship (Bachelor of Innovation), researcher chooses to investigate the Malaysian smart manufacturing ecosystem readiness assessment for Industry 4.0.

1.2. Background Of Study

Industry 4.0, also known as smart manufacturing, refers to the merger of operational technology and information to monitor physical production processes and employ data to make prescriptive, corrective, and adaptive decisions in order to cut operational costs. The term "industry 4.0" is a reference to the fourth industrial revolution, or more precisely, the transition to manufacturing that is smart and intelligent (Tay, Alipal and Lee, 2021). The implementation of Industry 4.0 necessitates the integration of vertical and

horizontal data throughout the whole of an organization. Vertical digitalization may be observed in a variety of sectors, including manufacturing, procurement, supply chain management, design, product life cycle management, logistics, operations, and quality. Vertical digitalization can also be seen in operations and quality. They are all linked to one another to ensure that a steady stream of data is provided. The process of integrating data from several parties, including as customers, suppliers, and strategic partners, might be considered part of horizontal digitalization. In order to integrate a company, its systems, networks, and operational processes will need to be upgraded or replaced, respectively. In the context of the smart and intelligent manufacturing model, digitally integrating a business system is insufficient. The integrated system requires end-to-end engineering transformation, strong data services, and analytics in order to convert the data that is created by systems, sensors, and machines into meaningful insights that may yield a return on investment (Tay, Alipal and Lee, 2021).

According to the National Institute of Standards and Technology (NIST), "smart manufacturing" is a fully integrated collaborative production system that can adjust in real time to changing circumstances in the plant, the supply chain, and consumer expectations(Tay, Alipal and Lee, 2021). Because linked systems are being used in smart manufacturing, the danger to cyber security is also increased. This is why implementing Industry 4.0 requires tight coordination with the company's IT specialists. To guarantee that best practices for cyber security are used throughout the company's digital ecosystem, IT experts must work in collaboration with senior management. An organization's internal culture revolution is one of the most important aspects of Industry 4.0 adoption in manufacturing. This calls for strong leadership that is dedicated to managing change and making the required investments in technology and education to effectively adopt smart manufacturing processes(Tay, Alipal and Lee, 2021).

1.3. Problem Statement

According to Anshari and Almunawar, (2022), there is a positive association between the preparedness of digital ecosystems and the adoption of open innovation by small and medium-sized enterprises (SMEs). Despite the fact that knowledge management is one of the most important factors in determining whether or not a nation will be successful in implementing the open innovation paradigm, According to a recent study, "smart manufacturing systems" have been actively contributing to the improvement of manufacturing technology in the modern industrial era. Technology that enables smart manufacturing boosts both operational efficiency and production, and it also has a significant influence on economies throughout the world. It has been discovered that the advent of the Internet of Things and the Industrial Internet of Things has been playing a significant role in improving manufacturing systems that are equipped with smart manufacturing systems (Phuyal, Bista and Bista, 2020).

There is research has been done, one of the most critical issues that requires further exploration is the interpretation of the term “industry 4.0”, based on its contribution at the manufacturing and business level, the value of the futuristic use cases, and the available technological enablers. It is widely known that different technological initiatives, developed around the globe, have been described as I4.0 advancements. These various forms of ingenuity have obscured the original I4.0 inspiration, and as a result, the methodology needed to achieve key developments and business visions has not yet been clearly defined (Konstantinidis et al., 2022).

1.4. Research Question

The following research question is being addressed in this study:

i. What is profile Malaysian smart manufacturing ecosystem readiness for Industry 4.0?

ii. What is level the Malaysian smart manufacturing ecosystem?
iii. What is the difference between the local and international ownership in terms of smart manufacturing?

1.5. Research Objective

The research's objective was determining the Malaysian smart manufacturing ecosystem readiness assessment for Industry 4.0. The following are the research objective:

i. To profile Malaysian smart manufacturing ecosystem readiness for Industry 4.0.
ii. To measure level the Malaysian smart manufacturing ecosystem.
iii. To study the difference between the local and international ownership in terms of smart manufacturing.

1.6. Scope Of Study

The research's scope is the distribution of questionnaires to analyse the Malaysian smart manufacturing ecosystem readiness assessment for Industry 4.0. The respondents will be in Malaysian manufacturing company businesses who hold executive-level or above positions. This research will be conduct to all Malaysian manufacturing firms.

This research will utilize the resource-based view (RBV) theory. The study discovered that the Resource-based view (RBV) hypothesis has become the dominant paradigm in the smart manufacturing, allowing us to comprehend how firm create efficient results. Furthermore, it provides us with vital information on how efficient the performance and how it managed.

1.7. Significant Of Study

1.7.1. Practical Contribution

According to the findings of this study (Anshari and Almunawar, 2022), SMEs in Indonesia This research examined some of the most important challenges that small and medium-sized businesses (SMEs) face when it comes to implementing open innovation, which is necessary for Industrial Revolution 4.0. The paper focuses on the ways in which the preparedness of the digital ecosystem effects the adoption of open innovation by SMEs in Indonesia. The research conducted by Tay, Alipal, and Lee (2021) looked at the data collected from seven different manufacturing businesses that were participating in Industry 4.0 projects in order to determine the many possibilities available for the companies' plans. According to the findings of the research, the application of Industry 4.0 in manufacturing companies is still in the experimental stage. [Citation needed]

1.7.2. Theoretical Contribution

The Resource Based View (RBV) of a company is based on the idea that a company's success is dictated by the resources available to it. The way these resources are utilized and arranged allows the company to function well and might even provide it a competitive edge. (ICAEW, 2016)

1.8. Limitation Of Study

There are various limitations to doing this research, researcher faced with some limitations such as time constraint, lack of skill and knowledge and the respondent honesty. Researcher has limit time of research due to the short period given in implementing her study. Researcher has some difficulties to

find as much as information and details related to her study in each timeframe. Then, this research only focuses on manufacturing firm in Malaysia respondents, thus the result is more focused on manufacturing firms than on respondent from other industries.

1.9. Operational Definition

a) Smart Manufacturing

Smart manufacturing is the notion of orchestrating physical and digital processes within factories and across other supply chain functions to optimize current and future supply and demand requirements. This is accomplished by transforming and improving ways in which people, process and technology operate to deliver the critical information needed to impact decision quality, efficiency, cost, and agility.

b) Industry 4.0

Industry 4.0 is revolutionizing the way companies manufacture, improve, and distribute their products. Manufacturers are integrating new technologies, including Internet of Things (IoT), cloud computing and analytics, and AI and machine learning into their production facilities and throughout their operations.

1.10. Chapter Summary

Finally, this background completed the research's background, which is connected to present status of Malaysian smart manufacturing ecosystem readiness assessment and Industry 4.0. There are additional explanations of why this study is being performed. Furthermore, this chapter presents three study questions and goals. This research is limited by a few factors, including respondent honesty and time constraints. This research is important because it gives information on the smart manufacturing ecosystem readiness assessment on the industry 4.0 in Malaysian.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter will discussed about the literature review and relevant theoretical model. The researcher discussed about the variables, measurement, and definition of industrial 4.0, smart product, smart factory and data driven services. The independent variable is clearly defined it.

2.2 Definition

2.2.1. Industrial Revolutions

The machining process of the early ages to the automated manufacturing industries of today: the manufacturing industries have come a long way in a relatively short amount of time. Manufacturing and industrialization systems have now reached their fourth generation since the beginning of the industrial revolution. These systems have progressed via many innovations and iterative tests over the course of the last few years. During this time span, there have been several advancements and adjustments made thus far. Figure 2 presents a timeline that details the many years of the industrial revolution. Within each of these ages are

highlighted significant accomplishments and innovations that are shared by the more recent revolution.(Tay, Alipal and Lee, 2021)

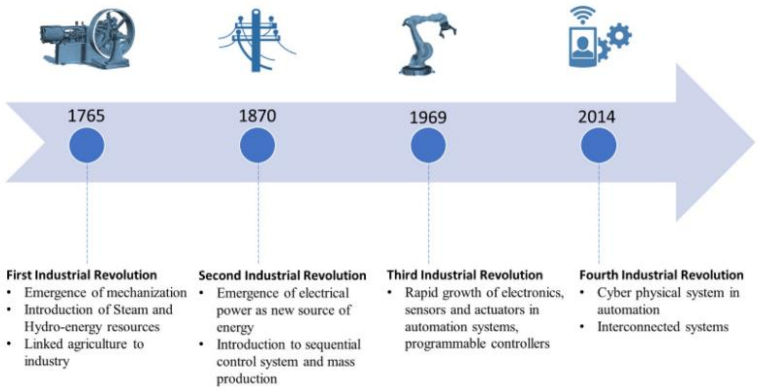

Figure 2.1: Chronology of Industrial Revolution.

Sources: (Phuyal, Bista and Bista, 2020)

a) First Industrial Revolution

In the first half of the 18th century, the United Kingdom was the first country in the world to begin the process of industrialization. At that time, the cotton industry was transitioning from a worker-based cottage industry to an economy based on machines. This transition took place in the cotton industry. The commencement of the new manufacturing process coincides with the time period known as the "first industrial revolution" in Europe and America, which is generally considered to have occurred between 1760 and 1820. During this time period, the textile industry was the first industry to make use of modern production technology. As a result, it was one of the largest sectors in terms of capital investment, output, and the number of job opportunities it provided. The creation of coal, iron, railways, and textiles were the important advancements of the first industrial revolution. The discovery of the spinning jenny in 1764 by James Hargreaves, which produced numerous spools of thread

at once, accelerated the production of machining. Mechanization, the process that replaced agriculture with industry as the foundations of the economic structure of society, began about this period. It was around this time that the industrial revolution began. The widespread mining of coal, in conjunction with the creation of the steam engine, resulted in a new kind of energy that propelled all processes ahead. This was made possible by the proliferation of railways and the quickening of economic, human, and material transactions.(Phuyal, Bista and Bista, 2020)

b) Second Industrial Revolution

The years 1830 to 1914 are considered to be part of the second industrial revolution, which is also often referred to as the technical revolution. The development of new technologies led to the discovery of alternative sources of energy, such as oil, gas, and electricity, which in turn led to the creation of a variety of new innovations. As a direct consequence of this, the development of the combustion engine set out to use these new resources to the most extent of their potential. In addition, the steel industry started developing and expanding in tandem with the exponential increase in demand for steel. As a result of developments in chemical synthesis, we now have access to synthetic fabric, colors, and fertilizer. At the turn of the 20th century, the discovery of the telegraph and the telephone ushered in a new era of innovation in the field of communication. The same can be said for the development of the vehicle and the airplane in the field of transportation. All of these innovations were made conceivable as a result of the concentration of research efforts and financial resources within the framework of an economic and industrial model predicated on the creation of new "big factories." The field of chemistry also started along the path that would lead to the

production of new artificial materials, such as disinfectants and antiseptics, in particular phenol and bromines, the function that bacteria play in the infection of wounds, salicylic acid, and so on. During this period of time, advancements in electric technology resulted in the development of electric generators, vacuum pumps, gas lighting systems, and transformers. It was discovered that electricity might be used as a generic means of transmitting energy. In the sphere of autos, developments like as diesel engines and clipper ships have been made in comparison to the acceleration of railways. Some of the contributions that were made in the sphere of agriculture were steam-powered threshing machines, seed drills, mechanical reapers, and tools made out of steel. It did this in an irreversible manner by altering the link between our understanding of nature and the ways in which it influenced our technological practices.(Phuyal, Bista and Bista, 2020)

c) Third Industrial Revolution

After the end of the second world war, industrial growth once again picked up where it had left off, and the years after 1969 are considered to be part of the so-called "third industrial revolution." Both World Wars I and II had an impact on the global economy as well as its development. The electromechanical systems were updated into computer-based control systems, and industrial robots and Programmable Logic Controllers (PLC) were the major ideas and implementations in the industrial automation system. The electromechanical systems were also upgraded. The advent of a new kind of energy known as nuclear energy, which had a potential that was greater than that of its forerunners, marked the beginning of the third industrial revolution. Not only did this revolution see the development of the transistor and

microprocessors, but it also saw the expansion of both telecommunications and computer technology. This new technique allowed for the manufacture of tiny material, which opened up a number of new avenues of investigation, most notably in the fields of biotechnology and space research.

Automation of manufacturing became possible because to advances in electrical and computer technologies during the third industrial revolution.(Phuyal, Bista and Bista, 2020)

d) Fourth Industrial Revolution

The phrase "Industry 4.0," also known as the "fourth industrial revolution," was first coined in 2011 by a group of corporate, political, and academic specialists in an effort to improve Germany's standing as a world leader in the manufacturing sector. It focuses primarily on the processing of real-time data and places a heavy emphasis on interconnection via the Internet of Things and machine learning. Connecting the internet of things and the industrial internet to the manufacturing system enables Industry 4.0 to enable machines to communicate with one another, exchange information, and make intelligent choices based on the algorithm of the manufacturing system. Artificial intelligence, robotic automation, adaptable factory automation systems, additive manufacturing, and augmented reality are the core components of the industry 4.0 initiative. The transition to I4.0 is a step-by-step procedure that requires some amount of time in order to completely update everything from the previous system. To be updated into current systems, physical infrastructures, the acceptance of new technologies, a familiarity with those technologies, and the availability of technical people are all important requirements.(Phuyal, Bista and Bista, 2020)

2.2.2. Smart Manufacturing

The term "smart manufacturing" refers to the process of integrating a number of different technologies, including those connected to production, computing, virtualization, communication, data management, and so on. The interoperability of diverse technologies has resulted in cost-effectiveness, timesaving, easier setup, greater comprehension, rapid reaction to market demand, flexibility, and remote monitoring, which has led to an expansion of the scope of smart manufacturing technologies. (Phuyal, Bista and Bista, 2020)

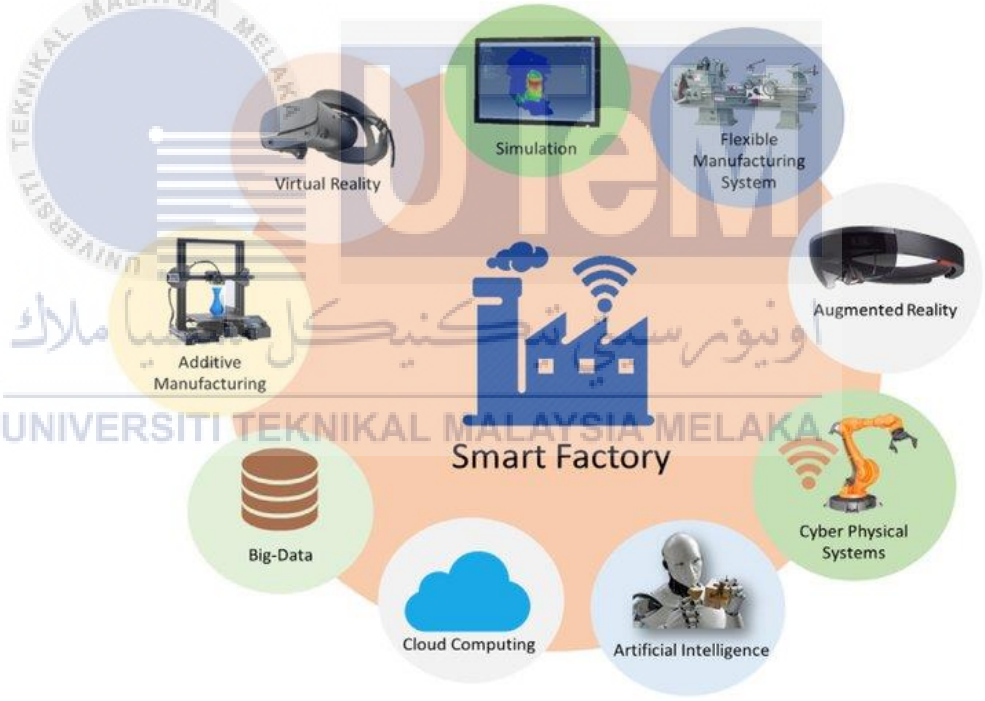

Figure 2.2: Components of Smart Manufacturing System.

Sources: (Phuyal, Bista and Bista, 2020)

2.2.3. Smart Manufacturing Ecosystem

The Smart Production System (SMS) is the digitalization of every component of the manufacturing system with interoperability, real-time control and monitoring, flexible manufacturing, rapid market reaction, sophisticated sensors, big data analytics, and increased productivity. There are two operating modes for the SMS: semi-autonomous and autonomous. The production engineer establishes the parameters and determines the objectives in the semi-autonomous system. In a completely automated system, the SMS determines the ideal operating parameters and automatically applies them to all the connected manufacturing units.

Building the capacity for cost-effectiveness, ideal product production and delivery times, product quality, and product customization flexibility is the manufacturer's top priority for remaining competitive in the market. The second issue is whether any production system can sustain and enhance performance over time utilizing information and shifting environmental conditions as changing variables. Many different technologies have been explored to establish a smart manufacturing system. One of the major challenges in transforming a current system into a smart manufacturing system may be the choice of technology. There are certain methods for making a wise decision. The Manufacturing Enterprise Solutions Association (MESA) Manufacturing Transformation Strategy (based on ISA-95 techniques) and the Supply Chain Readiness Level are typical approaches. They put a single technology or industrial execution system as their fundamental base rather than information and communication. The usage of information and communication technology is required to assess the current system and switch to a smart one.

The industry 4.0 model is a smart illustration of the use of information and communication technology. The many services provided by this sector of the economy may be transformed into smart services by fusing

effective data and system-based process management with business operations. The industry may become a smart industry by using IoT to connect the systems and services. To evaluate and safeguard the incoming data, various data analysis tools must be created and integrated with a security system.

The smart manufacturing ecosystem is shown in Fig. 4 by the National Institute of Standards and Technology (NIST), and it depicts how the many connected areas of smart manufacturing interact with one another and carry out their various duties. This eco-system demonstrates the relationship between the enterprise's product (green arrow), manufacturing process (blue arrow), and company (orange arrow) and their lifetime in a schematic manner. In Table 4, the elements of the NIST smart manufacturing system seen in Figure 4 are further described.

The internet-based fusion of physical entities via digital transformation and smart technologies is now the foundation for the next-generation of industries. The main technologically advanced nations have made many important announcements, including Industry 4.0 by Germany, Made in China 2025 by China, Industrial Internet by the USA, and Society 5.0 by Japan. These technologies have a similar goal of using smart and digital technology in order to improve the present manufacturing processes in the globe. They vary from one another in terms of implementation approach, target industry group, and predicted timescale for success.

Figure 2.3: NIST's smart manufacturing eco-system model

Sources: (Phuyal, Bista and Bista, 2020)

2.3 Smart Product.

Because it enables the customer to co-construct the customer's experience with the service so that it is tailored to the customer's specific context, the smart co-created design product is an essential asset for both the company and the consumer. This is because it enables the customer to co-construct the customer's experience with the service. In contrast to more conventional approaches to market research, this calls for collaborative effort on the part of a diverse group of market participants as well as the end users of the product. Co-design is the process of including and soliciting participation from stakeholders (businesses or consumers) throughout the design development process. This is done to ensure that the final product satisfies the requirements of the stakeholders and can be put to practical use. Co-design is also known as participatory design. A physical product that is equipped with components of information and communication technology (sensors, RFID, communications interface, etc.) to collect data on both its surrounds and its own status is referred to as a "Smart Object." It is only when products are able to gather data, are aware of their place in the manufacturing process, and are

able to communicate with higher-level systems that production processes will be able to be improved, led autonomously, and done in real time. In addition, the current condition of the many different things may be monitored and improved upon as soon as this becomes feasible. However, this isn't the only viable use for it; the industrial sector is only one of several. When intelligent goods are put to use during the consumption phase, it creates the way for the introduction of new services. For instance, it makes communication between end users and the businesses that produce the products easier to do. This assessment in the area of intelligent products is created by taking a look at the information and communications technology (ICT) add-on functionalities of different products and the degree to which data from the usage phase is assessed. (ERASMUS+ CBHE PROJECT Curriculum Development of master's degree Program in Industrial Engineering for Thailand Sustainable Smart Industry Curriculum Development of Master's Degree Program in Industrial Engineering 0 for Thailand Sustainable Smart Industry-MSIE4.0 Questionnaire, 2018)

2.4 Smart Factory.

The effective implementation of Industry 4.0 paves the way for the possibility of achieving distributed production that is highly automated. Smart workpieces, as opposed to normal ones, will control and monitor the manufacturing process, and in the final expansion phase, they will lead themselves autonomously through the production process. Smart workpieces will also regulate and monitor the manufacturing process. This activity takes place inside the atmosphere of the intelligent factory. A "smart factory" is a manufacturing environment in which the production and logistics systems are intended to a substantial degree to organize themselves without significant input from humans. This kind of environment is referred to by the name "smart factory." (ERASMUS+ CBHE PROJECT Curriculum Development of master's degree Program in Industrial Engineering for Thailand Sustainable Smart Industry Curriculum Development of Master's Degree Program in

Industrial Engineering 0 for Thailand Sustainable Smart Industry-MSIE4.0 Questionnaire, 2018)

In order for the smart factory to function properly, the cyber-physical systems, also known as CPS, are required. These devices exchange data across a network that is powered by information technology (IT) and is known as the Internet of Things. This creates a connection between the real and virtual worlds. One other component of Industry 4.0 is digital modeling, which encompasses the effective gathering, storing, and processing of data. The concept that drives the notion of the "smart factory" ensures that information will be provided, and that resources will be used in the most efficient way possible. In order to do this, it is necessary for production systems, information systems, and individuals from different businesses to collaborate with one another in real time. This kind of integrated system generates a large amount of data, which is subsequently processed, analyzed, and incorporated into decision-making models. (ERASMUS+ CBHE PROJECT Curriculum Development of master's degree Program in Industrial Engineering for Thailand Sustainable Smart Industry Curriculum Development of Master's Degree Program in Industrial Engineering 0 for Thailand Sustainable Smart Industry-MSIE4.0 Questionnaire, 2018)

A company's progress around the smart factory is measured using the following four criteria:

- Digital modelling
- Equipment infrastructure
- Data usage
- IT systems

2.5 Data Driven Services.

The distinguishing element of the Industry 4.0 paradigm is the enterprise-wide and cross-enterprise integration of the physical and virtual worlds. This integration may also occur across different enterprises. The rise of digitization and the abundance of data it has brought to production and logistics have made it possible to introduce what are in some cases entirely new forms and approaches to production planning systems (PPS) and supply chain management. This has made it possible to introduce what are in some cases entirely new forms and approaches to production planning systems (PPS) and supply chain management. This has made it feasible to introduce what are in some instances wholly new forms and methods to production planning systems (PPS) and supply chain management. These innovations have been made possible as a result of recent technological advancements (SCM). In order to accomplish the self-regulating workpiece, also known as smart operations, it is necessary to fulfill certain technical requirements in production and production planning. (ERASMUS+ CBHE PROJECT Curriculum Development of master's degree Program in Industrial Engineering for Thailand Sustainable Smart Industry Curriculum Development of Master's Degree Program in Industrial Engineering 0 for Thailand Sustainable Smart Industry-MSIE4.0 Questionnaire, 2018)

Industry 4.0 readiness in smart operations is determined using the following four criteria:

- Information sharing
- Cloud usage
- IT security
- Autonomous processes

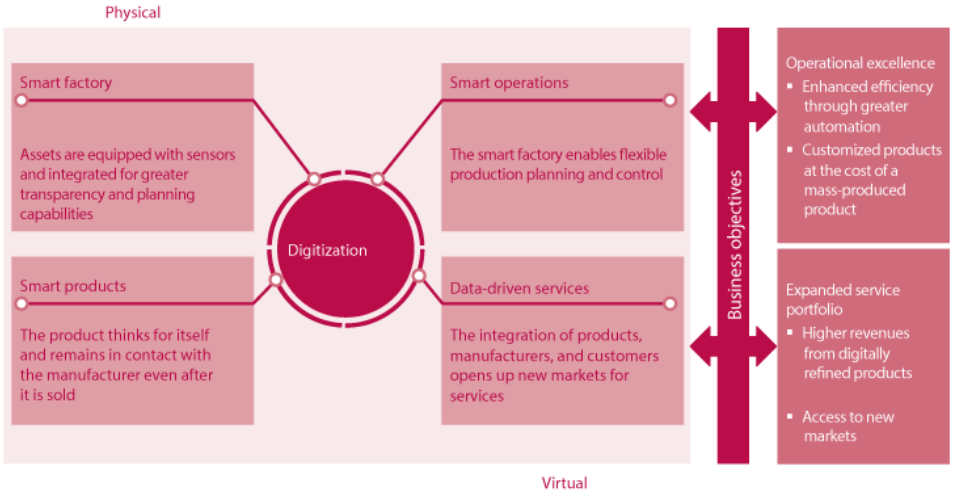

Figure 2.4: The readiness measurement model

Sources: ERASMUS+ CBHE PROJECT Curriculum Development of master's degree Program in Industrial Engineering for Thailand Sustainable Smart Industry Curriculum Development of Master's Degree Program in Industrial Engineering 0 for Thailand Sustainable Smart Industry-MSIE4.0 Questionnaire, 2018)

2.6 Conceptual Framework

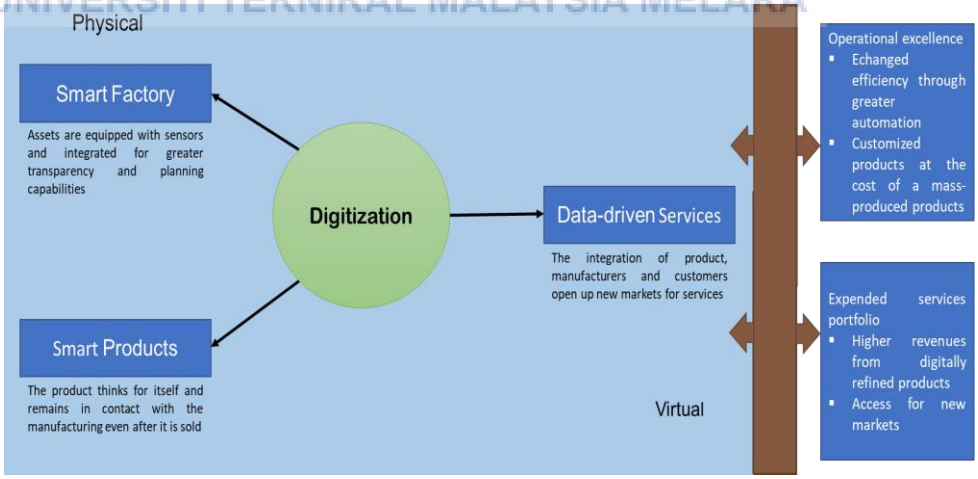

Figure 2.4: Conceptual Framework

Sources: ERASMUS+ CBHE PROJECT Curriculum Development of master's degree Program in Industrial Engineering for Thailand Sustainable Smart Industry

Curriculum Development of Master's Degree Program in Industrial Engineering 0 for Thailand Sustainable Smart Industry-MSIE4.0 Questionnaire, 2018)

2.7 Chapter Summary

In the context of this study subject, the literature reviews that are being covered are all Malaysian smart manufacturing ecosystem readiness assessment for Industry 4.0. In moreover, the researcher analysed the meaning of " industry 4.0" "smart manufacturing ecosystem," "smart product," "smart factory," and "data driven services" in this chapter, all of which are founded on prior study. Finally, the three independents are smart product, smart factory, and data driven services.

CHAPTER 3

RESEARCH METHODOLOGY

3.1. Introduction

In Chapter 3, the research design, as well as the many other types of research designs, will be explored in depth. After then, one of the study designs was picked out to be used for these investigations based on several different characteristics. Research methodology refers to the steps that need to be done for a researcher to successfully carry out their investigation (Kassu Jilchs, 2019). As a direct consequence of this, research methodologies are familiar, and these methods may be broken down into three distinct categories. One of the research methods was selected to carry out this enquiry, and the reason for this choice is provided below. The technique of data collection will also provide an overview of the process involved in gathering the information and data that is important.

3.2. Research Design

Malaysian smart manufacturing ecosystem readiness assessment for industry 4.0 was investigated in this study. A logical justification for selecting data sources, data collection processes, and data analysis methodologies was

provided by the research design, which served as the framework for collecting and analysing data to fulfil the research objectives and satisfy the research aims. This was accomplished through the research design, which also served as the framework for conducting the research (Saunders et al., 2016). The importance of research design lies in the fact that it paves the way for the smooth navigation of a wide variety of research methods, producing work that is as competent as is practically possible and providing comprehensive information with the fewest number of resources expended in terms of time, energy, and money (Innam, 2016). There are four different methodologies that may be used in research: exploratory, descriptive, explanatory, and evaluative (Saunders et al., 2016). For this investigation, the researcher decided to use an explanatory research design for the enquiry.

3.3. Methodology Choice

Quantitative methods, qualitative methods, and mixed techniques are the three categories into which many methodology options may be placed. A quantitative approach that makes use of a quantitative method is what the researcher involved in this investigation considers to be the most effective way to gather information for the study. In addition, quantitative approaches might be utilised to investigate the connection between Malaysian smart manufacturing ecosystem readiness assessment for Industry 4.0. A questionnaire is going to be used by the researcher to collect the data.

3.3.1. Quantitative Research Design

Since quantitative research design requires procedures that enable data to be collected in a structured manner, it is closely related to the positivist research philosophy, as discovered by Mark Saunders et al., (2016). This was discovered after the authors of the study

discovered that quantitative research design is closely related to positivist research philosophy. In addition, quantitative research is the process of gathering and evaluating numerical data. It is possible to utilise it to find patterns and averages, to create forecasts, to assess incidental relationships, and to generalise findings to bigger groups (Pritha Bhandari, 2020).

The researcher plans to make use of the quantitative study to investigate the relationship between the Malaysian smart manufacturing ecosystem readiness assessment for Industry 4.0. To provide evidence that this research study is entirely quantitative, the researcher will collect primary data via the use of a reliable questionnaire.

3.4. Data Sources

The processes for collecting data were geared toward the collection of the necessary information to achieve the objectives. Included in this analysis were secondary and primary data collectors that focused on quantitative data. Primary data sources and secondary data sources are the two categories of information and data sources that need to be processed. In this study, the researcher will examine both data sources, and the researcher will utilise the questionnaire method to gather data for analysis to gain primary data. Primary data will be obtained from this study.

3.4.1. Primary Data

According to Kassu Jilchs (2019), defined primary data are more trustworthy and have a better degree of confidence in the decision-making process. This is because the credible analysis is

directly related with the occurrence of occurrences. The key sources of data are the personnel of the sector as well as the working environment of the industry (observation and photography) (management and bottom workers by questionnaires, and discussions).

The core data for the research might be collected by sending out questions to each responder individually utilising the online questionnaire approach. An online questionnaire may be created with the use of a Likert scale that has seven items. An answer on a scale like the Likert scale was given to each argument, with a score of 1 indicating "strongly disagree" and a score of 7 indicating "strongly agree."

3.4.2. Secondary Data

Most researchers have traditionally relied on the time-tested method of secondary data collection when gathering information for their studies. The term "secondary data" refers to information that was compiled by a different party in the past. In addition, secondary data are information that was not received from the individual doing the research study, but rather from a third party who was conducting their own research at a different time and place in the past and who gathered the information for a different purpose (Oluwatosin et al., 2017).

The researcher studied the data that was connected to the subject of the study by reading a variety of publications and periodicals. The researcher gathered secondary data by utilising the Google Scholar web page and several library databases, such as emerald and Science Direct, to fulfil the goals and purposes of the study.

3.5. Location Of Research

A nation in southern Asia, Malaysia is situated on the Malay Peninsula and is geographically close to the island of Borneo. As a direct consequence of this, Malaysia was selected as the venue for the study since Malaysia is home to a significant number of SME's (SME). The site will be exclusive to the manufacturing firms in Malaysia business whose workers are, at the very least, at the executive level.

3.6. Time Horizon

Saunders et al. (2016) say that the time horizon is how long it will take to finish the research. Cross-sectional and longitudinal research look at time in different ways. The researcher will use a cross-sectional study to do this research because there isn't enough time to analyse the data and the research needs to be done quickly. A cross-sectional study is one in which data from a single point in time are looked at.

3.7. Research Strategic

The research plan lays out not just the methodology by which the investigation will be carried out, but also the overarching path that the investigation will take. The following are some examples of research strategies: the experiment, the archival research, the ethnography, the action research, the grounded theory, the narrative inquiry, the survey, and the case study (Saunders et al., 2016).

3.7.1. Survey Strategy

The researcher has determined that the best approach for this study will be to conduct the research using the survey technique. The researcher can gather quantitative data via the analysis of descriptive and constructive statistics thanks to the survey technique, which also makes it possible for the researcher to uncover potential links between the variables (Saunders et al., 2016).

To collect quantitative data as part of the survey approach, the questionnaire will be employed. The use of questionnaires as a method for collecting quantitative data enables researchers to amass an immense quantity of information and data from a diverse pool of respondents. It is appropriate for the researcher to use the survey technique to carry out the data collection method in order to the Malaysian smart manufacturing ecosystem readiness assessment for Industry 4.0. The use of an online questionnaire is often connected with a deductive method when referring to a survey technique. The online questionnaire displays a Google Form as the survey form; this form is one that any respondent may access, fill out, and submit online.

3.7.2. Questionnaire Design

To gather information useful for this study, a survey will be sent to personnel working in positions in manufacture firms that are executive level or above. The researcher will be the one to construct the questionnaire to evaluate the Malaysian smart manufacturing ecosystem readiness assessment for Industry 4.0. There are four distinct parts to the format of the questionnaire that was used for the survey. There are four distinct components included in the questionnaire.

The first component of the questionnaire inquired about the respondent's demographic information, which included their ownership, job tittle, working experiences and department. The primary objective of the first portion was to collect information about the respondents' general characteristics. The second section focuses on the smart product. The third section of the questionnaire focused on the smart factory in industry 4.0 The fourth section concentrated on the data driven services for smart manufacturing ecosystem.

Table 3.1: Questionnaire items

NO	ITEMS	SOURCES
Smart Product		
SP1	You company uses Machine to Machine communication where transmission of machine data between mechanical or electronic devices can be done automatically without human intervention.	ERASMUS+ CBHE PROJECT Curriculum Development of master's degree Program in Industrial Engineering for Thailand Sustainable Smart Industry Curriculum Development of Master's Degree Program in Industrial Engineering 0 for Thailand Sustainable Smart Industry-MSIE4.0 Questionnaire, 2018)
SP2	Your company is implementing Interoperability technology where it is able to connect and communicate in a coordinated way, without effort from the end user.	
SP3	Your company collects equipment capacity utilization automatically.	
SP4	Your company collects Employee utilization automatically.	
SP5	Your company collects Data about processing, process condition automatically.	
Smart Factory		

SF1	Your company currently uses Manufacturing Execution System (MES)	ERASMUS+ CBHE PROJECT Curriculum Development of master's degree Program in Industrial Engineering for Thailand Sustainable Smart Industry Curriculum Development of Master's Degree Program in Industrial Engineering 0 for Thailand Sustainable Smart Industry-MSIE4.0 Questionnaire, 2018)
SF2	Your company currently uses Enterprise Resource Planning (ERP)	
SF3	Your company currently uses Product Lifecycle Management (PLM)	
SF4	Your company currently uses Product Data Management (PDM)	
SF5	Your company currently uses Production Planning System (PPS)	
Data Driven Services		
DDS1	Data you collect used for Predictive maintenance.	ERASMUS+ CBHE PROJECT Curriculum Development of master's degree Program in Industrial Engineering for Thailand Sustainable Smart Industry Curriculum Development of Master's Degree Program in Industrial Engineering 0 for
DDS2	Data you collect used for Optimization of logistics and production processes.	
DDS3	Data you collect used for Creation of transparency across production process.	
DDS4	Data you collect used for Quality management.	
DDS5	Data you collect used for Optimization of resource consumption (material, energy)	

		Thailand Sustainable Smart Industry-MSIE4.0 Questionnaire, 2018)

3.8. Pilot Test

A pilot study is carried out that replicates all the procedures of the main study and validates the feasibility of the study by evaluating the inclusion and exclusion criteria of the participants, the preparation of the drugs and intervention, the storage and testing of the instruments used for measurements in the study, and the training of researchers and research assistants. The main study then follows the results of the pilot study (Benger, Coates, Davies, Greenwood, Nolan & Rhys, 2016).

The pilot test might find mistakes and weak points in the questionnaire, which would allow the questionnaire to be changed before it is sent to respondents. Respondents to the pilot test would give suggestions and information that would be used to make the final survey questionnaire. Due to time constraints, at least 15 or 20 people have been asked to take part in the pilot test.

3.9. Sampeling Design

According to Crossman (2019), a sampling design is a method that takes a portion of a population and uses that portion to make a decision that is representative of the whole population. The process of sampling is used to

define the target population of the study, to set sample size and sampling strategy, and to choose the technique that is most suited.

3.9.1. Sampling Population

The study's target population is manufacturing firm. The sample frame includes people who work in Malaysian manufacturing firm who hold executive-level or above positions in such enterprises. Additionally, small, and medium-sized firms have accounted for 98.5% of the total number of businesses in Malaysia (907065). (SME Cooperate Malaysia, 2020) [SME Cooperate Malaysia]

3.9.2. Sampling Technique

The terms "probability sampling" and "non-probability sampling" refer to two different types of sampling methods. The researcher will employ the method of probability sampling for the sampling procedure in this research. The researcher will use probability sampling, which requires them to assume based on the sample to answer the research question. To do this, the researcher will use the sample.

In addition, to reduce the size of the target population to a level that is more manageable, an approach known as simple random sampling, which is also a part of the probability sample, is used. According to Mark Saunders (2016), simple random sampling is a method that involves selecting a sample from a target population in a way that is completely at random using either a computer or a database of random numbers. It is possible to use a random number generator online to simplify the process of sample selection.

3.9.3. Sample Size

The sample size for this study is chosen by Krejcie and Morgan (1970). There are a total of 907065 small and medium-sized organizations in Malaysia, which accounts for 98.5 percent of the country's total commercial establishments (SME Cooperate Malaysia, 2020). According to the chart on sample size that was created by Krejcie and Morgan (1970), the sample size was maintained small because of the necessity for highly accurate data as well as the limitations of the available amount of time.

Table 3.1: Sample size for different sizes and population

Source: Krejcie & Morgan (1970)

N	S	N	S	N	S
10	10	220	140	1200	291
15	14	230	144	1300	297
20	19	240	148	1400	302
25	24	250	152	1500	306
30	28	260	155	1600	310
35	32	270	159	1700	313
40	36	280	162	1800	317
45	40	290	165	1900	320
50	44	300	169	2000	322
55	48	320	175	2200	327
60	52	340	181	2400	331
65	56	360	186	2600	335
70	59	380	191	2800	338
75	63	400	196	3000	341
80	66	420	201	3500	346
85	70	440	205	4000	351

90	**73**		**460**	**210**		**4500**	**354**
95	**76**		**480**	**214**		**5000**	**357**
100	**80**		**500**	**217**		**6000**	**361**
110	**86**		**550**	**226**		**7000**	**364**
120	**92**		**600**	**234**		**8000**	**367**
130	**97**		**650**	**242**		**9000**	**368**
140	**103**		**700**	**248**		**10000**	**370**
150	**108**		**750**	**254**		**15000**	**375**
160	**113**		**800**	**260**		**20000**	**377**
170	**118**		**850**	**265**		**30000**	**379**
180	**123**		**900**	**269**		**40000**	**380**
190	**127**		**950**	**274**		**50000**	**381**
200	**132**		**1000**	**278**		**75000**	**382**
210	**136**		**1100**	**285**		**1000000**	**384**

Note

N is population size

S is sample size

3.10. Descriptive Analysis

In descriptive analysis, numbers are used to describe and analyse variables to find the main trend and spread (Saunders et al., 2016). In this study, descriptive analysis tools were used to find out the ages, genders, and races of the people who were asked to take part. In other words, descriptive analysis is also used to collect information about the population and divide it into different groups. Each descriptive statistic makes a large amount of data easier to understand. The researcher will use the descriptive analysis to separate respondents who work in the SME business by ownership, job tittle, working experiences, and department. Will Kenton (2019) says that the most well-known types

of descriptive statistics are centre measures like mean, median, and mode, which are used in almost all math and statistics classes. This could be shown with variables like mean variable.

3.11. Chapter Summary

In this chapter, the researcher outlined the method for collecting variable data. It examines the research methodologies. The researcher will use an explanatory and quantitative design for this assignment. This research used primary and secondary data. This study's research plan will include a survey and questionnaire. Manufacturing firms will react to Google Form's digital inquiry. Malaysia was chosen since it has many manufacturing firms. This study will use cross-sectional samples and pilot testing. The researcher will use SPSS to analyse the data using Exploratory Factor Analysis, Descriptive Analysis, Multiple Regression Analysis, and Pearson's Correlation. Data analysis will explain the coefficient. The approaches used to validate this research's reliability are reliable.

CHAPTER 4

DATA ANALYSIS AND DISCUSSION

4.1. Introduction

The outcome of the data analysis gathered by the response to the title which the Malaysian smart manufacturing ecosystem readiness assessment for industry 4.0 was provided and analysed in this chapter. To begin, the reliability of each factor was assessed on 100 respondents using Exploratory Factor Analysis (EFA) in SPSS software. Second, quantitative data analysis was presented using descriptive statistics in the study. The descriptive analysis showed the results of demographic study. Third, to evaluate the link between variables. In this research, there are 15 questionnaires gathered using investigator-based surveys, which are randomly disseminated via Google Form online to employees in Malaysia at the senior management level. The researcher utilized the Statistical Package for Social Science (SPSS) software version 20 to analyse the data, and the results will be presented in table form.

4.2. Descriptive Analysis

Descriptive analysis is the process of using current and historical data to identify trends and relationships, it is sometimes called the simple from the

data analysis because it describes trends and relationships but does not dig deeper. Additionally, each data sample was evaluated, along with a graphical analysis of the sample. One sort of descriptive analysis is the preliminary analysis, which gathers information via surveys. The analysis explains the sample's operation and the data that are shown. Tables, diagrams, and summaries are used in the descriptive analysis approach to characteristic, describe, and explain the data gathered. The online survey questionnaire by via google form method was used in this study by the researcher to explain the questionnaire.

4.2.1. General Information of Respondents

General information of respondents refers to the demographic profile which including ownership, job tittle, working experiences, and department. A total of 120 respondents (company manufacture) as demographic sample profiles have been gathered by the researcher in this study.

4.2.2. Ownership

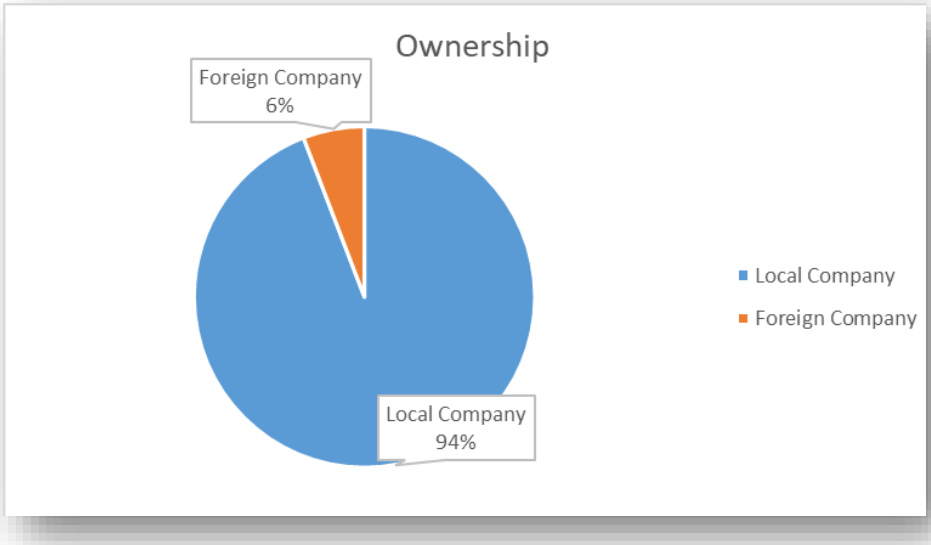

Figure 4.1: Ownership

Figure 4.1 above is related to the information of ownership which were obtained from the survey among 120 respondents. The findings show that 94% (n=113) were local company and 6% (n=7) were foreign company.

4.2.3. Job Tittle

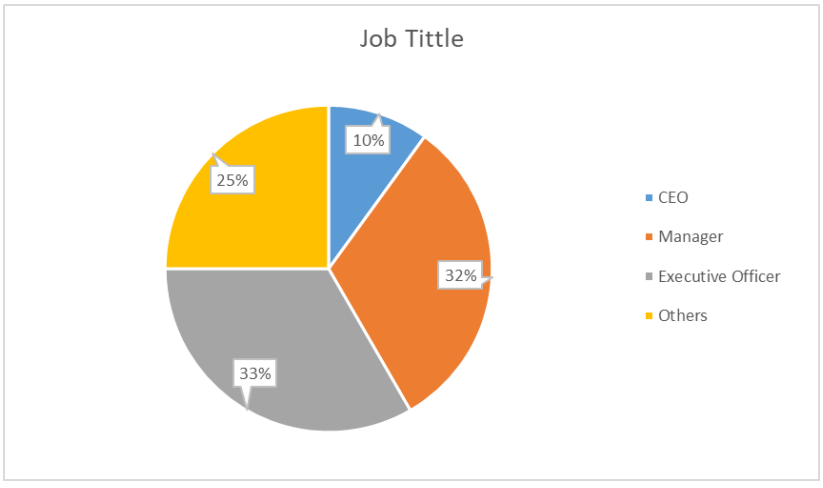

Figure 4.2: Job Tittle

Figure 4.2 shows that the job tittle of respondents that took part in this survey. Based on the pie chart above, there were 10% (n=12) of the CEO respondent while 32% (n=38) were manager respondents. For executive officer, there were 40 (33%) of them whom participated in this survey. There were 30 respondents from others job tittle (25%) from the survey which is others.

4.2.4. Working Experiences

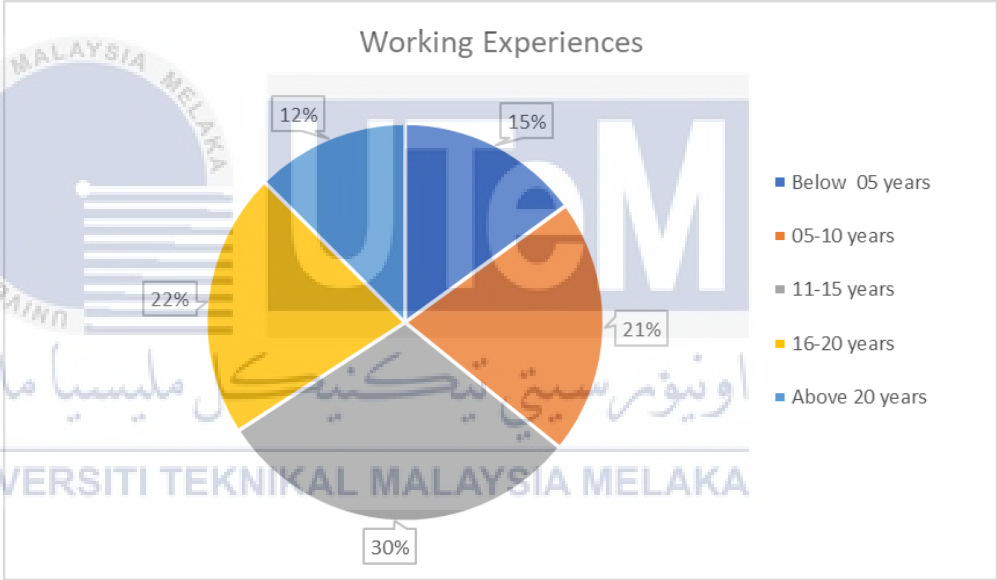

Figure 4.3: Working Experiences

Figure 4.3 refers to the working experiences of respondents from a total of 120 Manufacture. Based on the bar chart above, there were 15% (n=18) of the below 05 years while 21% (n=25) were 05 -10 years respondents. For 11 – 15 years and 16 – 20 years, there were 26 (30%) and 26 respondent (22%) them whom participated in this survey. There were 15 respondents for above 20 years (12%) from the survey.

4.2.5. Department

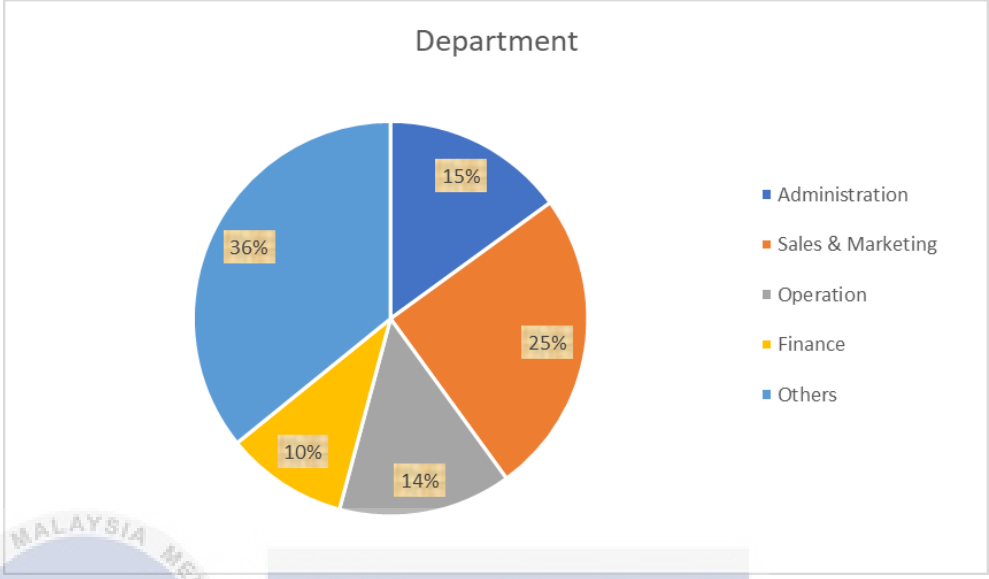

Figure 4.4: Department

Figure 4.4 illustrates department by the respondents in manufacture. Based on the data, most of the other respondents which is total 43 manufacture (36%). After that, among the total of 120 respondents, there were 30 (25%) respondents are from sales & marketing, followed by 17 (14%) of operation department respondents. Besides, there were 12 (10%) respondents who in finance department. At last, there were only 18 (15%) from administration respondents.

4.3. Mean Score Analysis For Variable

Mean score analysis used to identify and receive the information related to the characteristics of specific problems. The results will show on all variables such as Smart Product (SP), Smart Factory (SF) and Data Driven Services that used for the study Malaysian smart manufacturing ecosystem readiness assessment for industry 4.0. The data will be determined through

mean. Besides that, the researcher utilizes a 7-point Likert Scale for measuring total 10 items that related to the study of research.

4.3.1. Smart Product (SP)

Table 4.1: Descriptive Statistics for Smart Product (SP)

OWNERSHIP	SP1. You company uses Machine to Machine communication where transmission of machine data between mechanical or electronic devices can be done automatically without human intervention.	SP2. Your company is implementing Interoperability technology where it is able to connect and communicate in a coordinated way, without effort from the end user.	SP3. Your company collects equipment capacity utilization automatically	SP4. Your company collects Employee utilization automatically	SP5. Your company collects Data about processing, process condition automatically
LOCAL COMPANY	**5.35**	**5.58**	**5.35**	**5.58**	**5.60**
FOREIGN COMPANY	6.29	6.57	6.29	6.57	4.00

Table 4.1 describes the descriptive statistics of the variable which is Smart Product (SP). It illustrates that the scale of minimum rating for each item is 1 while the maximum rating is 7. According to the table, the results revealed that the item "You company uses Machine to Machine communication where transmission of machine data between mechanical or electronic devices can be done automatically without human intervention." scored the mean value for local is 5.35 and for foreign company is 6.29. Next, item of "Your company is implementing Interoperability technology where it is able to connect and communicate in a coordinated way, without effort from the end user" had the mean value of foreign company is 6.57 and for local company is 5.58 while the item of "Your company collects equipment capacity utilization automatically" had the mean value of local company is 5.35 and for foreign company is 6.29. The item of "Your company collects Employee utilization automatically showed a mean value of local company is 5.58 and for foreign company is 6.57. Lastly, the item of "Your company collects Data about processing, process condition automatically" had the least mean value for foreign company which is 4.00 while for local company is 5.60. The results revealed that

the item for Smart Product (SP) total mean for local company is 5.49 and for foreign company is 5.94.

4.3.2. Smart Factory (SF)

Table 4.2: Descriptive Statistics for Smart Factory (SF)

OWNERSHIP	SF1. Your company currently uses Manufacturing Execution System (MES)	SF2. Your company currently uses Enterprise Resource Planning (ERP)	SF3. Your company currently uses Product Lifecycle Management (PLM)	SF4. Your company currently uses Product Data Management (PDM)	SF5. Your company currently uses Production Planning System (PPS)
LOCAL COMPANY	**5.35**	**5.58**	**5.60**	**5.58**	**5.35**
FOREIGN COMPANY	6.29	6.14	4.14	6.57	5.71

Table 4.2 refers to the descriptive statistics of Smart Factory (SF). From the table, it shows the scale of minimum rating for each item is 1 while the scale of maximum rating is 7. The results revealed that the item "Your company currently uses Manufacturing Execution System (MES)" the mean for local company is 5.35 and for foreign company is 6.29 while for "Your company currently uses Enterprise Resource Planning (ERP)" the mean for local company is 5.58 and for foreign company is 6.14. Next, item of "Your company currently uses Product Lifecycle Management (PLM)" had the least mean value for foreign is 4.14 and for local company is 5.60 while the item of "Your company currently uses Product Data Management (PDM)" had the mean value for foreign is high (6.57) and for local is 5.58. Lastly, the item of "Your company currently uses Production Planning System (PPS)" had the mean value for local company which was 5.35 and for foreign is 5.71. The results revealed that the item for Smart Factory (SF) total mean for local company is 5.49 and for foreign company is 5.77.

4.3.3. Data Driven Services (DDS)

Table 4.3: Descriptive Statistics for Data Driven Services (DDS)

OWNERSHIP	DDS1. Data you collect used for Predictive maintenance	DDS2. Data you collect used for Optimization of logistics and production processes	DDS3. Data you collect used for Creation of transparency across production process	DDS4. Data you collect used for Quality management	DDS5. Data you collect used for Optimization of resource consumption (material, energy)
LOCAL COMPANY	**5.58**	**5.35**	**5.58**	**5.60**	**5.58**
FOREIGN COMPANY	6.57	6.29	6.14	4.00	6.57

Table 4.3 refers to the descriptive statistics of Data Driven Services (DDS). From the table, it shows the scale of minimum rating for each item is 1 while the scale of maximum rating is 7. The results revealed that the item "Data you collect used for Predictive maintenance" the mean for local company is 5.58 and its foreign value mean is 6.57. Next, item of "Data you collect used for Optimization of logistics and production processes had the mean value of foreign company is 6.29 and for local company is 5.38 while the item of "Data you collect used for Creation of transparency across production process" had the mean value of local company is 5.58 and for foreign company is 6.14. The item of "Data you collect used for Quality management" showed a mean value of foreign company is 5.60 and mean for local company of 4.00, this is least mean. Lastly, the item of "Data you collect used for Optimization of resource consumption (material, energy)" had the least mean value which was 5.58 for local company and with foreign company of 6.57. The results revealed that the item for Data Driven Services (DDS) total mean for local company is 5.52 and for foreign company is 5.91.

4.4. Summary

The approach utilized in the data analysis of survey results was explained in this chapter. The researcher selected excel to analyze the data gathered from 120 respondents in order to evaluate Malaysian smart manufacturing ecosystem readiness assessment for industry 4.0. The demographics of the respondents were collected and shown in the form of a pie chart for the descriptive analysis. The findings demonstrate that the variables of smart product, smart factory and data driven services.

CHAPTER 5

DISCUSSION, CONCLUSION AND RECOMMENDATION

5.1. Introduction

This chapter will be discussed about the overall results'. This chapter will go through the statistical analysis summary, the justification of research objectives, the implications of the study, the limitations of the research, and the recommendations. First, the researcher summarizes the survey results using statistical analysis. Following that, the study objective will be supported based on the test results. Furthermore, the researcher highlighted the research's implications and stated the study's limitations. The researcher will make recommendations to future researchers who wish to do similar study.

5.2. Summary Of Study

This researcher's objective is to investigate Malaysian smart manufacturing ecosystem readiness assessment for Industry 4.0. There were three independent variables in this study: smart product, smart factory and data driven services.

5.3. Discussion On The Demographic Background

The total of the respondents for this research were 120 respondents. The total number of ownership respondents for local company was 113, accounting for 94 %, while the total number of foreign company respondents was 7, accounting for 6%.

Next, for the job tittle an executive officer position had the highest proportion of 40 respondents (33 %). Overall, 12 respondents were from the CEO, with a percentage of 10 %. There were 38 respondents at the general manager / manager level, accounting for 32% of the total. With a percentage of 25%, the total is 32 respondents at others level.

Furthermore, the range of working experiences for the respondents which were answering the questionnaire is between below 05 years to 20 years and above. Most of the respondents are between of below 05 years, accounting for 18 out of 120 respondents, a total of 15% of the total number of respondents. A total of 25 respondents, or 21 % of the total, were between of 05 to 10 years. Then, 36 respondents, or 30 % of the total, were between 11 to 15 years old. Only 15 respondents, or 12% of the total, were above the 20 years. The respondents' working experiences ranged from 16 to 20 years, accounting for 22% or 26 respondents of the total.

Besides that, most of the respondents had a bachelor's degree, accounting for 239 respondents out of 62.2 %. There were 109 respondents who responded, with masters accounting for 28.4% of the total. The PhD had 36 respondents, representing 9.4 % of all respondents.

In addition, for the range of the department of respondents, others department had the largest total of 43 responses with a percentage of 36 %. Then there were 18 responses with a rate of 15 % who had administration

department. Following that, 30 respondents (25%) had sales & marketing and there were 17 responses with a rate of 14 % who had operation department. Finally, the lowest total of 12 respondents, with a proportion of 10 %, had in finance department.

5.4. Discussion On Research Objectives

The research objective was stated as below:

i. To profile Malaysian smart manufacturing ecosystem readiness for Industry 4.0.
ii. To measure level the Malaysian smart manufacturing ecosystem
iii. To study the difference between the local and international ownership in terms of smart manufacturing.

Research Objective 1: To profile Malaysian smart manufacturing ecosystem readiness for Industry 4.0.

For the first research objective, the researcher has found out to profile malaysian smart manufacturing ecosystem readiness for industry 4.0. The researcher has used the resource-based view (RBV) model in this research. The researchers describe readiness profiles of smart manufacturing ecosystems. All the variables that are smart products, smart factory and data-driven services are determinants in the RBV model which is seen as a smart manufacturing ecosystem for industry 4.0 from previous studies. Therefore, objective 1 has been achieved.

Research Objective 2: To measure level the Malaysian smart manufacturing ecosystem.

According to (ERASMUS+ CBHE PROJECT Curriculum Development of master's degree Program in Industrial Engineering for Thailand Sustainable Smart Industry Curriculum Development of Master's

Degree Program in Industrial Engineering 0 for Thailand Sustainable Smart Industry-MSIE4.0 Questionnaire, 2018), a smart factory is a production environment in which the production systems and logistics systems largely organize themselves without human intervention. Based on the findings obtained in Chapter 4 (Data Analysis), the researcher found out that the level of three variable is acceptable. In summary, all respondents agreed that the assessment of the readiness of Malaysia's smart manufacturing ecosystem for Industry 4.0. Based on (Tay, Alipal and Lee, 2021) "Industry 4.0 is a new trend in the manufacturing technology industry. It is equires the use of some expertise not only in IT, and data management but also knowledge of equipment as well as business understanding to make it happen. It's not easy to hire people who have everything rounded knowledge with its implications. In addition, manufacturing in the dust is always in a state of shortage of skilled workers, high turnover rates, and increased labor costs, increased the struggle manufacturers with the workforce to continue operating. Through the tests made, all the variables that are smart products, smart factories and data-driven services are significant to the level of Malaysia's smart manufacturing ecosystem and objective 2 is accepted.

Research Objective 3: To study the difference between the local and international ownership in terms of smart manufacturing.

For the third research objective, the researcher has found **out to study the difference between the local and international ownership in terms of smart manufacturing**. Based on the data obtained, between local companies and international or foreign companies, it shows that the data for international companies is higher than for local companies. This is because the data for international companies is 5.88 and for local companies is 5.51. This data includes three variables namely smart products, smart factory, and data-driven services. Based on (Phuyal, Bista and Bista, 2020) intelligent manufacturing systems have played an important role in the implementation of better manufacturing technology in the current industrial era. Smart manufacturing technologies improve operational efficiency, productivity and have a huge impact on the global economy. It has been found that the emergence of IoT

and IIoT has played an important role in improving manufacturing systems equipped with intelligent manufacturing systems. Various studies in manufacturing systems have investigated that there are many industries that intend to upgrade their industries with intelligent manufacturing systems. Therefore, objective 3 has been achieved.

5.5. Implication Of The Study

In terms of practical contribution, this research provides manufacturing firms in better understanding the smart manufacturing ecosystem assessment for industry 4.0. According to(Anshari and Almunawar, 2022) this study discussed some of the most essential issues of SMEs in adopting open innovation that is required for Industrial Revolution 4.0. It focuses on how digital ecosystem's readiness influences open innovation adoption for SMEs in Indonesia. By understanding its current state of readiness, it contributes to the policymakers in deciding how and where to adopt open innovation and develop digital ecosystem and identify which ones might best meet their needs for any developing countries.

5.6. Limitation Of Research

There are some limitations to this research. The researcher only had a limited time period of four months to collect data from the respondents, and as a result, the researcher was unable to obtain any further responses from the respondents. The first limitation that was encountered while conducting this research was a limitation regarding time. The data collection process consisted of the researcher sending out an email questionnaire beginning in October

2022 and continuing through January 2023. The second challenge that the study team encountered while carrying out this research was figuring out how to go about carrying out the survey. The researcher leaned more toward using an internet platform for the survey strategy, such as sending out emails. When the respondents attempted to disseminate the questionnaire to certain firms, they ran across a few obstacles, such as not having the right email address of the company or the company not replying to the email that was sent to them. The number of answers was the last limitation that needed to be considered. In this particular research, data from just 120 of the respondents was collected.

5.7. Recommendations Of Future Study

The researcher conducted an investigation on the Malaysian smart manufacturing ecosystem readiness assessment 4.0. The researcher has a few suggestions that they may pass on to the person who comes after them in the line of study. The first recommendation is that, going forward, researchers carry out their investigations using the qualitative method, so that they may get a deeper understanding of the viewpoint of the user. For the purpose of data collection, the researcher could interview the respondents. This strategy has the potential to boost respondent engagement, enabling the researcher to acquire more comments from the respondent that reflect a variety of perspectives. This will provide the organization with assistance in assessing the attitudes and behaviors of its personnel towards the implementation of the Business Intelligence system. Last but not least, it has been suggested that a future researcher do similar study in a new industry. Only workers who are employed by manufacturing firms are the focus of the researcher's attention in this study. Some of the Malaysian industries, including banking and finance, healthcare, 73 insurances, and telecommunications, have already used smart manufacturing into their business processes. Because of this, more research in these areas should be pursued with zeal.

5.8. Conclusion

In conclusion, the execution of a smart manufacturing ecosystem is critical for manufacturing firms in Malaysian in order to maintain a readiness assessment for industry 4.0. As a result, it is critical for the employer to understand the best method to implement the smart manufacturing ecosystem in their organization so that it may be used successfully and contribute to increased work productivity.

5.9. Summary

The three research objectives which are to find out the extent to which the company has integrated production digitally and automatically based on cyberphysical systems, to identify the extent to which processes and products in the company are digitally modeled and can be controlled through ICT systems and algorithms in the virtual world and to examine companies offering data-driven services that can only be done through product, production, and customer integration. The implications of the study, limitations of the study, and recommendations for further research were all explored in this chapter.

REFERENCE

Corporate Finance Institute. (2018). *Small and Medium Enterprises (SMEs) - Definition and Classification*. Corporate Finance Institute. https://corporatefinanceinstitute.com/resources/knowledge/other/small-and-medium-sized-enterprises-smes/

The World Bank. (2021). *SME Finance*. World Bank; www.worldbank.org. https://www.worldbank.org/en/topic/smefinance

Resource Based View of the Firm. (n.d.). Www.icaew.com. https://www.icaew.com/technical/business/strategy-risk-and-innovation/strategy/resource-based-view-of-the-firm#:~:text=The%20Resource%20Based%20View%20(RBV

Calzon, B. (2022, March 9). *Learn Here Different Ways of Data Analysis Methods & Techniques*. BI Blog | Data Visualization & Analytics Blog | Datapine. https://www.datapine.com/blog/data-analysis-methods-and-techniques/

Saunders, M., Lewis, P. & Thornhill, A. (2016). Research Methods for business students (7th edition). Harlow, England: Pearson Education Limited.

SME Corporation Malaysia. (2019). About SME Corp. Malaysia. SME Corp. Malaysia.

Bresciani, S., Ferraris, A., & Del Giudice, M. (2018). The management of organizational ambidexterity through alliances in a new context of analysis: Internet of Things (IoT) smart city projects. *Technological Forecasting and Social Change*, *136*, 331–338. https://doi.org/10.1016/j.techfore.2017.03.002

Janssen, M., van der Voort, H., & Wahyudi, A. (2017). Factors influencing big data decision-making quality. *Journal of Business Research*, *70*, 338–345. https://doi.org/10.1016/j.jbusres.2016.08.007

Scuotto, V., Ferraris, A., & Bresciani, S. (2016). Internet of Things. *Business Process Management Journal*, *22*(2), 357–367. https://doi.org/10.1108/bpmj-05-2015-0074

Emami, A. (2017). Gender risk preference in entrepreneurial opportunity: evidence from Iran. *International Journal of Entrepreneurship and Small Business*, *30*(2), 147. https://doi.org/10.1504/ijesb.2017.10002035

Emami, A., & Dimov, D. (2016). Degree of innovation and the entrepreneurs' intention to create value: a comparative study of experienced and novice entrepreneurs. *Eurasian Business Review*, *7*(2), 161–182. https://doi.org/10.1007/s40821-016-0068-y

What is Industry 4.0 and how does it work? IBM. (n.d.). Retrieved January 30, 2023, from https://www.ibm.com/my-en/topics/industry-4-0

Emami, A., & Khajeheian, D. (2018). Social Norms and Entrepreneurial Action: The Mediating Role of Opportunity Confidence. *Sustainability*, *11*(1), 158. https://doi.org/10.3390/su11010158

Eze, S. C., Chinedu-Eze, V. C., Bello, A. O., Inegbedion, H., Nwanji, T., & Asamu, F. (2019). Mobile marketing technology adoption in service SMEs: a multi-perspective framework. *Journal of Science and Technology Policy Management*, *10*(3), 569–596. https://doi.org/10.1108/jstpm-11-2018-0105

Iqbal, M., Kazmi, S.H.A., Manzoor, A., Soomrani, A.R., Butt, S.H. and Shaikh, K.A. (2018), "A study of big data for business growth in SMEs: opportunities and challenges", International Conference on Computing, Mathematics and Engineering Technologies (iCoMET), 3-4 March 2018 2018. 1-7.

Nayati Utami, H., Siti Astuti, E., Maulani Ramadhan, H., Trialih, R., & Alief Aprilian, Y. (2019). The interests of small- and medium-sized enterprises (SMEs) actor in using mobile commerce in effort to expand business network. *Journal of Science and Technology Policy Management*, *10*(3), 493–508. https://doi.org/10.1108/jstpm-08-2018-0081

OECD (2017), "Enhancing the contributions of SMEs in a global and digitalised economy", Meeting of the OECD Council at Ministerial Level.

Sen, D., Ozturk, M., & Vayvay, O. (2016). An Overview of Big Data for Growth in SMEs. *Procedia - Social and Behavioral Sciences*, *235*, 159–167. https://doi.org/10.1016/j.sbspro.2016.11.011

Singh, D. (2019). Implementation of technology innovation in MSMEs in India. *Journal of Science and Technology Policy Management*, *10*(3), 769–792. https://doi.org/10.1108/jstpm-06-2018-0065

Gartner_Inc. (n.d.). *Definition of smart manufacturing - gartner information technology glossary*. Gartner. Retrieved January 30, 2023, from https://www.gartner.com/en/information-technology/glossary/smart-manufacturing

Anshari, M. and Almunawar, M.N. (2022) 'Adopting open innovation for SMEs and industrial revolution 4.0', *Journal of Science and Technology Policy Management*. Emerald Group Holdings Ltd., pp. 405–427. Available at: https://doi.org/10.1108/JSTPM-03-2020-0061.

ERASMUS+ CBHE PROJECT Curriculum Development of Master's Degree Program in Industrial Engineering for Thailand Sustainable Smart Industry Curriculum Development of Master's Degree Program in Industrial Engineering 0 for Thailand Sustainable Smart Industry-MSIE4.0 Questionnaire (2018). Available at: https://i40-self-assessment.pwc.de/.

Konstantinidis, F.K. *et al.* (2022) 'Assessment of Industry 4.0 for Modern Manufacturing Ecosystem: A Systematic Survey of Surveys', *Machines*. MDPI. Available at: https://doi.org/10.3390/machines10090746.

Phuyal, S., Bista, D. and Bista, R. (2020) 'Challenges, Opportunities and Future Directions of Smart Manufacturing: A State of Art Review', *Sustainable Futures*. Elsevier Ltd. Available at: https://doi.org/10.1016/j.sftr.2020.100023.

Tay, S.I., Alipal, J. and Lee, T.C. (2021) 'Industry 4.0: Current practice and challenges in Malaysian manufacturing firms', *Technology in Society*, 67. Available at: https://doi.org/10.1016/j.techsoc.2021.101749.

APPENDIX 1

GANT CHART PSM 1

PROJECT ACTIVITIES	WEEK														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Information PSM 1															
Briefing PSM 1															
Topic, supervisor and confirmation															
1st meeting with Supervisor															
Discuss project title with supervisor															
Submit and approval title															
Briefing chapter 1 with Supervisor															
Discussing about LR and Research Framework															
Finding Research problem statement															
Submission draft chapter 1															
Checking and correction chapter 1															
Briefing chapter 2 & 3															
Submission chapter 1,2,3															
Submission PSM 1															

GANT CHART PSM 2

PROJECT ACTIVITIES	WEEK														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Construct Questionnaire															
Questionnaire Validation															
Distribute Questionnaire (Pilot Test)															
Questionnaire Modification															
Questionnaire Distribution															
Data Collection															
Data Analysis															
Complete Chapter 4															
Complete Chapter 5															
Preparation for Presentation															
PSM 2 Report Submission															
PSM 2 Presentation															

APPENDIX 3

QUESTIONNAIRE

ADOPTION OF BIG DATA ANALYTICS USING UTAUT2 MODEL APPROACH TOWARDS SMART SUPPLY CHAIN MANAGEMENT IN MANUFACTURING FIRMS

A process used to extract meaningful insights, such as hidden patterns, unknown correlations, market trends, and customer preferences for example While smart supply chain is supply chain that integrates the partners can self-organize and automatically adapt to environmental changes and makes an intelligent decision that best achieves business goals

By looking at the impact of big data analytics adopting on smart supply chain performance, a research work on the adoption of Big data analytics using UTAUT2 model is being carried out by the Faculty of Manufacturing Engineering, Universiti Teknikal Malaysia Melaka (UTeM).

Your cooperation is solicited in filling the questionnaire on behalf of your company. Please pass this questionnaire to the appropriate member (s) of your organization (at least 2-year experience in supply chain operations and use big data analytics (such as Management Information System (MIS), ERP, SAP, BAAN, cloud computing, etc.) in your daily work. If you do not feel comfortable to complete it.

You have been asked to take part in this study because you are an expert which has at least 2 years working experience in

The information given is **STRICTLY CONFIDENTIAL** and will be used only as a material for academic research.

A high response rate is vital for the success of this study. We would be delighted to answer any query regarding the questionnaire. Please return the completed questionnaire using the enclosed envelope.

Thank you for your time and kindness.

NOR RATNA BINTI MASROM
Faculty of Manufacturing Engineering,
University Teknikal Malaysia Melaka (UTeM),
76100 Hang Tuah Jaya, Melaka,
Malaysia.

QUESTIONNAIRE
[SOAL SELIDIK]

INSTRUCTION:
To complete this questionnaire, you are just required to TICK (✓) boxes and write in the space of the required information provided, if necessary.

[ARAHAN:
Untuk menjawab soal selidik ini, anda dikehendaki untuk menanda (✓) pada kotak jawapan dan menulis maklumat yang dikehendaki pada ruangan yang telah disediakan , jika perlu.]

SECTION A: INFORMATION ON THE SMART MANUFACTURING PRACTICE
[BAHAGIAN A: MAKLUMAT BERKAITAN AMALAN PENGILANGAN PINTAR]

What are your company's current smart manufacturing practices from the past two (2) years? Tick (✓) one answer for each statement as follows.
[Apakah amalan pengilangan pintar semasa di syarikat anda bagi tempoh dua (2) tahun yang lalu? Tandakan (✓) satu jawapan bagi setiap penrnyataan berikut.]

Strongly Disagree *(Sangat Tidak Setuju)* — Strongly Agree *(Sangat Setuju)*

1 → **7**

	Statement *[Pernyataan]*	*Scale [Skala]*						
		1	**2**	**3**	**4**	**5**	**6**	**7**
SSP1	You company have Machines/systems can be controlled through IT *[Mesin/sistem boleh dikawal melalui IT]*	□	□	□	□	□	□	□
SSP2	You company uses Machine to Machine communication where transmission of machine data between mechanical or electronic devices can be done automatically without human intervention *[Syarikat anda menggunakan komunikasi Mesin ke Mesin di mana penghantaran data mesin antara peranti mekanikal atau elektronik boleh dilakukan secara automatik tanpa campur tangan manusia]*	□	□	□	□	□	□	□
SSP3	Your company is implementing Interoperability technology where it is able to connect and communicate in a coordinated way, without effort from the end user. *[Syarikat anda*	□	□	□	□	□	□	□

	melaksanakan teknologi saling kendali di mana ia dapat menyambung dan berkomunikasi dengan cara yang diselaraskan, tanpa usaha dari pengguna akhir.]							
SSP4	Your company collects inventory data automatically *[Syarikat anda mengumpul data inventori secara automatik]*	□	□	□	□	□	□	□
SSP5	Your company collects Manufacturing throughout times automatically *[Syarikat anda mengumpul Pembuatan sepanjang masa secara automatik]*	□	□	□	□	□	□	□
SSP6	Your company collects equipment capacity utilization automatically *[Syarikat anda mengumpul penggunaan kapasiti peralatan secara automatik]*	□	□	□	□	□	□	□
SSP7	Your company collects Production residues/waste/WIP automatically *[Syarikat anda mengumpul sisa pengeluaran / sisa / WIP secara automatik]*	□	□	□	□	□	□	□
SSP8	Your company collects Employee utilization automatically *[Syarikat anda mengumpul penggunaan Pekerja secara automatik]*	□	□	□	□	□	□	□
SSP9	Your company collects Data about processing, process condition automatically *[Syarikat anda mengumpul Data tentang pemprosesan, keadaan proses secara automatik]*	□	□	□	□	□	□	□
SSP10	Your company collects Production times automatically *[Syarikat anda mengumpul masa Pengeluaran secara automatik]*	□	□	□	□	□	□	□
SSP11	Your company collects Overall equipment effectiveness (OEE) automatically *[Syarikat anda mengumpul keberkesanan peralatan keseluruhan (OEE) secara automatik]*	□	□	□	□	□	□	□
SSP12	Data you collect used for Predictive maintenance *[Data yang anda kumpulkan digunakan untuk penyelenggaraan Ramalan]*	□	□	□	□	□	□	□
SSP13	Data you collect used for Optimization of logistics and production processes *[Data yang anda kumpulkan digunakan untuk Pengoptimuman proses logistik dan pengeluaran]*	□	□	□	□	□	□	□
SSP14	Data you collect used for Creation of transparency across production process *[Data yang anda kumpulkan digunakan untuk Penciptaan ketelusan merentasi proses pengeluaran]*	□	□	□	□	□	□	□
SSP15	Data you collect used for Quality management *[Data yang anda kumpulkan digunakan untuk pengurusan kualiti]*	□	□	□	□	□	□	□
SSP16	Data you collect used for Optimization of resource consumption (material, energy) *[Data yang anda kumpulkan digunakan untuk Pengoptimuman penggunaan sumber (bahan, tenaga)]*	□	□	□	□	□	□	□

SSP17	Data you collect used for Automatic production control through use of real-time data *[Data yang anda kumpulkan digunakan untuk kawalan pengeluaran automatik melalui penggunaan data masa nyata]*	□	□	□	□	□	□	□
SSP18	Your company currently uses Manufacturing Execution System (MES) *[Syarikat anda kini menggunakan sistem pelaksanaan pembuatan (MES)]*	□	□	□	□	□	□	□
SSP19	Your company currently uses Enterprise Resource Planning (ERP) *[Syarikat anda kini menggunakan perancangan sumber perusahaan (ERP)]*	□	□	□	□	□	□	□
SSP20	Your company currently uses Product Lifecycle Management (PLM) *[Syarikat anda kini menggunakan pengurusan kitaran hayat produk (PLM)]*	□	□	□	□	□	□	□
SSP21	Your company currently uses Product Data Management (PDM) *[Syarikat anda kini menggunakan pengurusan data produk (PDM)]*	□	□	□	□	□	□	□
SSP22	Your company currently uses Production Planning System (PPS) *[Syarikat anda kini menggunakan sistem perancangan pengeluaran (PPS)]*	□	□	□	□	□	□	□
SSP23	Your company currently uses Production Data Acquisition (PDA) *[Syarikat anda kini menggunakan pemerolehan data pengeluaran (PDA)]*	□	□	□	□	□	□	□
SSP24	Your company currently uses Machine Data Collection (MDC) *[Syarikat anda kini menggunakan pengumpulan data mesin (MDC)]*	□	□	□	□	□	□	□
SSP25	Your company currently uses Computer-Aided Design (CAD) *[Syarikat anda kini menggunakan reka bentuk bantuan komputer (CAD)]*	□	□	□	□	□	□	□
SSP26	Your company currently uses Supply Chain Management (SCM) *[Syarikat anda kini menggunakan pengurusan rantaian bekalan (SCM)]*	□	□	□	□	□	□	□

SECTION B: INFORMATION ON THE BIG DATA ANALYTICS ADOPTION
[BAHAGIAN B: MAKLUMAT BERKAITAN PENGGUNAAN ANALITIK DATARAYA]

What are your company current in big data analytics adoption from the past two (2) years? Tick (✓) one answer for each statement as follows.
[Apakah penggunaan analitik dataraya di syarikat anda bagi tempoh dua (2) tahun yang lalu? Tandakan (✓) satu jawapan bagi setiap penrnyataan berikut.]

Strongly Disagree *(Sangat Tidak Setuju)* — Strongly Agree *(Sangat Setuju)*

1 — **7**

	Statement *[Pernyataan]*	*Scale [Skala]*						
		1	**2**	**3**	**4**	**5**	**6**	**7**
BDA1	Useful to carry out the tasks of your company *Berguna untuk menjalankan tugas syarikat anda*	□	□	□	□	□	□	□
BDA2	Offers faster delivery of tasks *Menawarkan penghantaran tugas yang lebih cepat*	□	□	□	□	□	□	□
BDA3	Helps improve productivity *Membantu meningkatkan produktiviti*	□	□	□	□	□	□	□
BDA5	Offers the use of quality information for company's growth *Menawarkan penggunaan maklumat berkualiti untuk pertumbuhan syarikat*	□	□	□	□	□	□	□
BDA6	Offers valuable information on clients *Menawarkan maklumat berharga kepada pelanggan*	□	□	□	□	□	□	□
BDA7	Easy access the clients' need. *Akses mudah keperluan pelanggan*	□	□	□	□	□	□	□
BDA8	Easy to understand *Mudah difahami*	□	□	□	□	□	□	□
BDA9	Easy to use *Mudah digunakan*	□	□	□	□	□	□	□
BDA10	Easy to learn *Mudah dipelajari*	□	□	□	□	□	□	□
BDA11	Helps generating valuable data easily *Membantu menjana data berharga dengan mudah*	□	□	□	□	□	□	□
BDA12	Trustworthy *Boleh dipercayai*	□	□	□	□	□	□	□
BDA13	All operational data are confidential *Semua data operasi adalah sulit*	□	□	□	□	□	□	□
BDA14	Get an immediate notification when the operational data is completed. *Pemberitahuan segera apabila data operasi selesai*	□	□	□	□	□	□	□

BDA15	Reliable *Boleh dipercayai*	□	□	□	□	□	□	□
BDA16	Your company intends to continue Big Data Analytics in the future *Syarikat anda berhasrat untuk meneruskan Analitik Dataraya pada masa akan datang*	□	□	□	□	□	□	□
BDA17	Your company will always use Big Data Analytics in operations *Syarikat anda akan sentiasa menggunakan Analitik Dataraya dalam operasi*	□	□	□	□	□	□	□
BDA18	Your company plan to continue Big Data Analytics frequently *Syarikat anda merancang untuk meneruskan Analitik Dataraya dengan kerap*	□	□	□	□	□	□	□
BDA19	Your company have the resources necessary to use Big Data Analytics *Syarikat anda mempunyai sumber yang diperlukan untuk menggunakan Analitik Dataraya*	□	□	□	□	□	□	□
BDA20	Availability of technical knowledge required with the connection of both domestic and international business partners. *Ketersediaan pengetahuan teknikal yang diperlukan dengan sambungan kedua-dua rakan kongsi perniagaan domestik dan antarabangsa.*	□	□	□	□	□	□	□
BDA21	Compatible with other organisations' activities for easy to access Big Data Analytics. *Sesuai dengan aktiviti organisasi lain untuk mengakses Dataraya dengan mudah.*	□	□	□	□	□	□	□
BDA22	Availability of trained staff to handle Big Data Analytics to complete tasks faster. *Ketersediaan kakitangan terlatih untuk mengendalikan Analitik Dataraya untuk menyelesaikan tugas dengan lebih cepat.*	□	□	□	□	□	□	□
BDA23	Using Big Data Analytics is entirely within your company's control. *Menggunakan Analitik Dataraya sepenuhnya dalam kawalan syarikat anda.*	□	□	□	□	□	□	□
BDA24	Your company have the knowledge necessary to use *Syarikat anda mempunyai pengetahuan yang diperlukan untuk digunakan*	□	□	□	□	□	□	□

SECTION C: INFORMATION ON THE BIG DATA ANALYTICS PERCEIVED RISK

[BAHAGIAN C: MAKLUMAT BERKAITAN RISIKO ANALITIK DATARAYA YANG DIRASAKAN]

What are your current perceived risk in big data analytics in your company from the past two (2) years? Tick (✓) one answer for each statement as follows.
[Apakah risiko yang dirasakan di dalam analitik dataraya di syarikat anda bagi tempoh dua (2) tahun yang lalu? Tandakan (✓) satu jawapan bagi setiap penrnyataan berikut.]

Strongly Disagree *(Sangat Tidak Setuju)* — Strongly Agree *(Sangat Setuju)*

1 → **7**

PR1	Could be malfunctioning and by obtaining wrong data could lead the company to make wrong decisions *Mungkin tidak berfungsi dan dengan mendapatkan data yang salah boleh menyebabkan syarikat membuat keputusan yang salah*	□	□	□	□	□	□	□
PR2	Unsafe to protect company's data *Tidak selamat untuk melindungi data syarikat*	□	□	□	□	□	□	□
PR3	The probability of something going wrong with the performance of Big Data Analytics implementation is high *Kebarangkalian sesuatu yang tidak kena dengan prestasi pelaksanaan Analitik Dataraya adalah tinggi*	□	□	□	□	□	□	□
PR4	Considering the expected level of performance of Big Data Analytics, using it would be very risky for company *Memandangkan tahap prestasi Analitik Dataraya yang dijangkakan, menggunakannya akan menjadi sangat berisiko bagi syarikat*	□	□	□	□	□	□	□
PR5	Provide company with erroneous data *Menyediakan syarikat dengan data yang salah*	□	□	□	□	□	□	□
PR6	The chances of company losing money using Big Data Analytics are very high *Peluang syarikat kehilangan wang menggunakan Analitik Dataraya adalah sangat tinggi*	□	□	□	□	□	□	□
PR7	Waste time by having to install new type of software *Buang masa dengan perlu memasang jenis perisian baru*	□	□	□	□	□	□	□
PR8	Generate inconveniences since a lot of time would have to be spent solving errors *Menjana kesulitan kerana banyak masa perlu dibelanjakan untuk menyelesaikan kesilapan*	□	□	□	□	□	□	□
PR9	Considering the investment in time and start-up of the System, such investment would be risk *Memandangkan pelaburan dalam masa dan permulaan Sistem, pelaburan tersebut akan menjadi risiko*	□	□	□	□	□	□	□
PR10	The probability of wasting time with system start-up and learning is very high *Kebarangkalian membuang masa dengan permulaan sistem dan pembelajaran sangat tinggi*	□	□	□	□	□	□	□
PR11	Conflict with company's concept *Konflik di dalam Kesesuaian dengan konsep syarikat*	□	□	□	□	□	□	□

PR12	Company's business concept will get worse and suffer a loss of reputation *Konsep perniagaan syarikat akan menjadi lebih teruk dan mengalami kehilangan reputasi*	□	□	□	□	□	□	□
PR13	The probability of using Big Data Analytics and losing control of data privacy is high *Kebarangkalian menggunakan Analitik Dataraya dan kehilangan kawalan privasi data adalah tinggi*	□	□	□	□	□	□	□
PR14	Using Big Data Analytics will lead to loss of privacy *Menggunakan Analitik Dataraya akan menyebabkan kehilangan privasi*	□	□	□	□	□	□	□
PR15	Using Big Data Analytics is globally risky *Menggunakan Analitik Dataraya adalah berisiko di seluruh dunia*	□	□	□	□	□	□	□
PR16	It is dangerous to use Big Data Analytics *Adalah berbahaya untuk menggunakan Analitik Dataraya*	□	□	□	□	□	□	□
PR17	Using *Analitik Dataraya* exposes our company to risk *Menggunakan Analitik Dataraya mendedahkan syarikat kami kepada risiko*	□	□	□	□	□	□	□

SECTION D: INFORMATION ON THE TECHNOLOGY READINESS
[BAHAGIAN D: MAKLUMAT BERKAITAN KESEDIAAN TEKNOLOGI]

What is your company's current in technology readiness from the past two (2) years? Tick (✓) one answer for each statement as follows.
[Apakah kesediaan teknologi syarikat anda bagi tempoh dua (2) tahun yang lalu? Tandakan (✓) satu jawapan bagi setiap penrnyataan berikut.]

Strongly Disagree
(Sangat Tidak Setuju)

Strongly Agree
(Sangat Setuju)

1 ⟶ **7**

	Statement *[Pernyataan]*	*Scale* *[Skala]*						
		1	**2**	**3**	**4**	**5**	**6**	**7**
TR1	New technologies contribute to a better quality of life *Teknologi baru menyumbang kepada kualiti hidup yang lebih baik*	□	□	□	□	□	□	□
TR2	Technology gives more freedom of mobility *Teknologi memberikan lebih banyak kebebasan mobility*	□	□	□	□	□	□	□
TR3	Technology gives more control over daily lives *Teknologi memberi lebih banyak kawalan ke atas kehidupan seharian*	□	□	□	□	□	□	□
TR4	Technology makes more productive *Teknologi menjadikan lebih produktif*	□	□	□	□	□	□	□
TR5	Other people come to you for advice on new technologies *Orang lain datang kepada anda untuk mendapatkan nasihat mengenai teknologi baru*	□	□	□	□	□	□	□
TR6	In general, you are the first in your circle of friends to acquire new technology when it appears *Secara umum, anda adalah yang pertama dalam kalangan rakan anda untuk memperoleh teknologi baru apabila ia muncul*	□	□	□	□	□	□	□
TR7	You can usually figure out new high-tech products and services without help from others *Anda biasanya boleh memikirkan produk dan perkhidmatan berteknologi tinggi baru tanpa bantuan daripada orang lain*	□	□	□	□	□	□	□
TR8	You keep up with the latest technological developments *Anda mengikuti perkembangan teknologi terkini*	□	□	□	□	□	□	□
TR9	When you get technical support from a provider of a high-tech product or service, you sometimes feel as if you are being taken advantage of by someone who knows more than you do *Apabila anda mendapat sokongan teknikal daripada pembekal produk atau perkhidmatan berteknologi tinggi, kadang-kadang anda merasa seolah-olah anda diambil kesempatan oleh seseorang yang tahu lebih banyak daripada yang anda lakukan*	□	□	□	□	□	□	□
TR10	Technical support lines are helpful because they explain things in understandable terms	□	□	□	□	□	□	□

	Talian sokongan teknikal membantu kerana mereka menerangkan perkara dalam istilah yang dapat difahami							
TR11	Sometimes, you think that technology systems are NOT designed for use by ordinary people *Kadang-kadang, anda fikir bahawa sistem teknologi TIDAK direka untuk digunakan oleh orang biasa*	□	□	□	□	□	□	□
TR12	There is no such thing as a manual for a high-tech product or service that's written in plain language *Tidak ada manual untuk produk atau perkhidmatan berteknologi tinggi yang ditulis dalam bahasa biasa*	□	□	□	□	□	□	□
TR13	Too much technology distracts people to a point that is harmful *Terlalu banyak teknologi mengalihkan perhatian orang ke titik yang berbahaya*	□	□	□	□	□	□	□
TR14	Technology lowers the quality of relationships by reducing personal interaction *Teknologi merendahkan kualiti hubungan dengan mengurangkan interaksi peribadi*	□	□	□	□	□	□	□
TR15	You do not feel confident doing business with a place that can only be reached online *Anda tidak yakin menjalankan perniagaan dengan tempat yang hanya dapat dicapai dalam talian*	□	□	□	□	□	□	□

SECTION E: INFORMATION ON THE CURRENT ON SMART SUPPLY CHAIN PERFORMANCES
[BAHAGIAN E: MAKLUMAT BERKAITAN PRESTASI RANGKAIAN BEKALAN PINTAR SEMASA]

What are your company's current smart supply chain performances from the past two (2) years? Tick (✓) one answer for each statement as follows.
[Apakah prestasi rangkaian bekalan pintar syarikat anda bagi tempoh dua (2) tahun yang lalu? Tandakan (✓) satu jawapan bagi setiap penrnyataan berikut.]

Strongly Disagree *(Sangat Tidak Setuju)* — Strongly Agree *(Sangat Setuju)*

1 — **7**

	Statement *[Pernyataan]*	*Scale [Skala]*						
		1	**2**	**3**	**4**	**5**	**6**	**7**
SSM1	The exchange of information will give better quality relationships with supply chain partners. *[Pertukaran maklumat akan memberikan hubungan yang lebih berkualiti dengan rakan kongsi rantaian bekalan.]*	□	□	□	□	□	□	□
SSM2	The involvement of stakeholders will give better decisions to produce new products. *[Penglibatan pihak berkepentingan akan memberikan keputusan yang lebih baik untuk menghasilkan produk baharu.]*	□	□	□	□	□	□	□
SSM3	The use of value stream mapping will identify and eliminate waste throughout the supply chain. *[Penggunaan pemetaan aliran nilai akan mengenal pasti dan menghapuskan sisa sepanjang rantaian bekalan]*	□	□	□	□	□	□	□
SSM4	Your supply chain will generate high stock turnover and minimizes inventory *[Rantaian bekalan anda akan menjana pusing ganti stok yang tinggi dan meminimumkan inventori]*	□	□	□	□	□	□	□
SSM5	Your supply chain can forecast customer demands. *[Rantaian bekalan anda boleh meramalkan permintaan pelanggan.]*	□	□	□	□	□	□	□
SSM6	Adequate information systems linkages exist with partners in the supply chain network. *[Hubungan sistem maklumat yang mencukupi wujud dengan rakan kongsi dalam rangkaian rantaian bekalan.]*	□	□	□	□	□	□	□
SSM7	The information exchange will help the establishment of business planning with the supply chain partners. *[Pertukaran maklumat akan membantu penubuhan perancangan perniagaan dengan rakan kongsi rantaian bekalan.]*	□	□	□	□	□	□	□
SSM8	Your company will have enough information to understand the skills and competencies of the supplier. *[Syarikat anda akan mempunyai maklumat yang mencukupi untuk memahami kemahiran dan kecekapan pembekal.]*	□	□	□	□	□	□	□

SSM9	Your company can replace one supply source with another at a low cost. *[Syarikat anda boleh menggantikan satu sumber bekalan dengan yang lain pada kos yang rendah.]*	□	□	□	□	□	□	□
SSM10	Integrated technology improved your supply chain management. *[Teknologi bersepadu meningkatkan pengurusan rantaian bekalan anda.]*	□	□	□	□	□	□	□
SSM11	Real-time enterprise improved your monitoring capabilities *[Operasi masa nyata meningkatkan keupayaan pemantauan anda]*	□	□	□	□	□	□	□
SSM12	Inventory levels are visible throughout the supply chain. *[Tahap inventori boleh dilihat di seluruh rantaian bekalan.]*	□	□	□	□	□	□	□
SSM13	Demand levels are visible throughout the supply chain. *[Tahap permintaan boleh dilihat di seluruh rantaian bekalan.]*	□	□	□	□	□	□	□
SSM14	The use of smart processes facilitates planning, sourcing, making and delivering goods. *[Penggunaan proses pintar memudahkan perancangan, penyumberan, pembuatan dan penghantaran barangan.]*	□	□	□	□	□	□	□
SSM15	The use of devices gives the activation of monitoring the proper handling conditions of goods *[Penggunaan peranti memberikan pengaktifan pemantauan keadaan pengendalian barang yang betul]*	□	□	□	□	□	□	□
SSM16	Smart processes provide more accurate information for effective decision making *[Proses pintar menyediakan maklumat yang lebih tepat untuk membuat keputusan yang berkesan]*	□	□	□	□	□	□	□

GENERAL INFORMATION
[MAKLUMAT AM]

1. Company Name: _____
   [Nama Syarikat:]

2. Ownership: ☐ Local (Malaysia) ☐ Foreign, please specify :_____
   [Pemilikan :] *[Syarikat tempatan]* *[Syarikat asing, sila nyatakan:]*

Respondents Information:
[Maklumat Responden:]

Name : _____
[Nama]

Job title : _____
[Jawatan]

Department : _____
[Jabatan]

Working experience (years) : _____
[Pengalaman kerja (tahun)]

Contact number : _____
[Number untuk dihubungi]

E-mail : _____
[Emel]

Would you like to receive a concise summary of the results from the survey?
[Adakah anda berminat untuk mendapatkan keputusan kajian tinjauan ?

☐ Yes ☐ Tidak
[Ya] *[No]*

Would you like to take part in the next phase of this study?
[Adakah anda ingin mengambil bahagian untuk fasa seterusnya dalam kajian ini ?

☐ Yes ☐ Tidak
[Ya] *[No]*

Thank you very much for your time and kind-co-operation. Please ensure that you answer as many question as possible. For analysis purpose, please return the questionnaire even if your company is not engage in cleaner production and lean production practice in your production activities.
[Terima kasih untuk masa dan kerjasama anda. Sila pastikan bahawa anda menjawab sebanyak soalan yang mungkin. Bagi tujuan analisis, sila kembalikan borang tinjuan ini walaupun syarikat anda tidak melibarkan diri dalam amalan pengeluaran bersih dan pengeluaran lean dalam aktiviti pengeluaran anda.]

---------- **END OF SURVEY**----------
(Kaji selidik Tamat)

GLOSSARY

	Statement	*Definition*
1.	**Supply chain** ***Rantaian bekalan***	A systematic approach to managing flows of assets from sourcing raw materials, and product manufacturing, to delivering to end customers significantly affects the business goals of the partners in supply networks. *Pendekatan sistematik untuk menguruskan aliran aset dari sumber bahan mentah, dan pembuatan produk, untuk menyampaikan kepada pelanggan akhir memberi kesan ketara kepada matlamat perniagaan rakan kongsi dalam rangkaian bekalan.*
2.	**Smart supply chain** ***Rantaian bekalan pintar***	A supply chain that integrates the partners can self-organize and automatically adapt to environmental changes and makes an intelligent decision that best achieves business goals *Rantaian bekalan yang mengintegrasikan rakan kongsi boleh mengatur sendiri dan secara automatik menyesuaikan diri dengan perubahan alam sekitar dan membuat keputusan pintar yang terbaik mencapai matlamat perniagaan*
3	**Supply chain partner** ***Rakan kongsi rantaian bekalan***	Successful long-term relationships amongst trading partners in the supply chain that are enabled by mutual trust, organizational compatibility, top management support, and information sharing *Hubungan jangka panjang yang berjaya di kalangan rakan perdagangan dalam rantaian bekalan yang diaktifkan oleh kepercayaan bersama, keserasian organisasi, sokongan pengurusan atasan, dan perkongsian maklumat*
4	**supply chain performance** **Prestasi rantaian bekalan**	The ability of a supply chain to cost-effectively carry out its activities while minimizing costs, for the main purpose of meeting the ultimate customer's needs *Keupayaan rantaian bekalan untuk menjalankan aktivitinya dengan kos*

		efektif sambil meminimumkan kos, untuk tujuan utama memenuhi keperluan pelanggan utama
5.	**Big Data Analytics** **Big Data Analytics**	A process used to extract meaningful insights, such as hidden patterns, unknown correlations, market trends, and customer preferences Proses yang digunakan untuk mengekstrak pandangan yang bermakna, seperti corak tersembunyi, korelasi yang tidak diketahui, trend pasaran, dan pilihan pelanggan
6.	**Big data analytics application in Supply chain management.** **Aplikasi Big data analytics dalam Pengurusan rantaian bekalan.**	Predictive analytics define and forecast all aspects of the supply chain, including inventory, procurement, delivery, and returns for example ERP, Cloud Computing, RFID, or IoT, etc. Analisis ramalan menentukan dan meramalkan semua aspek rantaian bekalan, termasuk inventori, perolehan, penghantaran, dan pulangan contohnya ERP, Pengkomputeran Awan, RFID atau IoT