C34

THE INDUSTRIAL REVOLUTION 4.0 IN MALAYSIA: CHALLENGES, BARRIERS, OBSTACLES, AND RECOMMENDATIONS FOR ACTION

BY

KONG SIAO CHING
LIM YEE LIAN
LOKE WEI YUN
MAK PUI JUN
WONG BOON JIAN

A final year project submitted in partial fulfillment of the requirement of the degree of

BACHELOR OF BUSINESS ADMINISTRATION
(HONS) BANKING AND FINANCE

UNIVERSITI TUNKU ABDUL RAHMAN

FACULTY OF BUSINESS AND FINANCE
DEPARTMENT OF FINANCE

SEPTEMBER 2020

DECLARATION

We hereby declare that:

(1) This undergraduate FYP is the end result of our own work and that due acknowledgement has been given in the references to ALL sources of information be they printed, electronic, or personal.

(2) No portion of this FYP has been submitted in support of any application for any other degree or qualification of this or any other university, or other institution of learning.

(3) Equal contribution has been made by each group member in completing the FYP.

(4) The word count of this report is 25,324.

Name of Student:	Student ID:	Signature:
KONG SIAO CHING	1706372	
LIM YEE LIAN	1601208	
LOKE WEI YUN	1705749	
MAK PUI JUN	1602520	
WONG BOON JIAN	1805424	

Date: 3th September 2020

ACKNOWLEDGEMENTS

This undergraduate research project could not have been completed without the steadfast dedication and cooperation among the members of the group. We as a group would like to express our gratitude and appreciation to those who had in any assisted us in completing this research project.

First and foremost, we would like to thank Universiti Tunku Abdul Rahman (UTAR) for giving us the opportunity to experience the process of conducting a research study in the form of Final Year Project.

Secondly, we would like to extend our sincerest and deepest gratitude towards our well-respected research supervisor, Dr. Abdelhak Senadjki had not only delivered us with a wealth of professional guidance and advices on our work, but also provided us with plentiful of moral and emotional support throughout the consultations which helped us to stay motivated during the hard times.

Thirdly, we would like to thank our examiner, Dr. Tan Ai Lian who is ever generous and supporting. Her invaluable comments and advices have contributed to the significant improvement in our final draft.

Fourthly, we would like to thank our fellow respondents who had participated in our questionnaire surveys and helped us in retrieving the data that we very much needed.

DEDICATION

A million thanks to our beloved supervisor, Dr. Abdelhak Senadjki and examiner, Dr. Tan Ai Lian who gave us the precious opportunity to complete this research project under their guidance. Their incredible knowledge, expertise and experience had indeed been alleviated and helped us in many ways.

Besides, we would like to thank each and every group member, Kong Siao Ching, Lim Yee Lian, Loke Wei Yun, Mak Pui Jun and Wong Boon Jian for the hard work in the past 8 months to make it possible in completing this research project.

Lastly, we would like to dedicate this research project to businessmen all around the globe. Fourth Industry Revolution is now a key to transform the Industry 3.0 in every business sector to create more innovation opportunity and improved efficiency which had inspired us greatly to conduct this study.

TABLE OF CONTENTS

	Pages
Copyright Page ……..	ii
Declaration ……..	iii
Acknowledgement ……..	iv
Dedication ……..	v
Table of Contents ……..	vi
List of Tables ……..	xii
List of Figures ……..	xiii
List of Abbreviations …….	xiv
List of Appendices ……..	xv
Preface ……..	xvi
Abstract ……..	xvii
CHAPTER 1 INTRODUCTION ……...	1
1.0 Introduction ……..	1
1.1 Overview of Fourth Industrial Revolution …….	1
1.1.1 Asian-Pacific Regional Level ……...	3
1.1.2 Barriers of Fourth Industrial Revolution Adoption ……...	8
1.2 Development of Fourth Industrial Revolution in Malaysia ……...	10
1.2.1 Progress of Fourth Industrial Revolution adoption …….	10
1.2.1.1 Internet of Things (IoT) ……	11
1.2.1.2 Cloud Computing ……	11
1.2.1.3 Big Data Analytics ……	12
1.2.1.4 Cybersecurity ……	13
1.2.2 Barriers of Fourth Industrial Revolution adoption …….	14
1.2.2.1 Technologies Acceptances ……	14

1.2.2.2 Awareness …… 15
1.2.2.3 Financial Resources …… 15
1.2.2.4 Competence and skills …… 16
1.2.2.5 Government Policies …… 17
1.3 Overview of Malaysia companies ……. 18
1.3.1 Company's perspective on Fourth Industrial Revolution ……. 18
1.3.2 Preparation for Fourth Industrial Revolution adoption ……. 19
1.4 Problem Statement …….. 21
1.5 Research Objectives …….. 22
1.5.1 General Objective …….. 22
1.5.1 Specific Research Objectives …….. 22
1.6 Research Question ……. 23
1.7 Significance of study ……. 23
1.8 Chapter layout ……. 24
1.9 Conclusion ……. 24
CHAPTER 2 LITERATURE REVIEW …….. 25
2.0 Introduction …….. 25
2.1 Review of Relevant Theory …….. 25
2.1.1. Theory of Technology Acceptances …… 25
2.1.2. Theory of Awareness …… 27
2.1.3 Theory of Financial Resources …… 28
2.1.4 Theory of Appropriate Competence and Skills …… 30
2.2 Empirical Review ……. 32
2.2.1 Relationship between Technology Acceptances with Fourth Industrial Revolution …….. 32
2.2.2 Relationship between Awareness with Fourth Industrial Revolution …….. 33
2.2.3 Relationship between Financial Resources with Fourth Industrial Revolution …….. 35

2.2.4 Relationship between Appropriate Competence and skill with Fourth Industrial Revolution …….. 36
2.2.5 Relationship between government policies with Fourth Industrial Revolution …….. 38
2.3 Research Gap …….. 39
2.4 Research Framework …….. 41
2.4.1 Technologies Acceptance ……. 41
2.4.2 Awareness ……. 42
2.4.3 Financial Resources ……. 42
2.4.4 Appropriate Competence and Skill ……. 43
2.4.5 Government Policies ……. 43
2.4.6 Control variable ……. 44
2.4.6.1 Relationship between Company's Business and Fourth Industrial Revolution …….. 44
2.4.6.2 Relationship between Company Size and Fourth Industrial Revolution …….. 44
2.4.6.3 Relationship between Company Age and Fourth Industrial Revolution …….. 45
2.5 Hypotheses Development ……. 46
2.6 Conclusion ……. 51
CHAPTER 3 METHODOLOGY …….. 52
3.0 Introduction …….. 52
3.1 Research Design …….. 52
3.2 Data Collection Method …….. 52
3.2.1 Primary data ……... 53
3.3 Sampling Design …….. 53
3.3.1 Target Population …… 53
3.3.2 Sampling Frame and Sampling Location …… 53
3.3.3 Sampling Elements …… 53
3.3.4 Sampling Technique …… 54
3.3.5 Sample Size …… 54
3.4 Research Instrument ……... 56

3.4.1 Questionnaire Design …….. 56
3.4.2 Pilot Test …….. 56
3.4.3 Reality Test …….. 57
3.5 Variable Measurement ……. 58
3.5.1 Fourth Industrial Revolution …….. 58
3.5.2 Technology Acceptance …….. 59
3.5.3 Awareness …….. 59
3.5.4 Financial Resource …….. 60
3.5.5 Appropriate competence and skill …….. 60
3.5.6 Government Policies …….. 60
3.5.7 Company's Business …….. 61
3.5.8 Company Size …….. 61
3.5.9 Company Age …….. 62
3.6 Constructs Measurement ……... 62
3.6.1 Scale Measurement …….. 62
3.6.1.1 Nominal Scale …….. 63
3.6.1.2 Ordinary Scale …….. 63
3.6.1.3 Likert Scale …….. 63
3.6.2 Origins of Constructs (Questionnaire) …… 64
3.7 Data Processing …….. 65
3.7.1 Data Checking …… 65
3.7.2 Data Editing …… 65
3.7.3 Data Coding …… 66
3.7.4 Data Transcribing …… 67
3.8 Data Analysis ……... 68
3.8.1 Descriptive Analysis …….. 68
3.9 Analyses ……... 68
3.9.1 Indicator Reliability ……. 68
3.9.2 Internal Consistency Reliability ……. 69
3.9.3 Convergent Validity ……. 69
3.9.4 Discriminant Validity ……. 69
3.9.5 Checking Structural Model ……. 70
3.10 Conclusion ……... 70

CHAPTER 4 DATA ANALYSIS …… 71
4.0 Introduction …….. 71
4.1 Descriptive Analysis …… 71
4.2 Analyses …….. 73
4.2.1 Data Reliability ……... 73
4.2.2 Internal Consistency Reliability ……. 74
4.2.3 Convergent Validity ……. 74
4.2.4 Discriminant Validity ……. 75
4.2.5 Assessment of Structural Model ……. 76
4.3 Result and Discussion ……. 78
4.3.1 The Impact of Technology Acceptance on Adoption of Fourth Industrial Revolution in Malaysia …….. 79
4.3.2 The Impact of Awareness on Adoption of Fourth Industrial Revolution in Malaysia …….. 80
4.3.3 The Impact of Financial Resources on adoption of Fourth Industrial Revolution …….. 81
4.3.4 The Impact of Appropriate Competence and Skill on adoption of Fourth Industrial Revolution …….. 82
4.3.5 The Impact of Government Policies on Fourth Industry Revolution Adoption …….. 83
4.3.6 The Impact of Company's Business on Fourth Industry Revolution Adoption …….. 84
4.3.7 The Impact of Company Size on the adoption of Fourth Industrial Revolution …….. 85
4.3.8 The Impact of Company Age on Fourth Industry Revolution Adoption …….. 86
CHAPTER 5 DISCUSSION, IMPLICATIONS AND CONCLUSION …….. 88
5.0 Summary Research …….. 88
5.1 Contribution …….. 89
5.2 Policy Implication …….. 89
5.3 Limitations …….. 91
5.4 Recommendation …….. 92
5.5 Conclusion …….. 93

REFERENCES ……………………………………………………………….. 94
APPENDICES ………………………………………………………………... 123

LIST OF TABLES

			Pages
Table 2.1	:	Hypothesis Development	44
Table 3.1	:	Determining Sample Size of a Know Population	52
Table 3.2	:	Rule of thumb about Cronbach's Alpha Coefficient	54
Table 3.3	:	Example of Nominal Scale	59
Table 3.4	:	Example of Ordinary Scale	59
Table 3.5	:	Example of Five-point Likert Scale	60
Table 3.6	:	The Origins of Constructs of measurement in the research	60
Table 3.7	:	Data Coding for Section A (Demographic Profile)	62
Table 3.8	:	Example of data coding for Section B, C, D, E, F, and G	63
Table 4.1	:	Respondents Demographic Information	67
Table 4.2	:	Reliability for Constructs	70
Table 4.3	:	Cross Loading for Constructs	71
Table 4.4	:	Heterotrait-Monotrait (HTMT) Values	72
Table 4.5	:	Inner VIF Value	73
Table 4.6	:	Bootstrapping Result	74

LIST OF FIGURES

			Pages
Figure 1.1	:	The stages of Industrial Revolution	1
Figure 1.2	:	Regional level of Fourth Industrial Revolution adoption	3
Figure 1.3	:	Development of Fourth Industrial Revolution in Malaysia	9
Figure 2.1	:	Theory Technology Acceptance Model (TAM)	25
Figure 2.2	:	Theoretical Framework	39
Figure 4.1	:	Results of Measurement Model	124
Figure 4.1	:	Results of Structural Model	125
Figure 4.3	:	Results of Bootstrapping and Path Coefficients	126

LIST OF ABBREVIATIONS

4IR	Fourth Industrial Revolution
AW	Awareness
TA	Technology Acceptance
FR	Financial Resources
ACS	Appropriate Competence and Skill
GP	Government Policies
CB	Company's Business
CS	Company Size
CA	Company Age
ICT	Information and communication technology
CPS	Cyber-Physical Systems
IoT	The Internet of Thing
IIOT	Industrial Internet of Things
AI	Artificial Intelligence
SMEs	Small and Medium-sized Enterprise
TAM	Technology Acceptance Model
PU	Perceived Usefulness
PEOU	Perceived Ease of Use
R&D	Research and Development
DOI	Diffusion of Innovation
RBV	Resource-Based View
HCT	Human Capital Theory
G	Gender
A	Age
EB	Educational Background

LIST OF APPENDICES

			Pages
Appendix 4.1	:	Results of Measurement Model	124
Appendix 4.2	:	Results of Structural Model	125
Appendix 4.3	:	Results of Bootstrapping and Path Coefficients	126
Appendix A	:	Questionnaire	127

PREFACE

This research is submitted in partial fulfilment of the requirement for the degree of Bachelor of Business Administration (HONS) Banking and Finance at Universiti Tunku Abdul Rahman (UTAR). This research paper is conducted under the supervision of Dr. Abdelhak Senadjki.

The title of this study is "The Industrial Revolution 4.0 in Malaysia: Challenges, Barriers, Obstacles, and recommendations for action". The independent variables included in this study are Awareness, Technology Acceptance, Finance Resources, Appropriate Competence and Skill, and Government Policies. The general objective of this research is to examine the impact of independent variables on Fourth Industrial Revolution adoption.

The beginning of this study introduces the topic selected, research background, and discusses about the relationship between the dependent variable and independent variables. This study then proceeds to examine in detail about the relationship between the variable based on past relevant studies and theory in the literature review. Afterwards, this study collects important data using the primary data methodology, along with convenience sampling and snowball sampling. The data collected is then analysed and presented in order to achieve the study's ultimate goal. The results of the relationship between variables are discussed in Chapter 4. Last but not least, the overall test results, contribution, policy implication, limitations and recommendations were concluded in the last chapter.

ABSTRACT

The global trend of adopting Fourth Industrial Revolution is accelerate but Malaysia still not widely implemented it. This research is aimed to examine the reasons affecting the Industry to adopt Fourth Industrial Revolution in Malaysia. Fourth Industrial Revolution and five independent variables which are Technology Acceptance (TA), Awareness (AW), Finance Resource (FR), Appropriate Competence and Skill (ACS) and Government Policies (GP) has been adopted in this research. This research has used questionnaire method to collect relevant data. The questionnaire designed consists of 42 questions and a total of 385 sets of responses were collected. Smart PLS 3 software has been used to analyse the result. Of the five independent variables, it was found that TA, ACS, FR are significantly influence the industry to adopt Fourth Industrial Revolution. However, AW and GP shown an insignificant relationship with the industry to adopt Fourth Industrial Revolution in Malaysia. This study has discussed about the policies aiming towards helping the industry to adopt Fourth Industrial Revolution in Malaysia such as provide training and education, provide incentive and funding, create regulatory framework as well as conduct Industry 4.0 campaign for entrepreneurs. The limitation of this research is measurement of barrier to adopt Fourth Industrial Revolution, this study was used cross-sectional data only, and the data obtained is not available to defined all the barriers occur in others developing countries.

CHAPTER 1: INTRODUCTION

1.0 Introduction

1.1 Overview of Fourth Industrial Revolution

Industrial revolution 1.0 was began in 1800 with mechanization and mechanical power generation. It makes the evolution from hand-operated work to the initial manufacturing process mainly in the textile industry. The main driver of the change is to improve the life's quality. It can enhance productivity by using hydroelectric power, making better use of steam power and improving machine tools. The Industrial Revolution 2.0 is developed in the beginning of the 20th century when the world entered into the introduction of steel and use of electricity in factories (Rubmann et al., 2015). The introduction of electricity enables manufacturers to increase efficiency and help factory machinery become more mobile. It is easier to use than the water and steam, and enables the businesses to concentrate power to a single machine. The Industrial Revolution 3.0 was developed in 1969 which is characterized by introduction of digitization of microelectronics and automation technology. This facilitates flexible production during the manufacturing process, where several products can be manufactured on a flexible production line by using the programmable machines. However, this production system still lacks with the flexibility in terms of production quantities (Davies, 2015).

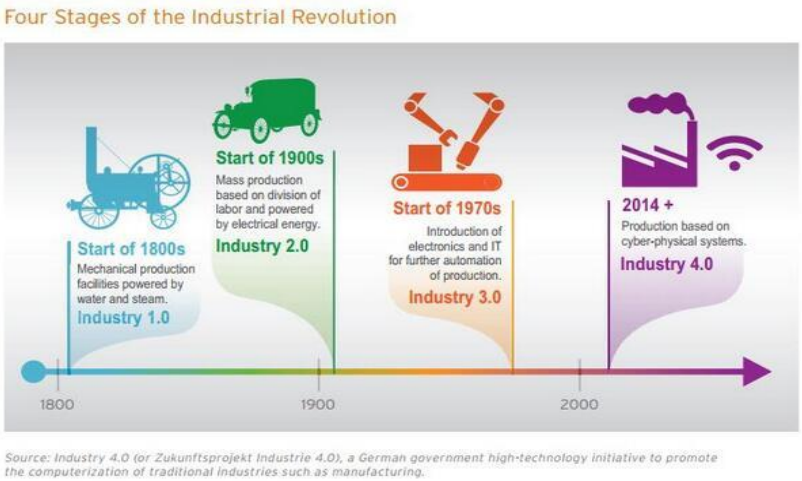


Figure 1.1: The stages of Industrial Revolution

Malaysia are now in the Industry 4.0 which is in the era of information and communication technology (ICT). In 2011, Industry 4.0 was first launched at the Hannover trade Fair where the concept was highlighted by a group on a mandate from Research Union Economy-science of German Ministry of Education and Research. Industry 4.0 is concerning to the combination of all production areas through the digitization and the establishment of new communication channels. This can be described as when the use of information increase and automation technologies in manufacturing sector. It enables to control the value chain of the life cycle of the products in order to meet the demand of customer (Lee & Lee, 2015). According to Hofmann and Rusch (2017) state that the digital technologies application is known as "smart manufacturing", "integrated industry" and "industrial internet".

In line with globalization change, Industry 4.0 proposes a commitment method based on business integration and manufacturing processes, and also the integration of all sectors in value chain of the company. Refer to European Commission in 2016, telecommunication technology and infrastructure contribute the connection between people, collaboration and integration of people, system and machines. Industry 4.0 bringing the new innovations into production by the modern face of the information era. This included Cyber-Physical Systems (CPS), the Internet of Thing (IoT),

Industrial Internet of Things (IIoT), Cloud Computing, cognitive computing and Artificial Intelligence (AI) (Davies, 2015; Lee & Lee, 2015; Rubmann et al., 2015).

Further, Industry 4.0 can be characterized by; (1) there will more automation compare with third industrial revolution, (2) industrial revolution able to bridge the physical and digital world via cyber-physical systems, (3) closed-loop data models and customization of products, (4) the transition from the control system of central industrial to a system where production steps defined by smart products. This revolution has created new opportunities for developing countries to embrace the technologies used such as artificial intelligence (AI), big data analytics, and blockchain to achieve leapfrog development and stay aligned with developing markets. By using this digital-driven industrial revolution, governments are improving their social and economic inclusion via the transformation towards a smart society (Manda & Dhaou, 2019).

1.1.1 Asian-Pacific Regional Level

Industry 4.0 had become a norm to the global and, Asian advanced countries also take part in adopting Industry 4.0 such as China. China was rapid growth in Industry 4.0 in these recent years where they are active in doing digital investments as well as start-up ecosystems around the world. Referring to Woetzel et al. (2017), China was ranks among the world's top three for the venture capital investment in digital technology such as virtual reality, autonomous vehicles, 3-D printing, robotics, drones and artificial intelligence (AI). They reform traditional manufacturing sector to smart manufacturing which similar to The United States revolution. China manufacturing sector had built their own digitalized factory where focus on the intelligentization of production, with end-to-end data flow as base and driving force (Radu, 2018).

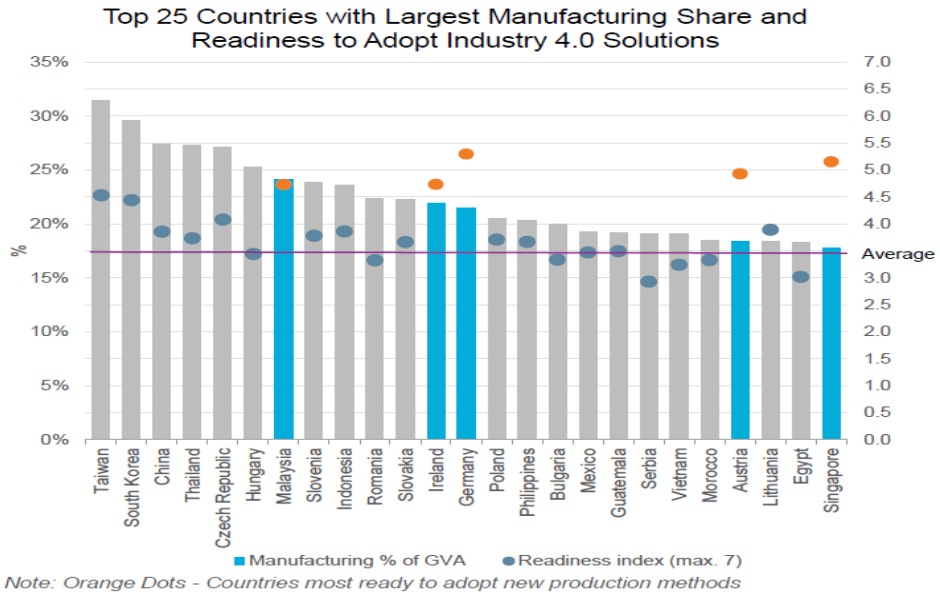


Figure 1.2: Regional level of Fourth Industrial Revolution adoption

In additional, financial institution of China also developed digital technologies into their financial system such as digital credit service, digital wealth management, digital insurance, digital payment, internet financing. Meanwhile, all the stored and recorded data are known as big data that can use for precision marketing and cross-selling. Subsequently, e-commerce is also rapidly growth in China industrial. One of the good examples is Alibaba company where they successful developed online shopping website, Taobao became the world biggest e-commerce website (Thiemann et al., 2019).

In addition, Japan also known as an advanced country among Asian countries. The government of Japan also involved in the Industry 4.0 where deployed Industrial Value Chain Initiatives (IVI). They focus on Internet of thing (IoT) technologies that aims to combine between humans, data, digital machines in their manufacturing sector to control product quality, optimize in packaging, efficiency in inventory management as well as production flow monitoring. Meanwhile, Japan manufacturing sector also adopt digital manufacturing (DM) in their management where to improves the overall efficiency of the production. This software provides and supports process planning, factory modelling, visualization and simulation of operations, human factory analysis as well as collaborative communication. Moreover, a Singapore-based provider of data-driven digital experience for bank and fintech firm, Moneythor had opened an office in Tokyo where they are

focusing on the digital banking (Andreasyan, 2020). The digital banking service that existed in Japan was included the Wallet Mobile, Apple-Pay, Mobile Chip Readers and "All in One Thing" (manage all loyalty card in mobile phone) (Walsh, 2015). Apart from that, Japan also launched PayPay, a joint venture between Paytm (India's mobile payments firm), Softbank and Yahoo Japan where supported by one million merchant partner and local store. Similarly, Revolut, European fintech unicorn will cooperate with Rakuteh, Sompo Japan Insurance and Toppan and will focusing on e-wallet, payment cards and insurance products.

Furthermore, Hong Kong also taking steps into Industry 4.0. With the establishment of the Guangdong-Hong Kong-Macau Greater Bay Area (GBA) in Southern China, Hong Kong manufacturing industry is highly value added to meet global and domestic demands for technology and innovation. Subsequently, smart manufacturing is becoming the new norm to Hong Kong. The government of Hong Kong such as Hong Kong Science and Technology parks Corporation (HKSTP) were fully support domestic manufacturing industry to smart manufacturing revolution either in technical support or resources support. This such as 1.1m square-foot facility for scalable manufacturing and prototyping will be home to both Hong Kong and International small and medium sized enterprises (SMEs), allow these businesses the space and support to develop their capabilities in smart manufacturing ("Hong Kong's manufacturing goes back to the future," 2019). Besides, Hong Kong's fintech sector also rapidly growth in these recent years where more than 600 fintech companies established in the home city. These fintech sectors almost cover all aspects of fintech, including blockchain, insurance, RegTech, payment tech, wealth tech, quants and algorithmic trading ("InvestHK to hold Hong Kong Fintech week 2020 from November 2 to 6 in Hong Kong and Shenzhen," 2020). For example, Big data and Artificial intelligence (AI) developed by Oriente and MioTech where they provided leading financial services and technology company using cutting-edge technologies (Kang et al.,2016) such as AI machine learning, and data science while wealthtech established by Futu Securities and FinEx Asia where providing global fintech platform a one-

stop online investing service and experience to international online brokers as well as investor ("Top 19 fintech startups in Hong Kong 2019," 2019).

Besides, Singapore also had developed Industry 4.0 in Jurong Island. They concentrate on optimising the Eco-industrial park (EIP) data storage, big data, sensor technologies, cyber-infrastructure as well as high performing computing (HPC). Subsequently, Singapore's Economic Development Board (EDB) introduced Singapore Smart Industry Readiness Index where give entrepreneur a common framework of Industry 4.0 and evaluate industrial's reading levels (Pan et al., 2015). Meanwhile, Enterprise Singapore and Singapore Standards Council also introduces the first standards mapping tool in the world where contribute global standards in operations, supply, automation and Smart industry Readiness index areas for manufacturing sector. Fintech Companies also began digital money transfer in Singapore such as CoinPip, Fastacash Pte. Ltd and Toast Me ("Top 30 fintech startups in Singapore," 2019). They provide global social payments platform which allow users to transfer money through social networks. By using Bitcoin, it can be easier and faster to pay the remote workers, as well as remit money to others foreign countries directly through smartphone without having the use of the existing banking infrastructure. Further, Singapore fintech company has also reformed its lending structure to digital lending that provide a vibrant crowd lending platform to connect companies that look for loans for capital expansion, equipment purchases or other needs in order to broad investor community. They also involve in Blockchain or crypto-currency area. For example, Ripple Singapore created a real-time payment system that based globally by providing enterprise-grade solutions to banks and financial institution.

Moreover, Australia is also adopting Industry 4.0 in their country by introducing 4.0 testlab. Testlabs program known as a million-dollar Industry 4.0 program to support industrial sector move to the smart factories in the future ("Industry 4.0," 2020). For example, develop skill needed, provide enterprise and researchers with a physical space for trail and explore, and also enable the educational institution industries to collaborate. They concentrate in advanced manufacturing processes, automation and robotics,

Internet of Thing (IoT), cloud computing, advanced algorithms and smart sensors. For example, in order to prevent the SMEs to embrace Industry 4.0, an audit tool that use to identify the technological capability gaps can be developed. At the same time, it also can provide funding for Hospital 4.0 where this Hospital 4.0 is a cloud-based AI digital health platform. This platform can help to eliminate the problems by giving the best practice clinical guidelines and providing the up-to-date information to decision makers ("Fourth Industrial Revolution Australian businesses in transition," 2019). Besides, Australia manufacturing using operational software program including Enterprise Resource Planning (ERP), Project Lifecycle Management (PLM), Bill of Material (BOM) and Customer Resource management where this program can provide interface and updates on product manufacturing process to the customers. There will be a better communication around supply chain management, invoicing and payments when using Electronic Data Interchange (EDI).

Apart from that, South Korea had implemented the Manufacturing Innovation 3.0 method that reflects Industry 4.0 and the production technologies could be enhanced by adopting automation and data exchange. The purpose of Manufacturing Innovation 3.0 is to recognize innovation in production by deploying the concept of a smart factory and advances in core technologies related to Cloud Manufacturing, Energy Saving, 3D printing, IoT, Big Data and Smart Sensor (Kim, 2019). Cloud Manufacturing could improve efficiency, lower down the cost of product lifecycle, and allow for optimal resource loading. This could help customer to generate multi-tasking by exploiting on-demand access in order to shared collection of diversified and distributed manufacturing resource that form temporary and reconfigurable product lines. For the energy saving section, South Korea had launched the Factory Energy Management System (FEMS). The systems that included in FEMS were energy consumption visualization system, air compressor equipment and heat recovery ventilation system, and renewable energy and natural gas energy monitoring system. Korea was also planned to expand to Building Energy Management System and Housing Energy Management System. Apart from that, South Korea was also the

first country that launch the nationwide 5G connectivity which is ultrafast internet infrastructure that can handle 10 gigabits of data per second. Furthermore, Kakao, an internet company in South Korea was cooperated with FinTech company in investment and lending activities (Garikipati, 2019). For example, "investment" tab and "loans" tab application created by Fintech partner company where users can make investment and granting loan with a single tab in application.

1.1.2 Barriers of Fourth Industrial Revolution Adoption

One of the barriers or challenges that faced before the Industry 4.0 enter into market is the skills challenges. Skills, knowledge communities and innovation systems provide knowledge guideline for developing and implementing smart and digital initiatives (Abdoullaev, 2011). Electronic readiness including the electronic skills and electronic literacy are considered to be the basis in the success of so-called smart societies. Skill mismatches and redundancy are the example of skills challenges which is due to the changes in the job scopes as a result of advances in technology and manufacturing techniques. In addition, the e-readiness will affect the ability of the citizens to engage in social and economic activities (Manda & Backhouse, 2016). Low levels of e-readiness in developing countries such as South Africa is considered an obstacle to the transition toward a smart society.

The next challenges that faced by Industry 4.0 before they enter into the market is the infrastructure challenges. Developing countries not only faced the social challenges, but also technological and infrastructure challenges. According to Zhou, Liu, and Zhou (2016) had mentioned that the identified challenges of introducing new technologies, such as analytics, network development and smart device in the developing countries in China which have the advanced infrastructure. Therefore, lack of ICT infrastructure in developing countries is one of the main challenges that governments might face when implementing Industry 4.0 (Manda & Ben, 2019). For example, by comparing to the development of economy that are considered leaders in broadband and other ICT infrastructure, the broadband penetration in

developing countries is still low ("United Nations," 2014; "International Telecommunication Union," 2015). Poor broadband penetration in South Africa is one of the obstacles that hinder transformation to so-called smart societies driven to economic and social development based on advanced technology, digital connectivity, skills, innovation and knowledge (Manda & Backhouse, 2016).

Lack of expertise is another challenge that faced by Industry 4.0 before they enter into the market. The obstacles to the development of Industry 4.0 are due to the shortage of rule and regulations as well as the working procedures in developing countries. Insufficient of legislation is also the obstacles for the development of cloud computing, augmented reality, network security, augmented reality, and artificial intelligence in developing countries. According to the past researcher Turkes, Oncioiu, Aslam, Marin-Pantelescu, Topor, and Capușneanu (2019) the lack of expertise can also represent the boundary of the development of Industry 4.0, which means that the company is lack of culture, there is no training will be provided on acquiring the digital skills, and has no experts to promote the implementation of new technologies. Due to the low technical skills of construction workers, training and development of employees is required and the demand for integrated skills is also increasing. Therefore, there will be a big challenge in order to create and develop new competencies to ensure that the project organization is optimized and attract new talents into the labor. It is necessary to provide operators with sufficient skills to handle the machinery in order to maintain high execution rates of robotic during the construction process (Aripin, Zawawi & Ismail, 2019).

Furthermore, shortage of financial resources is also one of the challenges that faced by Industry 4.0 before they enter into the market. Some of the non-cloud computing adopters had stated that they did not have sufficient financial resources to support this cloud migration. Poor understanding about the benefits of cloud environment and how to alleviate some of the SMEs is also the reason for not adopting cloud computing (Carcary, Doherty & Conway, 2014). This lack of financial resources usually will limit the ability of SMEs to obtain strategic benefits from new technologies. There is

some of survey respondents believe that they do not have sufficient financial resources to support Cloud migration. There is a shortage of financial resources to invest in the new initiatives due to high execution costs in developing the technologies and difficulties in justifying the real value has been identified in terms of the financial barriers (Phaphoom, Wang, Samuel, Helmer & Abrahamsson, 2015).

1.2 Development of Fourth Industrial Revolution in Malaysia

1.2.1 Progress of Fourth Industrial Revolution adoption

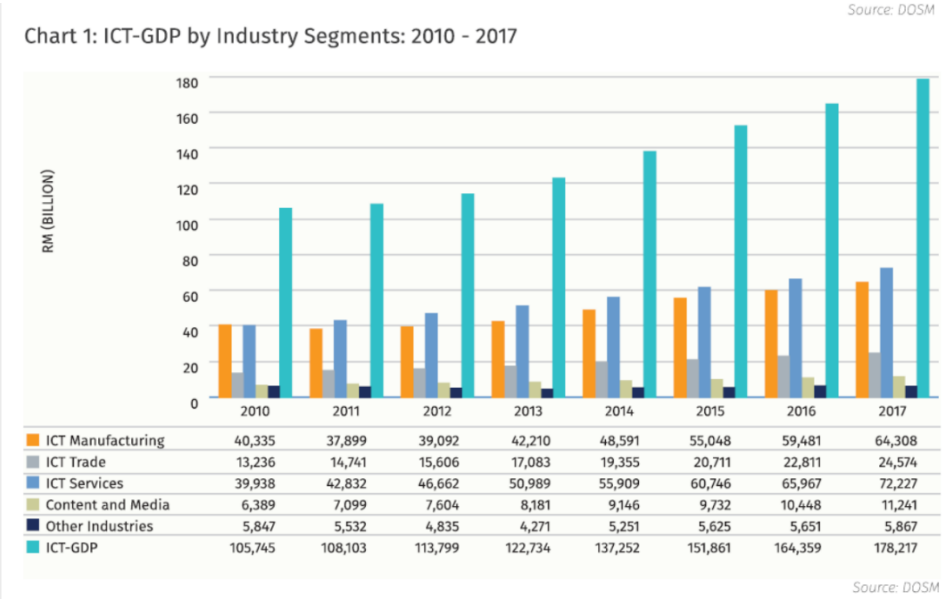


Figure 1.3: Development of Fourth Industrial Revolution in Malaysia

Information and Communication Technologies (ICT) is an important part of the development of Industry 4.0, as this revolution is triggered by ICT (Perakovic, Perisa & Zoric, 2019). According to the report from Statistics Malaysia's Information and communications Technologies (ICT) Satellite Department, the ICT industry size were rapidly growth from 2010 to 2017 (refer to figure 1.3). The value of ICT industry contributes a large proportion to the growth of Gross Domestic Product. Malaysian National ICT Association stated that the average wage growth rate in ICT industry further grew in 2019, about 3.8 per cent are consistent with the development of ICT industry. However, the salaries seen to grew slowly in this decade due to the lower supply of skilled labor in the market ("PIKOM ICT job market

outlook in Malaysia 2019," 2019). This is because the demand of ICT skilled labor in the market is higher than the supply of ICT skilled labor. Subsequently, Pikom's chairman expected Malaysia economy will turn around in mid-2020 with newly introduced Industry4WRD program by Malaysia government (Ismail, 2019). This project is focus on Industry 4.0 to develop country's future economy.

1.2.1.1 Internet of Things (IoT)

Internet of Things is being to develop across many sectors such as manufacturing, automotive, healthcare and infrastructure (Ann, 2017). Although the level of adoption will be different, the implementation internet of things will be widely used in various industries. However, there are some of the listed companies in Malaysia announced to develop this technology, even some of the unlisted technology companies are also active in this area. For example, Cyberview Sdn Bhd which is one of the initiatives to help in the development of Internet of Things (IoT) in Malaysia, and is implementing various IoT-based solution such as the intelligent traffic management systems, public safety monitoring and energy management ("InvestKL," 2017). In April 2019, Maxis companies has launched the first commercial narrowband Internet of Things (NB-IoT) service in Malaysia. NB-IoT is a network for IoT technology, which was similar to the 5G and has able to support millions of connected things in consuming low power in order to extend battery life. Besides, companies are able to deploy industrial IoT applications to form new data streams and enable actionable insights by connecting to the common device such as sensors. These technologies will boost Big Data and able to support advanced data analytics in order to make decisions such as new business opportunities ("Digital News Asia," 2019).

1.2.1.2 Cloud Computing

Cloud computing is growing very fast in others country but in Malaysia the adoption of cloud computing is still slow. This has become a worrying issue because implement the cloud is seen as a quick and easy way for small and medium enterprises to join the digital economy (Elnaz & Baharak, 2014). Cloud computing has a dramatically changed in the information technology

environment and the way business is conducted in any organization (Hamid & Yusof, 2015). In October 2017, the former Prime Minister Datuk Seri Najib Razak has introduced a "Cloud First" strategy in Malaysia in order to increase the speed of the adoption of digital technology in the country and improve the digital economy (Lago, 2019). By adopting the cloud computing technology, it will enable the government to quickly provide innovative public sector services without large amount capital to invest in information technology infrastructure such as servers and storage (Al Lami, Maelah & Ghassan, 2019). Good adoption of cloud computing will benefit Malaysian government via the use of collaboration platform such as the SME cloud computing adoption program. The objective of this program is to accelerate the adoption of cloud computing in local SMEs and also to increase the efficiency and competitiveness in conducting their business (Abolfazli et al., 2015). The government of Malaysian is also encouraging the private sector to adopt cloud computing (Lago, 2019) because by adopting cloud computing, the implementation cost of e-commerce is low and zero maintenance cost (Mohabbattalab, Heidt & Mohabbattalab, 2014). According to Malaysia Digital Economy Corporation (MDEC) CEO, Datuk Yasmin Mahmood had stated that the digital disruption is unavoidable because they believe that the cloud can successfully synthesize digital technology into their business processes. This digital technology can help them to improve the efficiency and productivity of their business model and also to maximize their profits that will give a big impact to the growth of local economy (Ayisy, 2018).

1.2.1.3 Big Data Analytics

The growth of the Internet and social networking and the huge number of smart mobile devices usage have contributed to the overloading amount of data that can be accessed by companies (Azhar, 2015). For example, the smartphone apps of taxi service provided by the Uber is firmly rooted in Big Data Analytics (BDA). It is referring to the big data principle of huge volume of sourcing and uses real-time analytics to estimate and forecast when the drivers will arrive to pick up passengers and how much they will be charged (Adnan, 2016). Although data reporting and collection has

become part of the business functions, but there are not many companies and organizations have the tools and technology to monetize the value of data (Azhar, 2015). In November 2013, the Prime Minister in Malaysia announced that the Ministry of Communications and Multimedia, Malaysia Digital Economy Corporation (MDEC) and Malaysian Administrative Modernization and Management Planning Unit (MAMPU) to lead the implementation of Malaysia's Big Data Analytics (BDA) during the MSC Implementation Ceremony Meeting. After that, there is a Public Sector Big Data Analytics Pilot Project started at March 2015 which has provided the facilities and infrastructure for the implementation of the Big Data Analytics by the public sector agencies ("My Government," 2020). Furthermore, MDeC has also set up a task force consisting of partners from higher education institutions, private sector and government agencies to study the development of the industry in Malaysia. They also establish a one-stop centre for companies to learn how to get started and implemented with big data analytics, so that they can implement some concepts in their business (Azhar, 2015). For example, AmBank Group Bhd is incorporating the use of big data analytics into its banking operations. Subsequently, big data analysis will enable banking groups to avoid unnecessary risks because it enables banks to identify SMEs that may prove to be potential non-performing loans (NPL) candidates (Rosli, 2017).

1.2.1.4 Cybersecurity

Increasing awareness of the importance of cybersecurity has led Malaysian companies to focus more on addressing cyber threats. According to the director of Cisco Malaysia, there are more than 10,000 cyber alerts a company will receive (Birruntha, 2020). There will be very high risk if focus on the development of digital technology without improving the protection of its technologies. Therefore, most of the government initiatives and policies introduced by the government are based on the digitization such as the online management systems which are require multiple layers of protection features (Sharon, 2019). Moreover, Cybersecurity Malaysia is a national cyber security technical and expert agency, which is under the Ministry of Communications and Multimedia. For example, it has deployed

BlackBerry software in order to protect the problem of sensitive data and enable secure mobile working. BlackBerry also help cybersecurity in Malaysia to solve security collaboration and meet new compliance requirements and provides confidence that our country's valuable intellectual property is safe and secure. It also provides protection and secure towards applications, devices, networks and autonomous systems at every layer of the enterprise and Internet of Thing (IoT) device from threats (Henderson, 2019).

1.2.2 Barriers of Fourth Industrial Revolution adoption

During the MITI's last conversation with the Federation of Manufactures of Malaysia (FMM) in 2017, most of the manufacturers are aware of the Industry 4.0 concept, but so far only 30% of companies have just started adopting the modern technologies under Industry 3.0. In 2015, the country was ranked 10th in the world with an export value of US $ 57.28 billion ahead of Switzerland, Belgium and Canada in high-tech exports (Ghaz, 2017). The changes in the production and value creation process of the digital revolution are huge and pose a real challenge to small and medium enterprise in Malaysia.

1.2.2.1 Technologies Acceptances

The following barriers of achieving Industrial Revolution face by Malaysia is the acceptance of technologies from either the perspective from the employers or employees. According to the report from Pandiyan (2017), Malaysia is slow to embrace to Industry 4.0 due to the reason of the acceptance of technologies. There was also stated that Malaysia already known as a country that will stuck at the level of Industry 3.0 in the term of manufacturing technology. This is because there were many are still preferring to keep the foreign workers and using manpower in manufacturing instead of invest into automation and IT. According to the Ministry of International Trade and Industry (2019), it also stated that the

manufacturer in Malaysia has low acceptances of the new technologies was due to the reason of the adoption cost of the Industry 4.0 technologies and replace worker by machine, computers or robotic is higher. The other major reason is that it is uncertain whether the benefits of these technologies are an obstacle to the introduction and development of innovative technologies in Malaysia. Thus, the uncertainty brought by the new technologies also affects the acceptance of technologies (Aripin et al., 2019).

1.2.2.2 Awareness

Obviously, Malaysia is still not ready to compete due to the gap in digital infrastructure and lack of awareness on the concept and benefits of Industry 4.0 (Sakinah, 2020). A better understanding of Industry 4.0 is important for manufacturing companies to make informed investment decisions, especially in assessing impact in order to determine the automation costs and benefits, and capitalizing on data (Sharon, 2019). A structured awareness plan is needed to educate and promote understanding and the need for action by local companies, especially SMEs. The digital adoption rate especially in small and medium enterprise is almost 20%, while most of the manufacturing companies use less than 50% of automation. According to the global surveys, Malaysia has been one of the top scoring in their areas in terms of digital readiness. However, the motivation of industry players themselves is insufficient. The key challenges include a lack of awareness in term of the impact and benefits of keeping new technologies, especially among small and medium enterprises. The high cost of technology adoption and the slow return on investment also make people extremely reluctant to jump into the Industry 4.0 trend (Yatid, 2019).

1.2.2.3 Financial Resources

Most of the SMEs want to develop Industry 4.0 but they force to stop it due to lack of financial resources (Jayashree, Malarvizhi & Hassan Reza, 2019). Industry 4.0 requires some adjustments to the existing installations and also

requires new set-up of information technology infrastructures. Developing and introducing the Industry 4.0 technology is very challenging to SME because it requires large amount of investments in technologies (Tan, Hemashwary & Shahryar, 2019). One of the factors is the cost implication which can help to improve design existing IT infrastructure and implement a new system. These costs are very challenges to the SME especially for the small companies when adopting the Industry 4.0. These large amounts of investment will ultimately have a huge impact to SMEs in the long run as they fully implement the Industry 4.0, this will become cost effective to the SMEs (Ghaz, 2017). For example, before the company decide which technology want to invest in Industry 4.0, they need to understand their business performance as well as their operational problems. If not, all the actions they make were fall into the trap of wasting time, efforts and the financial resources that they invest in the Industry 4.0 ("The Race Towards Industry 4.0," 2018). This will lead the company faced a lot of competitors if they did not adopt the Industry 4.0 and will affect the performance of that company (Sharmila, 2018).

1.2.2.4 Competence and skills

One of the biggest challenges facing by the SMEs in Malaysia in order to adopt the Industry 4.0 is the skill challenge. According to the past researcher Racheal (2020) said that lack of skill in science, technology, engineering and mathematic (STEM) will cause the employee cannot adapt to the fast-evolving technology. When Industry 4.0 is adopted worldwide for the workforce training, the employment conditions still need to be inferred in advance. All the labor need to have different set of skills. The SMEs have no choice, they have to adopt intelligent production and other elements of Industry 4.0 into their operations in order to remain competitive. The biggest changes needed to prepare by the workforce is their mindset. This can help them to improve their productivity and efficiency and also can make use the digital platform to expand the markets (Tay, Lee, Chan, Alipal & Hamid, 2019). Employees must actively learn how to participate in the new

revolution, engage in a lifelong learning process, and constantly improve their performance and technical knowledge. Employees with professional skills are less important than employees with multi-purpose skills because they are easier to adapt new skills (Ahmad, Shamsuddin & Abu Seman, 2018).

1.2.2.5 Government Policies

Government has been implementing some form of industrial policy where aimed at stimulating industrial growth and ultimately promoting the economic transition from low-productivity agriculture to high-productivity manufacturing (Pack & Saggi, 2006). However, the results have been disappointing, especially to the current trend such as adoption of Industry 4.0 where government did not respond to the changes of global business environment. According to the report from The Star, Malaysia only in the preparation steps where did not really begin Industry 4.0 (Tan, 2019). The reason is that government did not regard it's as an important issue lead to poor awareness among industrial in Malaysia. According to Bianchi and Labory (2019) industrial policy is necessary to design and implement to provide an idea about industrial revolution. However, Malaysia government was late to introduce industrial policy compare to others countries, where they newly launched Malaysia's National Policy on Industry 4.0 on 2018 (Saieed, 2018). A study from Kuo, Shyu, and Ding (2018) stated that formulation and implementation of science and technology policy will affect overall scientific of the country and technological development and industrial environment as well as accelerate the formation of national industrial competitiveness. While it's links to the government Malaysia where they did not play a significance influencer or assist industries in revolution in these recent years. As compare to the government of United States, where they launched and advanced manufacturing national policy plan to promote the manufacturing return of US, rebuild manufacturing competitiveness since 2012.

1.3 Overview of Malaysia companies

1.3.1 Company's perspective on Fourth Industrial Revolution

Malaysia government have launched the National Industry 4.0 policy which related to technologies adoption toward the implementation of Industry 4.0 (Saieed, 2018). This policy provides the action plan in catalysing the implementation of Industry 4.0 to increase productivity and competitiveness of manufacturing sector. This increase the awareness of Malaysia companies towards the Industry 4.0 (MITI, 2019). According to Mahmood (2016), Malaysia Digital Economy Corporation Sdn Bhd (MDEC) perceived Industry 4.0 as a building upon a vibrant domestic ICT industrial, the transformative use of digital solution, and the continuous cultivation of strong and supportive ecosystem. In addition, they also had changed the name of their company from Multimedia Development Corporation Sdn Bhd to The Malaysia Digital Economy Corporation Sdn Bhd, just to remind themselves of today's digital economy reality (Basu, 2016).

While in an industry perspective, Industry 4.0 is a digital economy where represents the third wave of information technology (IT) transformation is more innovative, productivity and economic growth than the previous two waves (Mandel, 2019). According to Financial Times (2019), they had interviewed the founder of Top Glove, Tan Sri Lim Wee Chai, who is one of the tops influencer Malaysia in 2019. He perceived that as the pace of technological advancement keep accelerating, digital transformation must be adopted to guarantee that every company, regardless of size so as to keep up with the pace of rapid change market trends and needs. He also added that the Industry 4.0 is the future and it is inevitable where SMEs in Malaysia have to ready and start to learn about integrate new technologies into the processes of the business, connect digitally with customers and embrace Industry 4.0 (Lim, 2019). The way to reach to the market and capability in reaching more customer will definitely change as SMEs adopted Industry 4.0.

However, small and medium enterprise may perceive as a force to survival in the future business environment. As the incremental usage of high-tech technologies in globalization, enterprises are necessary to follow the trend in order to have competitive with their competitors, in both locally or overseas (Muhammad, Char, Yosao' & Hassan, 2010). Subsequently, they are also hard to implement Industry 4.0 due to several challenges such as shortage of IT support, shortage of financial resource or shortage of strategic of implementation (Muhammad et al., 2010; "Development of SMEs in Malaysia," 2018). Because of these issues, they also perceived it is an unnecessary plan to develop Industry 4.0. They are still not ready and prefer to maintain current business stage rather then moving to next stage even it will create more opportunities and profit in future (Tan, 2019).

1.3.2 Preparation for Fourth Industrial Revolution adoption

However, by develop Industry 4.0 require a high-speed connection in this uses of Internet of Things, big data or cloud computing (Ortiz, Marroquin & Cifuentes, 2020). According to Telekom Malaysia Berhad announcement, they have enhanced their internet access speed and prepared to establish more fibre services in Malaysia especially rural area (Yeoh, 2019). Similarity to Digi Telecommunications Berhad, Maxis communication Berhad and Celcom Axiata Berhad also increased their internet access coverage especially 4G centre in city such as KL centre. In addition, they also taking part in develop 5G internet access in Malaysia where corporate with Cyberview to facilitate, build and nurture the development of 5G ecosystem (Tariq, 2020; Toh, 2019). This is due to establish stable and faster Internet of thing (IoT) to allow big data transfer as well as increase connection between business to business, business to customer in future with the changes of Industry 4.0 (Rao & Prasad, 2018). Besides, small and medium enterprise (SMEs) also participate in National Policy on Industry 4.0 (Industry4WRD) where develop by the government in Malaysia (Mageswari, 2019). Companies received information and knowledge or strategic from the Knowledge Research for Science and Technology Excellence (KRSTE.my) and implement into their organization.

The general manager of Packaging Sales and Service (M) Sdn Bhd, Mr. Mano Subramaniam said that they had begun provide its customers with machines that support Industry 4.0 since few years back in preparation for fully fledged Industry 4.0 (Moreira, 2019). He added that "our small-to-medium enterprises have machines with a sensor which able to implement autonomous or artificial intelligence into their machines". At the same time, small medium enterprise (SMEs) also corporate with web development companies to implement web-based Smart 4.0 system with complete data connection where prepared for big data, cloud computing and internet of thing (IoT). Most of the technologies used are HTML, Microsoft Azure, Bootstrap or Amazon web services.

Aside from developed of Industry 4.0 in SMEs, financial institution Malaysia also prepared well to meet the Industry 4.0 especially in commercial banks. Hong Leong Bank, one of the biggest commercial banks in Malaysia also had developed preparation plan for revolution. According to Fong (2017), Hong Leong Bank have previously launched HLB Launchpad, where is a platform to nurture new ideas and talent from Fintech and Tech Startups that will reinvent the way of bank today (Fong, 2018). The plan is the first public-private partnership between Hong Leong Bank, Cradle and Malaysian Business Angel Network (MBAN). Other than that, Hong Leong Bank also engage on investing in in-depth technologies like AI and they had developed cognitive banking technology with IBM Watson in 2016. Besides, Maybank, the biggest commercial bank Malaysia has been seen establishing their annual Maybank Fintech programme with the key standard of "Go-to-market" partnership (Kana, 2017). They have also launched their Maybank Fintech Sandbox in 2017 where provide the chances to start-ups and innovators to develop and test new thinking by leveraging on the banking group's internal digital and technical expertise. In addition, Maybank also the first bank to corporate with foreign fintech partner likes Alipay and WeChat Pay and they also launch their digital wallet called MaybankPay, as well as Maybank QRPay (Fong, 2018).

1.4 Problem Statement

Recently, Industry 4.0 was a most popular trend in the world where refers to a new phase. It focuses on the interconnectivity, automation, machine learning, and real-time data. Industry 4.0 enhance productivity and efficiency, better flexibility and agility, as well as increased profitability. Industry 4.0 technology may help a company in automated business processes, increase efficiency, expand their business sector as well as gain competitive advantage. Industrial technologies also influence business sector through production systems, customer segment, value proposition, channels, value chain, revenue streams, opportunities and new market segment. Development of Industry 4.0 are kept on rising on increasing in these recent years and implemented by several countries such as United States, United Kingdom, German, Japan, Singapore, China, or even South Korea. Even implementation of Industry 4.0 is widespread around the worldwide, but Malaysia still not widely adopt Industry 4.0.

Some reason such as poor standards and technology is also an issue that will delay the development of industrial revolution because of the shortage of financial resources. The implementation of Industry 4.0 technology needed large investment in owning the technologies, as well as maintenance fees. Thus, industries are often not willing to take the high risks and put high cost on investment into the technology (Nagy, Olah, Erdei, Mate & Popp, 2018). Besides, lack of the required skills and technical expertise are also the challenges faced by the implementation of Industry 4.0 technology due to high skilled and innovative workforce become a major requirement to perform effectively and efficiently in implementing the new advance technologies (Kiel, Muller, Arnold & Voigt, 2017). Educators also hard to keep up with the right or proper technical skills due to the advances in technology occur every second. Similarity, skilled labor might become out of date in the event that they did not renovate new skills from time to time (Sagita & Khairunnisa, 2020). Industry 4.0 will remove some of existing

jobs and replace it with some new jobs which require higher skill and knowledge levels. Malaysian Ministry of Education mentioned that "the role of higher education institutions is to help the students to adapt to the changes introduced by Industry 4.0 in order to meet the changes of business environment" (Lawrence, Lim & Abdullah, 2019).

In order to determine the reason of failure of Industry 4.0 adoption in Malaysia, this research is organized to test the variables which makes Industry 4.0 unsuccessful adopt in Malaysia. After knowing the factors and reasons of unsuccessful Industry 4.0 adoption, government and companies can develop strategy and policy to overcome the issues.

1.5 Research Objectives

1.5.1 General Objective

The purpose of this research is to determine the barriers of industry sector on Industry 4.0 in Malaysia. This paper intends to examine the major barriers by considering the influences of technology acceptance, awareness, financial resources, appropriate competence and skills, and government policies. Further, this research also to clearly understand about which barriers and challenges will have significant impact on Industry 4.0.

1.5.1 Specific Research Objectives

I. To examine the impact of technology acceptance on Industry 4.0 in Malaysia.
II. To examine the impact of awareness on Industry 4.0 in Malaysia.
III. To examine the impact of financial resources on Industry 4.0 in Malaysia.
IV. To examine the impact of appropriate competence and skill on Industry 4.0 in Malaysia.
V. To examine government policies on Industry 4.0 in Malaysia.

1.6 Research Question

- Does the lack of technology acceptance have significant impact on the Industry 4.0 in Malaysia?
- Does the lack of awareness have significant impact on the Industry 4.0 in Malaysia?
- Does the lack of financial resources have significant impact on the Industry 4.0 in Malaysia?
- Does the lack of appropriate competence and skill have significant impact on the Industry 4.0 in Malaysia?
- Do the government policies have significant impact on the Industry 4.0 in Malaysia?

1.7 Significance of study

This study observes and examines the significant impact of technology acceptance, awareness, financial resources, appropriate competence and skill, and government policies on the Industry 4.0 adoption in Malaysia company. This study is also disclosed the research gap as well as lack of knowledge on this issue. Previously, major of the studies were concentrated on advanced countries, and the finding of the study could broaden the boundaries of studies in barriers when adopting Industry 4.0. The finding and discussion might be significant and useful for market users such as management, investor, cabinet or more.

Further, this study will expand past studies that examine the impact of various variable where contribute the Industry 4.0 adoption in Malaysia company. This study also used primarily data rather than secondary data as well as Structural Equation Modelling and SmartPLS software in analysing data. This research also the first study that targeted industry Malaysia where focus on Malaysia company to test the challenges to adopt Industry 4.0. Moreover, this study also focused on the new variables that did not discussed in previous studies which are the effect of the government policies,

awareness of industry and the firm's perception on the digital technologies toward implementation of Industry 4.0.

1.8 Chapter layout

This study contributes 5 chapters where each chapter represents its own significant and purpose. In this chapter 1 highlighted research background, issues and objective has been investigated. In chapter 2 will present the related literatures by other researcher regarding the barriers to adopt Industry 4.0 in Malaysia will be inspected in order to establish theoretical framework and hypothesis. While in chapter 3 involved explanation of the process of the study such as methodology, model used and procedures. Besides, Chapter 4 shows analyses and interpretation of the data collected. Lastly, chapter 5 is the discussion of conclusive implication and limitation of study together with the recommendations for future researches.

1.9 Conclusion

Sententiously, this chapter contribute an overview of the barrier determinants towards Industry 4.0 from Malaysian. Moreover, the purpose and the objectives of this research also have been listed out in this section. The next section will present about the past studies about dependent variable and independent variables as well as theoretical review and framework approach for this research.

CHAPTER 2: LITERATURE REVIEW

2.0 Introduction

This part is to discuss the previous studies on the Industry 4.0, relationship between technology acceptances, awareness, financial resources, appropriate competence and skill, government policies to adopt Industry 4.0. It also included limitation of previous studies, proposed conceptual framework of our model as well as hypotheses of the study.

2.1 Review of Relevant Theory

2.1.1. Theory of Technology Acceptances

Technology acceptance defined by using technology acceptance model (TAM) where created by Davis (1989). Rafique, Anwer, Shamin, Minaei-Bidgoli, Qureshi, and Shamshirband (2018) mentioned that TAM can be applied for identify the elements affecting the acceptance of technology. This theory is measuring an individual attitude and behavioural on the utilize of technology (Mohammad, Leng, Lada & Amboala, 2011). TAM theory was develop based on the reasoned action of an individual behaviour (Ajzen, Icek & Martin, 1980). Donmez-Turan and Kir (2019) highlight that TAM explained user's acceptance towards information system and determine the function of actual system use. TAM was extended its definition by using two exogenous variables, which are perceived usefulness (PU) and perceived ease of use (PEOU) (Davis, Bagozzi & Warshaw, 1989). They defined perceived usefulness is the degree of an individual believed used of technology can enhance their performance, either in work or life. While the perceived ease defined a person to believe that it does not require any effort to use technology.

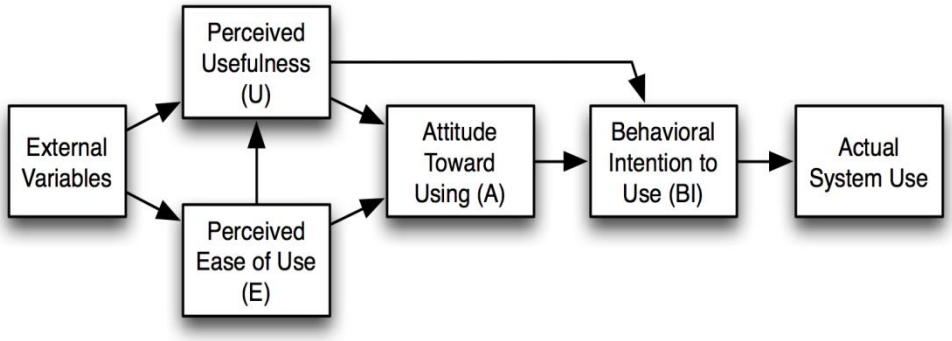


Figure 2.1: Theory Technology Acceptance Model (TAM)

Fan (2017) stated that TAM can help to improve government, business as well as citizen relationship and increase the urban service operation effectively and efficiency. TAM also allow users to understand human dimension of acceptance of technology accurately (Townsend, 2013).

However, there is several limitations on the theory which found by Momani and Jamous (2017). They said that TAM only provides feedback on the factors which are perceived usefulness (PU) and perceived ease of use (PEOU) but did not disclosed other factor that can increase technology adoption. For example, flexibility, information of currency, as well as integration. Further, TAM also did not provide any specification on how expectancies affect behaviour. In additional, TAM also cannot predict user behaviour within culture. Surendran (2012) studies was showed the relation was statistically insignificant as well as TAM was not a powerful model to determine technology acceptance. Consequently, Ajibade (2018) suggested that modified TAM model able to overcome the limitation. He stated that TAUM (modified model) able to indicate employee and firm internal factor to use new technology such as personal ambition and goal. At the same time, TAUM also involved company's culture and environment to examine the intention to use technology.

There has been much research about TAM model. TAM model is to posit the reasoned action influence by the individual attitude and social environment such as influence by friend, family members, partner or

colleagues. Both PU and PEOU are the perceived benefit on the new technology, where individual willing to accept the new technology if they understand its usefulness and ease of application. In line with Industry 4.0 adoption, new technology makes firm and employee fear to use due to the unknown benefit and risk. While TAM allow company to understand human dimension of acceptance of technology accurately. This can influence the firm and employee acceptance on Industry 4.0 advance technology. The model can also determine the reasons for not accepting Industry 4.0 adoption.

2.1.2. Theory of Awareness

Diffusion of Innovation (DOI) theory that popularized by Roger (1962) can be used to explain the concept of awareness. Diffusion of Innovation is referred to the process that will be occurred when people are adopting new idea or product. This theory remains as the popular theory that investigate the behavior or intention of the users in adopting the new technological innovation like Industry 4.0. This theory speculated that the innovation as being communicated through certain channels over the time within a particular people. This theory is not only used by the company or organization that will adopt the new technologies or innovations but also will be used by the individual who will use the new technologies and innovations (Roger, 2010). Furthermore, the innovation decision process in Diffusion of Innovation model consists of five stages which are knowledge or awareness, persuasion or interest, decision or evaluation, implementation or trial a confirmation or adoption (Kaminski, 2011).

i. Knowledge or Awareness: Exposed into the innovation but there was lack of completed information.
ii. Persuasion or Interest: Interested in the new things and looking for additional information.
iii. Decision or Evaluation: Mentally apply innovation to present and future situation and decide whether to try.
iv. Implementation or Trial: Makes full use of innovation.

v. Confirmation or Adoption: Decide whether to continue the full use of innovation.

In the first stage of the DOI model was mentioned that the knowledge and awareness is the first condition that should be considered in the investigation of the adoption of new innovation. Since Industry 4.0 is considered as the new innovation that newly proposed in Malaysia. Therefore, the awareness should be the one of the conditions that affected the implementation of Industry 4.0. Moreover, DOI theory has been used for many researchers in previous. Al-Jabri and Sohail (2012), DOI was applied as a based-line theory in that particular research for investigate the elements that will affect the adoption of the mobile banking system in Saudi Arabia. Mustonen-Ollila and Lyytinen (2003) were also applied DOI theory to identify the potential factors that influencing the IS process innovation adoption. Recently, DOI theory was also used by the researchers, Sabi, Uzoka, Langmia, and Njeh (2016) to examine the elements that affected the use of cloud computing in education sector.

However, DOI theory was also consisted of some limitations. Momani and Jamous (2017) stated that the DOI theory do not provide the information on how the acceptance and rejection of the decision was affected by the attitude and how the decision was affected by the innovation factors. Moreover, the individual's resources or social support to the adoption of the new innovation of technologies were did not concerned in the DOI theory. According to Shiau, Huang, Yang, and Juang (2018), DOI and TAM integrated model able overcome the limitation of DOI theory to examine the adoption of the innovations. They stated that DOI and TAM integrated model have strong similarities and complementariness, where provide reason of the individual intention to use technology.

2.1.3 Theory of Financial Resources

Previous researchers defined financial resource is a monetary fund use for goods and services in a specific period (Briazkalo, 2016; Yurii & Fedosov,

2008). Kyrylenko (2006) added that financial resources are accumulated from different sources in the form of money or currency is used to meet corporate needs. The common understanding is the better way to obtain fund that used to strengthen inventive activities on a firm level such as higher investment in Research and Development (R&D) (Brown, Fazzari & Petersen, 2009; Hall & Lerner, 2010), and reinforce investment in long-term research (Aghion, Angeletos & Manova, 2010). Kerr and Nanda (2015) also added that financial resources are the basic indispensable for inventive processes.

However, there are several studies applying the theory, Resource-Based View (RBV) to explain financial resources concept. Resource-Based View theory (RBV) developed by Wernerfelt (1984), where to provides a framework to measure and explain the firm resources. Financial resources are often subsumed under the categories of the firm specific resources (Greene, Brush & Brown, 1997). Barney (1991) stated that Resource-Based View (RBV) consist of financial resources (business fund, corporate capital), human resources (experience, knowledge, intelligence and skill of the individual worker), physical capital resource (firm's plant, technology, and equipment) and organizational asset (firm's planning, structure, and system) that utilized by firms. Kostopoulos, Spanos, and Prastacos (2002) classify firm resources into two divisions: 1) tangible resources, which are financial resource and physical resource; 2) intangible resource, involved employee, prestige, trademark as well as organizational procedures. They also added that RBV also enable to determines the firm's capacity to innovate. Moreover, it is also a resource where anything can be considered as a strength or weakness, either in the form of tangible or intangible asset which are semi-permanent for a company (Wright, Mcmahan & Mcwilliams, 1994).

But there are some of the limitations in the theory. According to Kostopoulos et al. (2002) stated that the RBV theory only provides the measurement of firm's resources but did not disclosed how resource and capability are created. It also did not explain how to identify the origin of the firm resource and capabilities. Further, RBV did not disclosed how

resources can obtain, develop and improve to maintain competitiveness and growth. However, this limitation can be overcome through internal analysis. This study suggest that organization audit should evaluate their performance based on industry average and strategic group average benchmark. This analysis should track the company performance at least 3 to 5 years in order to accurately assess company performance. Such evaluation helps to locate company performance, resources, capability within these years (Nijssen & Frambach, 2001).

Refer to the RBV theory defined by several research, RBV theory help firm to understand their current resources and utilize these strategic resources to create competitive advantage. This included create innovation, adopt advanced technology as well as invest in R&D. In line with the revolution of Industry 4.0, where require higher investment in technology, R&D and expertise to adopt successfully. As a result, RBV theory able to let firm to understand their current resources and capacity to innovate. Understanding their current status and developing strategies will increase the likelihood of success in adopting Industry 4.0.

2.1.4 Theory of Appropriate Competence and Skills

Human capital theory (HCT) provides a theoretical basis for a better understanding of the role of individual in promoting innovation and adoption of technology. This theory is also about the role of human capital in the production process for investment in skills and knowledge including in the form of schools or trainings. Besides, it also refers to the personal knowledge, skill and experience that can be used to cultivate innovative and technology activities (Danquah & Amankwah-Amoah, 2017). According to the Zhao (2008), HCT provides a useful theoretical support for the companies in order to help the companies to set up a series of effective human capital investment and promote corporate development or even economic growth which under reform conditions.

According to the Danquah and Amankwah-Amoah (2017), the quality of human capital in the wider society will promote innovation and new technologies adoption. Besides, the human capital is significantly positive affected on the adoption of technology. According to Agolla (2018), HCT has a significant relationship with the Industry 4.0 adoption because HCT also considers that knowledge will brings more cognitive skill to individuals through improving their skill and efficiency potential for carrying out activities. Hence, the generated of HCT able to meet the needs for intelligent manufacturing competitiveness in the Industry 4.0. According to the Ahmad, Shamsuddin, and Aslinda (2018) stated that today's workers do not necessarily lack of skill, but the new era like the Smart Manufacturing may requires skills that they do not have. Therefore, HCT include knowledge and skills that can be utilize to generate value to ensure the success of the organization.

However, the limitation of HCT is that the higher education and skills developed by the individuals will lead to higher level of income (Marginson, 2017). Besides, the government will have to provide research incentives to the qualification training centre and other higher education institutions while focusing on the human capital qualification in the Industry 4.0. Therefore, this will lead to higher cost for organization and government in providing training and education to the individuals (Silva, Kovaleski & Pagani, 2019). However, higher education institutions such as universities can propose new professional courses directed for vocational training. Due to the development of new discipline in education institutions and the adjustment of the curriculum are required by Industry 4.0 (Sackey & Bester, 2016). Therefore, researchers, professionals from teaching or students should unite and reconsider the necessary criteria for human capital for the purpose of reducing financial burden of organization and government in providing the training to the individuals.

2.2 Empirical Review

2.2.1 Relationship between Technology Acceptances with Fourth Industrial Revolution.

The investigation in the relationship between technology acceptance and Industry 4.0 has done by several studies to examine whether technology acceptance become an obstacle in the Industry 4.0 adoption. Horvath and Szabo (2019) shows that organizational resistance was significantly affected the Industry 4.0 adoption in medium sized firms. It is strong barrier to the change in introduction of new technologies. The studies also stated that the organizational resistance was due to the employees afraid of losing jobs, lower understanding about new technologies as well as the fear to the unknown experience. Besides, Orzes, Rauch, Bednar, and Poklemba (2018) also done a research about the Industry 4.0 implementation barriers in Italy, Austria and Thailand. The result shows that the adoption of the Industry 4.0 is affected by acceptance of labor due to the reason of their fear to lose the jobs opportunity and the uncertainty on the beneficial of Industry 4.0 in majority of the SMEs. Apart from that, finding of Muller, Kiel, and Voigt (2017) were also showed that the employees' qualification and acceptance have significant effect to the implementation of Industry 4.0.

However, according to the studies done by Massod and Egger (2019), the study was aimed how the user acceptance can affect and became a barrier in implementation Industry 4.0. The data which obtained in that study was came from 365 individuals through survey section. Moreover, the main methodology that used to test the hypothesis in the study were PLS-SEM Analysis. The result shows that that there was an insignificant in the relationship in the user acceptance and Industry 4.0 adoption. The result showed difference with other previous studies is due to the reason of researchers did not utilized the acceptance model on user level into the study to examine the hypothesis of technology acceptance.

Furthermore, Stentoft, Jenson, Philipsen, and Haug (2019) conducted questionnaire survey to the many companies to study the obstacles for Industry 4.0 readiness. From those companies, about 190 of them were

provided a full and useful answer for them to conducted the Unstandardized Regression Coefficient Model and Bootstrapping test to analysis the obstacles for Industry 4.0. The result of Bootstrapping test was showed that the lack of employees' readiness could neither affect the Industry 4.0 readiness nor the Industry 4.0 adoption.

From previous research, some concluded that the technology acceptance affected on the Industry 4.0 adoption and vice versa. Based on the theory that used to support in this research was stated technology acceptance has significantly affected the Industry 4.0 adoption. Hence, this research will adopt this variable for further investigation. This study will examine whether this variable is positively affected the adoption of Industry 4.0 in Malaysia by fully utilize acceptance model on user level to examine the hypothesis of technology acceptance and using SMART-PLS model in analyzing data.

2.2.2 Relationship between Awareness with Fourth Industrial Revolution.

There were many researchers were done many investigations and studies to investigate actual relationship between the awareness and the Industry 4.0 implementation. According to Saeed, Juell-Skielse, and Uppstrom (2012), the low awareness of people on the Cloud EPR was the obstacle to the adoption of it. There were many companies are do not know of the presence of the Cloud ERP. It is hard to convince them to adopt the new technologies that they do not have deep knowledge. Therefore, the lower the awareness will lead to decrease the firm's technological readiness to adopt the Cloud EPR.

According to Senarathna, Wilkin, Warren, Yeoh, and Salzman (2018), the studies was targeted to determine the elements that influence the cloud computing adoption in Australian SMEs. It stated awareness of cloud computing were referred to the knowledge and understanding the cloud computing and technologies' concept and opportunities that will brought by

it. The result of the study was concluded that the awareness of cloud computing has strong significantly positive relationship with cloud computing adoption. Besides, there was another study from Sabi, Uzoka, Langmia, and Njeh (2016) was showed that the awareness is significantly related with the willingness to adopt the Cloud computing since the awareness about new technologies are the initial stage in the process of technologies adoption which can influence the perception of users and the intention of adoption.

Moreover, there was a finding stated that lack of the understanding of the new technologies is the essential problem that existing upon the new technologies implementation due to there have lack of the awareness on the new technologies about benefit of it. Therefore, it will lead the adoption the Industry 4.0 to failure if the enterprises were lack of awareness of it (Ali, Soar & Yong, 2016). This finding was also supported by the result in the study from Carcary et al., (2014). The result of the study also showed that the lack of awareness on the new technologies were one of the issues that affected the new technologies adoption. Similarity, Dominic, Seungmin, and David (2019) stated that companies, there have the problem of absence of the awareness or have only little awareness about the changes in the business environment regarding Industry 4.0 especially in the small and medium enterprises (SMEs). The studies also added that major of the SMEs underestimate Industry 4.0 potential to disrupt their production technology and business operation model. Based on the information that obtained on above, lack of awareness of the SMEs is significantly impact on the Industry 4.0 adoption. This is because SMEs have lower understanding on benefit of Industry 4.0 adoption. By referring previous studies, lack of awareness will affect Industry 4.0 adoption. Thus, it is an obstacle that hinder the implementation of Industry 4.0. Hence, the lack of awareness will be used and further discuss in this study to investigate the Industry 4.0 implementation in Malaysia.

2.2.3 Relationship between Financial Resources with Fourth Industrial Revolution.

There are several studies has been done by the past researcher regarding the relationship between the financial resources and Industry 4.0. The adoption of Industry 4.0 in the small and medium sized enterprises is negatively affect by the lack of financial resources. The implementation projects of it in SMEs is still a cost driven plan because large amount of funding and investment needed to be raised to drive the digitalization process (Agostini & Nosella, 2019; Balasingham, 2016; Carcary et al., 2014; Prause, 2019; Turkes et al., 2019).

Besides, Horvath and Szabo (2019) has highlighted that the insufficient of financial resources also has a negative effect towards the small and medium enterprise in the projects of development. However, the past researchers, Mishina, Pollock, and Porac (2004) had discussed that the scarcity of resources might become a disadvantage and the reason of leading the organization have poor performance. The small and medium enterprise that are operating their production activities can use the advantages of their operational capabilities to compete with the large multinational companies. Yet, the major disadvantages for the company to implement Industry 4.0 is lack of financial resources because this will limit their development opportunities.

Insufficient financial resources are a big problem to some smaller companies because implementation of Industry 4.0 need a large amount of investment. This will show that the shortage of financial resources will have a negative effect towards the smaller company that want to adopt the Industry 4.0. Smaller companies may encounter some problems on the implementation of the advanced manufacturing technologies that will result in the lower level of costly technologies adoption. For instance, implementation of statistical process control and just-in-time manufacturing are the problem faced by the company if the company has insufficient financial resources (Kennedy & Hyland, 2003).

According to Pereshybkina, Castillo Conde, and Kalyesubula (2017), they had mentioned that the financial resources is one of the main sources used

to successfully adopt digital transformation. If a company want to adopt Industry 4.0 but they faced shortage of financial resources, this will cause the company have a negative effect towards the adoption of digital transformation. Adopting Industry 4.0 technologies required large amount of investment to cover the product facilities, hardware and software installation as well as developing the infrastructure of information technology.

Overall, all the researchers had mentioned that a large amount of financial resources will have a negative effect the company in order for them to adopt the Industry 4.0 since it is expensive. It is still an infancy and costly to most of the SMEs. SMEs not only need a large amount of fund to invest in advanced manufacturing technologies, they also need to prepare some funds for them to do the maintenance just in case the technology broken. They also need funds to create training programs for their employees to increase their expertise in Industry 4.0.

2.2.4 Relationship between Appropriate Competence and skill with Fourth Industrial Revolution.

According to the previous researchers, lack of competence and skilled workers is one of the significance elements which influence the development of Industry 4.0. Besides, it is important to have a qualified workforce for the Industry 4.0 adoption due to the reason of the skills are essential to develop better education and new technologies. However, the high demand for the competence and skilled workers and lack of expertise is one of the obstacles to achieving Industry 4.0 (Huang, Chicoma & Huang, 2019). According to Wijayanti and Turgel (2019) has found that the current condition of the Indonesian labor market is not sufficient for the implementation of Industry 4.0 since there was low level in both education and digital knowledge in the majority of workers in Indonesia. Therefore, the needs of the highly skilled and educated workers was increased since the arrival of the digital era in order to solve complex issues and problems in the short time in the labor market. Moreover, the implementation of Industry 4.0 provides many benefits for the small and medium enterprise, but they are facing some obstacles such as insufficient digital skills in the labor

market, and the number of cyber-attacks which may endanger the commercial secrets are still increasing. Even though national initiatives promote the development of enterprises towards new business model and technologies, but the technologies' development which is like big data management, smart devices as well as skills are major difficulties of the industrial sector (Ristuccia, 2019).

According to the Klingenberg and Antunes (2017) mentioned that the skills is significantly related with Industry 4.0, since there was the shortage of skilled and high software costs, the spread of the technology's development was slower than expected. According to the Luff (2017), SMEs are often constrained by many issues when having implementation on Industry 4.0, such as shortage of skilled workers and technical knowledge. However, they do not pay enough attention to improve the skills and knowledge of their workforce or unwilling to take advantage in the government-sponsored training opportunities for programmers. According to the Tortorella and Fettermann (2018) have found that several government institutions was begun to investigate and study the Industry 4.0 technologies adoption in their nations, which included United States, Germany and Canada. Therefore, insufficient competence and skills was concluded and considered as the big obstacle among the factors that externally affecting the implementation of Industry 4.0.

According to the Ismail, Kadir, Khan, Yih, and Al Hosaini (2019) also stated that SMEs must make sure the labor organization are having the appropriate skills as well as the capabilities to promote the economic transformation of the countries in line with the Industry 4.0. Therefore, there have no choice of the SMEs to adopt creative production by adding more Industry 4.0 elements in their operations. Besides, a lack of skilled workers is preventing manufacturers from taking advantages on these technology trends, and some of them are unable to expand their production due to lack of appropriate skills. Therefore, the adverse labor market conditions and evolving of skill requirements become the challenge in adopting Industry 4.0 by manufacturers (Krachtt, 2019).

Above studies has indicate that insufficient competence and skills can be a significance variable that impact on Industry 4.0 in Malaysia. Besides, it also identified that insufficient skill and low education or technology knowledge will affect the companies on expand their development on the technologies or production. However, this research will discuss further whether insufficient competence and skill is positive impact on Industrial 4.0 in Malaysia.

2.2.5 Relationship between government policies with Fourth Industrial Revolution.

Mwai (2019) defined government policies is the rule that purposely develop to have better guides decision, to ensure have positive outcomes either in community or unit. Industry policy are one of the government policies where to enhance business environment, or transform the structure of sectors, as well as technology in order to assist economy growth (Pack & Saggi, 2006; Reich, 1992).

Some studies emphasize the importance of government policies for successful Industry 4.0 adoption. Cao, Chen, Zhang, Gao, Zhang, and Kumar (2019) studies shows significant relationship between government policies with Industry 4.0. They concluded that government developed a series of fair and complicated rules and regulations which significant helping and promoting industry revolution. Novak (2019) concluded government policies is the crucial factor that affect adoption of Industry 4.0. She highlighted that digital policy such as blockchain policy will create varied interests among industries to involved in transformation. Darcy, Chris, Brendan, Mikayla, and Jason (2019) mentioned government policies is positively affecting the Industry 4.0 development. They added government policies enable the process of industry revolution to take place where create the awareness among enterprises. Furthermore, Porter and Linde (1995) studies also shows positive effect of regulation toward industry revolution. They explained it in such ways: 1) government policy is the signal to the companies about new technology improvements, 2)

policy development regarding digital technologies as well revolution able to raise corporate awareness, 3) government policy creates pressure that enhance innovation and progress. 4) government policy levels the transitional playing field.

However, some of the research suspect the positive relationship between government policies with Industry 4.0. According to Australian Government-Productivity Commission (2016), government policies is a risk for industry to adopt Industry 4.0. Laws or regulations developed by government restricted the expansion of companies' business. Government policies banned the use of robotic in business operation to prevent higher unemployment rate limit the adoption of Industry 4.0. Besides, the political climate in term of rule and regulation is significantly hinder the growth of Industry 4.0, either in business culture or social culture (Aljifri, Pons & Collins, 2003).

There is no doubt that government policies is significantly affecting the adoption of Industry 4.0. Refer to previous studies, government policies may able to create some effect on Industry 4.0 adoption such as increase industries awareness, provides incentives, programme and infrastructure. However, it cannot ensure that this effect whether will positively or negatively affect the adoption of Industry 4.0. Some studies have also determined that government policies will become a barrier for the Industry 4.0 adoption. Thus, government policies will affect on Industry 4.0 adoption, either in negative or positive way. A good policies framework will ably create the positive outcome and vice versa.

2.3 Research Gap

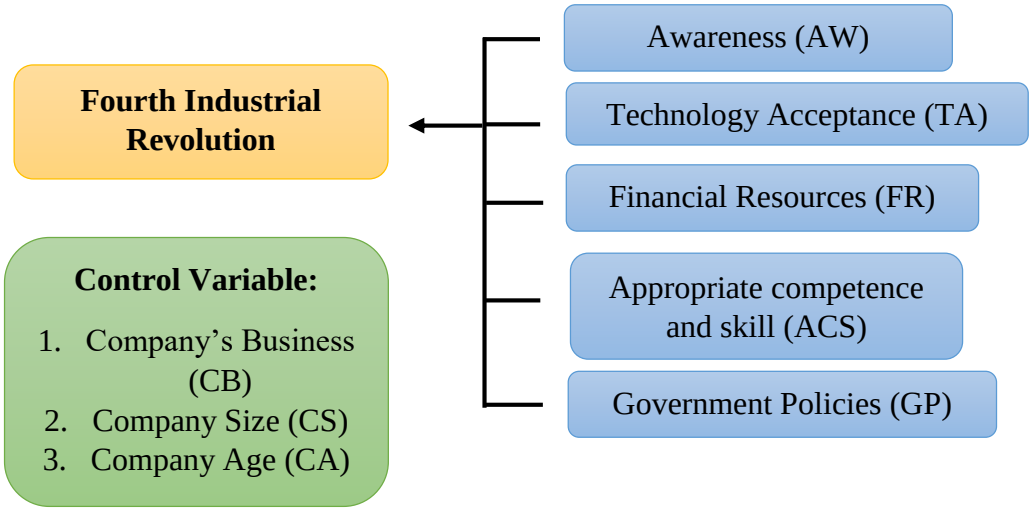
Refer on the previous studies, major of the barrier of Industry 4.0 adoption have been carried out such as lack of skilled labor, conflicts between labor due to changes in the working environment (Muller & Voigt, 2017; Kiel, Arnold & Voigt, 2017), lack of financial resources (Kiel et al., 2017; Koch, Kuge, Geissbauer & Schrauf, 2014), data security (Breuning, Kelly, Mathis

& Wee, 2016; Kiel et al., 2017), lower standardization and lack of integrated understanding (Muller & Voigt, 2017), lower degree of education system (Karadayi, 2019) and lack of vision (Saatcioglu, Ozispa & Kok, 2019) as well. However, some of the specificate barrier have not yet carry out in this several years such as awareness of industry, government role in correlation with laws and regulation, and acceptance of technology (perception) as well.

Further, there are also relatively less studies carried out regarding barrier of Industry 4.0 in developing nation such as Malaysia. Some studies only highlight some major barrier such as cost of Industry 4.0 adoption (Turkes et al., 2019), lack of strategic understanding and poor level of managers' perception (Horvath & Szabo, 2019). They did not analyse what manner of government policies influence the development of Industry 4.0 and the firm perception on digital technologies as well as industry transformation. Hence, this research studies on the specific factor preventing adoption of Industry 4.0 as well as their relationship in correlation with Malaysia Industry 4.0.

2.4 Research Framework

Figure 2.2: Theoretical Framework



2.4.1 Technologies Acceptance

According to the previous studies, technologies acceptance was found to significant affect on Industrial revolution adoption (Sardround, 2012; Smith, 2014; Hegemmann, 2015; Lin, Tsai, Gatti, Je-Chian, Lee & Shih, 2014). There are also numerous of models and frameworks have been created to illustrate user perception on digital technologies adoption such as TAM (Davis, 1986, 1989; Bagozzi & Warshaw, 1989; Mohammad, Leng, Lada & Amboala, 2011; Donmez-Turan & Kir, 2019), Planned Behaviour Theory (Ajzen, 1985), DOI Theory (Rogers, 2003), Reasoned Action Theory (Fishbein & Ajzen, 1975), PC Utilization Model (Thompson, Higgins & Howell, 1991), Model of Motivational (Davis, Bagozzi & Warshaw, 1992), UTAUT (Venkatesh, Morris, Davis & Davis, 2003), Theory of Social Cognitive (Bandura, 1986). Putting all these theoretical models together which reflect that technology acceptances can significantly affected the Industry 4.0 adoption.

2.4.2 Awareness

Lall, Torvatn, and Seim (2017) highlighted that failure of Industry 4.0 adoption is mainly caused by the low awareness among operators. Similarly studies also indicated lack of awareness lead to failure of Industry 4.0 adoption (Saeed et al., 2012; Senarathna et al., 2018; Sabi, Uzoka, Langmia & Njeh, 2016; Dominic, Seungmin & David, 2019). Besides, an empirical evidence shown that poor degree of awareness on advanced technologies and lack of experienced on it will increase the barrier of Industry 4.0 adoption (Stentoft, Jenson, Philipsen & Haug, 2019). Some of the studies focus on manufacturing sector, stated that unawareness among practitioners towards sustainable supply chain management (SSCM) challenges proves to be a troublesome to SSCM implementation (Batista, Bourlakis, Smart & Maull, 2018; Sajjad, Eweje & Tappin, 2015).

2.4.3 Financial Resources

Further, a number of sources concluded that lack of financial sources also a significant challenge for implementation of Industry 4.0 (Erol, Jager, Hold, Ott & Sihn, 2016; Kiel et al., 2017; Muller & Voigt, 2017). Adoption of Industry 4.0 required firm to increase their yearly investment by 50% to achieve the goals of Industry 4.0 successfully (Koch, Kuge, Geissbauer & Schrauf, 2014). Kache and Seuring (2017) also added that implementing Industry 4.0 require higher investment in workforce, processes and technology at both, corporate and supply chain level. Large amount of funding and investment causes companies' inability to adopt Industry 4.0 (Dalenogare, Benitez, Ayala & Frank, 2018). Shortage of financial resources remain the key of barrier to develop Industry 4.0.

2.4.4 Appropriate Competence and Skill

Besides, Major of the previous studies agreed that lack of appropriate competence and skill also significantly affecting adoption of Industry 4.0 (Adolph, Tisch & Metternich, 2014; Erol, Jager, Hold, Ott & Sihn, 2016; Shamim, Cang, Yu & Li, 2016; Karre, Hammer, Kleindienst & Ramsauer, 2017; Muller & Voigt, 2017; Kiel et al., 2017). Higher skilled workforce is required to fulfill the changed circumstances where it brings negative or positive impact on employees. Higher labor skills requirements remain the main key to successfully adopting the Industry 4.0 (Hung, 2016). In addition, firms are necessary to have appropriate expertise and skill to develop Industry 4.0 in their business operation (Breuning, Kelly, Mathis & Wee, 2016). They further mentioned that lack of appropriate competence and skill will paralyzes firm's ability to cooperate with their digital supplier when their employees lack of skill to use what they are buying. Lower degree of skilled labor remains the significant barrier of Industry 4.0 (Koch, Kuge, Geissbauer, & Schrauf, 2014).

2.4.5 Government Policies

Subsequently, major of the studies also found that government policies are significantly influencing development of Industry 4.0 (Cao, Chen, Zhang, Gao, Zhang & Kumar, 2019; Novak, 2019; Darcy, Chris, Brendan, Mikayla & Jason, 2019; Porter & Linde, 1995). Turkes et al., (2019) studies shows the attitude of small and medium enterprises (SMEs) were positive towards regulation requirement but it's negative to client requirement. Changed legislation to promote Industry 4.0 increase the number of companies to take part in Industry 4.0. One of the surveys analysed by Kroll et al. (2016), studies show government policies significantly affecting Industry 4.0 adoption, where providing subsidies for training offers for labor to proficient with digital

technologies. Dominic, Seungmin, and David (2019) mentioned regulations such as "Smart Industrial Policies" created digital vision and digital strategy enable to drive different types of industries towards Industry 4.0.

2.4.6 Control variable

2.4.6.1 Relationship between Company's Business and Fourth Industrial Revolution

Company's business is the form of business entity that utilize economic resources to produce different types of goods and services to customer. Refer to Hong and Zhu (2006), empirical studies shown company's business significantly affecting Industry 4.0. They added that service industry is more willing to utilize Industry 4.0 compare to manufacture and wholesale. Meanwhile, Tortorella and Fettermann (2017) also highlighted that business type is significant affect Industry 4.0 adoption. Empirical studies shown that major of manufacturing companies adopted Industry 4.0 are from technology sector.

2.4.6.2 Relationship between Company Size and Fourth Industrial Revolution

Dzikowski and Tomaszewski (2014) stated that company size is significantly influence the company to take innovation activities. He indicates that larger company are more active in taking innovative compare to small and medium-sized company. Schroder (2016) found that company size is affecting Industry 4.0 adoption. Small or medium size company often face more challenges in adopting Industry 4.0 such as shortage of financial resources, insufficient capacity to analyse Industry 4.0 based solution as well as insufficient Information and Communication technology (ICT) experts. Caramela (2018) was then added that small and medium-sized

company incapable to implement new technology due to the fear of being dependent and insufficient resources to adopt new tech.

However, Winter (1984) found a negative relationship between company size and innovation. He stated that different size of company is promoted under different condition such as economic and technological conditions. Empirical studies show that small and medium firms have inherent advantages in the high-tech industry. Meanwhile, Hong and Zhu (2006) also highlighted that larger company were decelerate by their business structure inertia.

2.4.6.3 Relationship between Company Age and Fourth Industrial Revolution

The length of time of a business are one of the internal factors affect company decision making (Dholakia & Kshetri, 2004). However, there is insufficient research and development that examine the actual effect on Industry 4.0 adoption which brought by company age. Dholakia and Kshetri (2004) empirical study shown that age of company is significant effect on the level of innovation activities. Researchers added that oldest company usually slow to adopt high technology compare to middle-aged company as well as young company. Hollenstein and Worter (2004) stated that employee's tenure supposed to be control by the firm age, since the employee age will be getting order with the company they work in. Schleife (2006) highlighted that older worker is less likely to used newly technology while young worker prefers to used advanced technology.

2.5 Hypotheses Development

Table 2.1: Hypothesis Development

Dependent Variable		Independent variable
Fourth Industrial Revolution	H_1: Technology Acceptance has positive impact on Fourth Industrial Revolution.	Technology Acceptance
	H_2: Awareness has positive impact on Fourth Industrial Revolution.	Awareness
	H_3: Financial Resources has positive impact on Fourth Industrial Revolution.	Financial Resources
	H_4: Appropriate Competence and Skill has positive impact on Fourth Industrial Revolution.	Appropriate Competence and Skill
	H_5: Government Policies has positive impact on Fourth Industrial Revolution.	Government Policies
	H_6: Company's business has positive impact on Fourth Industrial Revolution.	Company's Business
	$H_{7:}$ Company size has positive impact on Fourth Industrial Revolution.	Company Size
	$H_{8:}$ Company age has positive impact on Fourth Industrial Revolution.	Company Age

H_1: Technology Acceptance has positive impact on Fourth Industrial Revolution

A positive perception of digital technologies will increase willingness to adopt it and vice versa. Cragg and King (1993) said that perceived outside support such as consultation increase the acceptance of technology among enterprise, and significant motivate for innovation and technology adoption. Further, Yap, Soh, and Raman (1992) also added that increase technology acceptance by providing consultation and vendor support positively influence the successful adoption of digital technologies. Chau and Tam (2000) mentioned that negative perception on Industry 4.0 adoption significantly affecting the successfulness in development of Industry 4.0. Besides, positive perception on Industry 4.0 among top management enhance the progress towards Industry 4.0 (Sila, 2003). Hence, this study proposes a hypothesis "Technology acceptance has positive impact on Industry 4.0 adoption".

H_2: Awareness has positive impact on Fourth Industrial Revolution

Major of the industries are having low awareness towards the changes of business environment, especially Industry 4.0 (Senarathna et al., 2018; Sabi, Uzoka, Langmia & Njeh, 2016; Ali, Soar & Yong, 2016; Carcary et al., 2014). Poor awareness about the gains which caused by lack of knowledge significant affect Industry 4.0 (Luthra & Mangla, 2018). According to Kaczorowska-Spychalska (2018), the degree of awareness among firms towards the notion of Industry 4.0 such as the role and benefits of Internet of Thing (IoT) and Artificial intelligence (AI) will affect their interest to adopt revolution. Besides, the lower degree of situation awareness among firms is one of the barriers to develop Industry 4.0 (Lall, Torvatn & Seim, 2017). Based on these relationships, this study proposes a hypothesis "Awareness has positive impact on Fourth Industrial Revolution".

H_3: Financial Resources has positive impact on Fourth Industrial Revolution

Investment in Research and Development (R&D) for each year that required when adopting Indudtry 4.0 is increased in order to achieve Industry 4.0 goals successfully (Koch, Kuge, Geissbauer & Schrauf, 2014). Lack of financial support for innovation and higher capital investment requires to develop Industry 4.0 hinders the firms to adopt revolution (Kulkarni, Bhattacharjee & Narwane, 2020). The higher initial investment to adopt Industry 4.0 becomes a drawback that firms refuse to adopt revolution (Walker, Sisto & Mcbain, 2008; Sivestre, Monteiro, Luiz & Viana, 2018). Further, higher disposal cost also limits the manufacturing sector to adopt sustainability in their business operation (Mollenkopf, Stolze, Tate & Ueltschy, 2010; Jia, Zuluaga-Cardona, Bailey & Rueda, 2018). Therefore, this study proposes a hypothesis "Financial resource has positive impact on Fourth Industrial Revolution".

H_4: Appropriate Competence and Skill has positive impact on Fourth Industrial Revolution

Skilled workers, persons with qualified technical skills are needed in Industry 4.0 adoption. All findings from previous studies agree that low-qualified labors will eliminate along with the development of Industry 4.0 (Erol, Jager, Hold, Ott & Sihn, 2016; Shamim, Cang, Yu & Li, 2016; Karre, Hammer, Kleindienst & Ramsauer, 2017). Based on Spottl (2017), he summarised his result into three parts: 1) companies without Industry 4.0 did not require skilled labor as their production did not changed; 2) companies with a beginning stage of Industry 4.0 require a few number of skilled labor, where a slight increase in qualified skilled workers; 3) companies with higher degree level of Industry 4.0 require higher number of qualified skilled labors, where increase 20 percent to 30 percent in their companies. Hence, this study proposes a hypothesis "Appropriate competence and skill has positive impact on Fourth Industrial Revolution".

H_5: Government Policies has positive impact on Fourth Industrial Revolution.

Government create the awareness among enterprises through rule, regulations or policies where enable the process of industry revolution to take place (Allen, Berg, Markey-Towler, Novak & Potts, 2020). Government developed a series of fair and complicated rules and regulations which significant helping and promoting industry revolution. Lack of standard legislation by government reducing the progress of Industry 4.0 adoption (Kulkarni et al., 2020; Geissbauer, Vedso & Schrauf, 2016; Huang, Li, Yin & Zhao, 2013; Kagermann, Wahlster & Helbig, 2013; Trappey, Govindarajan, Chung & Sun, 2017). Thus, this study proposes a hypothesis "Government policies has positive impact on Fourth Industrial Revolution".

H_6: Company's business has positive impact on Fourth Industrial Revolution.

Company's business refers to the type of business performed by a group of people that constitutes a legal entity. There are many companies play roles in different field such as agriculture, mining, manufacturer, banking or services. According to Hong and Zhu (2006), the company's willingness to implement Industry 4.0 is affected by the business nature of the company. Companies from manufacturing sector will be more inclined to adopt Industry 4.0 due to the potential benefits (Tortorella & Fettermann, 2017). Hence, this study proposes a hypothesis "Company's business has positive impact on Fourth Industrial Revolution".

H_7: Company size has positive impact on Fourth Industrial Revolution.

Company size refer to the degree of a company's environment which is suitable to use or take advantage of a variety of innovation (Gantz, 1990; Iacovou, Benbasat & Dexter, 1995; Saarinen & Vepsalainen, 1994). Different size of company has to manage their systems differently. Company size are one of the factors affecting company ERP, or known as

Enterprise Resource Planning. Larger company usually have advantage in resource allocation to take innovation than smaller company (Dzikowski & Tomaszewski, 2014; Schroder, 2016). According to Caramela (2018), small and medium-sized company are side away from Industry 4.0 adoption due to the shortage of financial resources as well as lack of expect in high-tech. The higher cost of high-tech adoption and a slow return on investment lead them reluctant to enter Industry 4.0. However, larger company are active in innovation and inherent advantage in financial resource which make them capable to enter Industry 4.0. Hence, this study proposes a hypothesis "Company size has positive impact on Fourth Industrial Revolution".

H_8: Company age has positive impact on Fourth Industrial Revolution.

Company age describe to a period of time of a business in a community. According to Dholakia and Kshetri (2004), decision performance will influence by age when in a complex decision situation. They emphasize that oldest company is more difficult to revolutionize that the middle-aged or youngest company. This is because larger company were decelerated by their business structure inertia. While, youngest company have more intention to adopt Industry 4.0 compare to oldest company (Won & Park, 2020). They pointed out that company age will only influence adoption decision however will not affect on implementation. Hence, this study proposes a hypothesis "Company age has positive impact on Fourth Industrial Revolution".

2.6 Conclusion

In short, chapter 2 contains an overall of past studies that examine the barrier to adopt Industry 4.0. The findings contribute a certain level of correlation between Fourth Industrial Revolution and independent variables such as technology acceptance, awareness, financial resource, appropriate competence and skill, and government policies. Further, this chapter also developed research framework and hypothesis to let readers to understand clearly about the centre of this research. The next chapter will introduce methodologies as well as empirical model to examine the hypotheses.

CHAPTER 3: METHODOLOGY

3.0 Introduction

This chapter discuss about the methodology where consists of research design, sampling design, research instrument, variable measurement, construct measurement, data processing, as well as data analysis.

3.1 Research Design

Research design describes the research strategy to integrates different elements in a logical manner to address the research problem. A huge number of respondents took part in this research leads to quantitative research method. Further, sampling location also one of the reasons to implement quantitative research method. Quantitative research is well at providing information from a larger sample. It also very suitable for testing hypotheses and theories (Sukamolson, 2007). Quantitative research is also used to control the structure of study, and the data produced can be evaluated by using standardized tests. Besides, this method is required to randomly selecting samples from the population and randomly allocating sample to different study group (Carr, 1994).

3.2 Data Collection Method

Data collection play a major role in statistical analysis. It is used by gathering the information to address key evaluation issues that has been identified by the past researchers in the evaluation process. Our research is using quantitative data collection method such as questionnaire to collect data. Data can be divided as primary and secondary data and our research is focus on the primary data. Questionnaire that distributed to targeted respondent through online survey platform such as “Google Form”. There are 500 set of questionnaires spread to targeted player regardless of races and state in Malaysia.

3.2.1 Primary data

The purpose of this study is aims to determine the barriers and challenges of Industry 4.0 adoption in Malaysia, so that, primarily data is the preference method. Primary data is the first hand data that is collected through several methods such as interviews, surveys, questionnaires or observations by the researchers (Parveen & Showkat, 2017). The data obtained is associated with the variables that used in this research and fully utilized for further research. In this research, the data obtained is collected through using the self-administered survey questionnaire.

3.3 Sampling Design

3.3.1 Target Population

The management level, who are aged between 24 to 65 years old from every business sector in Malaysia was targeted in this study. According to the Labour Force Department Malaysia, the number of employed in fourth quarter of 2019 were 15.77 million while 5% were from management level. Hence, 0.79 million of the management levels in Malaysia were the targeted population for this study.

3.3.2 Sampling Frame and Sampling Location

The sampling frame is a list of all individual that has been the targeted population in this study. The sampling frame that being targeted in this study were those who working in management level from any business sector regardless of the races and the sampling location were in every state in Malaysia.

3.3.3 Sampling Elements

The questionnaire has been distributed to all the respondents through online for this research. Thus, the online survey has been conducted. The

respondents were only focused to the management level in the organization. Moreover, the respondents were targeted regardless of any business sector, business size as well as business age.

3.3.4 Sampling Technique

The sampling techniques has been adopted in this research are 'snowball sampling technique' and 'convenience sampling technique'. 'Snowball sampling' is also defined as a reputational sampling or network sampling or chain sampling which is a selection design process that usually done by using networks (Etikan & Bala, 2017). The selection of the research sample will be useful for communication, human decision-making or diffusion of knowledge.

'Convenience sampling' can be defined as volunteer sampling or haphazard sampling or accidental sampling which is a sampling method that used to select respondents that are often readily and easily available (Taherdoost, 2016). Sometimes, the convenience sample is also called as 'accidental sample' because the components can be selected in the sample simply as they are just happened to be located spatially or administratively that is located exactly where researchers collect data.

Both of the techniques are usually used by the researcher because it is cheaper and is easier to choose compare to other sampling techniques. The questionnaire will be distributed via online which is the Google Form as it is very convenient to gather all the data from all respondents.

3.3.5 Sample Size

Sample size is the number of observations in the total number of samples in the research. Besides, sample is only part of the targeted population (Etikan, Musa & Alkassim, 2016). Table 3.1 was created by Krejcie and Morgan (1970) show the determining sample size from a given population which is used to identify the sample size for this research. According to the Table 3.1, the minimum total number of sample size used in this research should be at least 384 respondents, but the targeted respondent for this survey is 385 respondents.

Table 3.1: Table for Determining Sample Size from a given Population

N	S	N	S	N	S	N	S	N	S
10	10	100	80	280	162	800	260	2800	338
15	14	110	86	290	165	850	265	3000	341
20	19	120	92	300	169	900	269	3500	346
25	24	130	97	320	175	950	274	4000	351
30	28	140	103	340	181	1000	278	4500	354
35	32	150	108	360	186	1100	285	5000	357
40	36	160	113	380	191	1200	291	6000	361
45	40	170	118	400	196	1300	297	7000	364
50	44	180	123	420	201	1400	302	8000	367
55	48	190	127	440	205	1500	306	9000	368
60	52	200	132	460	210	1600	310	10000	370
65	56	210	136	480	214	1700	313	15000	375
70	59	220	140	500	217	1800	317	20000	377
75	63	230	144	550	226	1900	320	30000	379
80	66	240	148	600	234	2000	322	40000	380
85	70	250	152	650	242	2200	327	50000	381
90	73	260	155	700	248	2400	331	75000	382
95	76	270	159	750	254	2600	335	1000000	384

Notes: population size (N) and sample size (S)

3.4 Research Instrument

Questionnaire through online has been conducted in the study due the convenient of this method. Collect the data and information from all the targeted population through online are easier to reach to them compared to conduct a questionnaire physically. The time and the cost to conduct the questionnaire were also relatively reduce by the used of the online method.

3.4.1 Questionnaire Design

The questionnaire for this research were consisted of 42 questions and those 42 questions were coming from the all 7 sections which are Section A to Section G. In Section A of the questionnaire was discuss about the demographic of the respondents such as gender, education level, age, types of business, company size, as well as company age. Then, Section B were designed to discuss about the dependent variable which is the adoption of the Industry 4.0 in Malaysia. After that, Section C to Section G were focus on the questions that based on the factors that influencing the adoption of Industry 4.0 in Malaysia which related to the independent variable in this study respectively, which included the technology acceptance, awareness, financial resource, appropriate competence and skills and the government policies. The purpose was to investigating the significance or insignificance relationship between those independent variables and the adoption of Industry 4.0 in Malaysia.

3.4.2 Pilot Test

Pilot study or 'small study' is one of the important stages in a research project to test the research protocols, data collection tools, sample collection strategies, and other research techniques in preparation for a larger scale research. It aimed to identify potential problem areas and deficiencies in the research tools and solutions before conducting a comprehensive study. It can also help members of the research team become familiar with the

procedures in the protocol and help them make decisions between two competitive research methods, such as using interviews instead of self-managed questionnaires (Schattner & Mazza, 2016). Pilot study is usually focus on the projects or developments that are carried out before a wider range of projects or developments. In other words, pilot study is very helpful for decision making and can therefore serve as "a small-scale experiment or series of observations to decide how and whether to launch a comprehensive project" (Fraser et.al., 2018).

There are 30 sets of questionnaires will be distributed and it will take one week to collect all the feedback. The questionnaire had been proved by the supervisor before distributing it to the managers.

3.4.3 Reality Test

This study uses the Cronbach's Alpha Reliability Test which is a reality test that used to determine the relationship between dependent and independent variables. This reality test is used to measure or estimate the reliability or internal consistency for a given test items (Gliem & Gliem, 2003). Generally, a score of 0.8 is probably considered as reasonable and good. Table 3.2 shows the rule of thumb measures for Cronbach's Alpha Coefficient.

Table 3.2: Rule of thumb Measures for Cronbach's Alpha Coefficient

Cronbach's Alpha Coefficient Range (α)	**Internal Consistency**
$0.5 > \alpha$	Unacceptable
$0.6 > \alpha > 0.5$	Poor
$0.7 > \alpha > 0.6$	Questionable
$0.8 > \alpha > 0.7$	Acceptable
$0.9 > \alpha > 0.8$	Good
$\alpha \geq 0.9$	Excellent

3.5 Variable Measurement

The research aims to determine the relationship between exogenous and endogenous variables. Research methodology is defined as follows:

$$IR4 = \beta_0 + \beta_1 TA + \beta_2 AW + \beta_3 FR + \beta_4 ACS + \beta_5 GP + \beta_6 CB + \beta_7 CS + \beta_8 CA$$

Where the model describe as follows:

IR4 = Fourth Industrial Revolution

β_0 = Intercept

β_1 = Technology Acceptance

β_2 = Awareness

β_3 = Financial Resources

β_4 = Appropriate Competence and Skill

β_5 = Government Policies

β_6 = Company's Business

β_7 = Company Size

β_8 = Company Age

3.5.1 Fourth Industrial Revolution

In this study, Industry Revolution 4.0 is the dependent variables. This study used "I think adopting Industrial 4.0 might be useful in the future" which was adopted from the research of Tjikongo and Uys (2013). Moreover, this study was also adopted and revised from the study that done by Hassan, Nasir, Khairudin, and Adon (2016) and used "I understand the benefits of implement Industrial 4.0", "I believe that implementation of Industrial 4.0 can enhance employee productivity", "Our organization interested in adopting Industrial 4.0 in order to gain competitive advantages" and "Our organization supports the implementation of Industrial 4.0." Furthermore,

this research also used "Our organization considered to implement 4.0" which was also adopted and adjusted from the study of Basl (2017).

3.5.2 Technology Acceptance

The measurements from the study of Muller, Kiel, and Voigt (2018) were adopted into this research which were "Our employees do not trust Industry 4.0 technologies.", "Our employees afraid of dependence on Industry 4,0 technologies." and "We expect non-acceptance of Industry 4.0 by employees.". Furthermore, this research also used "Our employees fear of losing job after implemented Industry 4.0 technologies.", "Our organization fear to adopt Industry 4.0 technologies due to the unknown experiences." as well as "Our organization fear to adopt Industry 4.0 technologies due to the uncertainty of benefits." which were adopted and modified from the study that done by Horvath and Szabo (2019).

3.5.3 Awareness

The items for awareness in this study were adopted and modified from Greiner and Franza (2003) and used "Our organization is lack of awareness about Industry 4.0 technologies." and "Our organization were lack of information about Industry 4.0." Besides, this study was also adopted and modified the items from the research from Luthra and Mangla (2018); Luthra, Kumar, Garg, and Haleem (2015) which were "Our organization have low knowledge on the concept of Industry 4.0.", "Our organization have low understanding of implementation of Industry 4.0." as well as "Our organization have poor research and development on Industry 4.0 adoption.". Moreover, this research also used "Low level of adoption of Industry 4.0 technologies in the market in Malaysia." which was taken from the research that done by Carcary et al. (2014).

3.5.4 Financial Resource

This study was adopted and modified the items from Balasingham (2016) and used "A large amount of financial are needed by a company to adopt IR4.0", "A large company have to prepare large amount of financial before entering to IR4.0" and "Most of the companies do not have enough financial to invest in IR4.0." Moreover, "Insufficient of financial resources can hinder company in development project" as well as "Shortage of financial resources is a limitation in the adoption of IR4.0" were adopted and revised the items from Horvath and Szabo (2019). Lastly, the item of the lack of financial resources in this study is also adopted and used the item from the research of Schroder (2016) and used "Adoption of IR4.0 is expensive".

3.5.5 Appropriate competence and skill

This study was adopted from the research of Ismail et al. (2019) and used "I know what skills are needed for organization to adopt Industrial 4.0", "I always upgrade my skills and information of Industrial 4.0" and "Employees' disability to learn the required skills or knowledge is the obstacles for organization in implement Industrial 4.0." Besides, "Lack of competence and skilled worker is an obstacle in the implementation of Industrial 4.0" was adopted and revised from the research of Huang et al. (2019). Moreover, the item of the appropriate competence and skill in this study are also adopted from the study of Basl (2017) and used "My organization have provided support and training for employees to develop new skills." Lastly, "I have the skill that necessary to help organization in implementing Industrial 4.0" was also adopted and modified the item from the study of Ahmad, Segaran, Soon, Md Sapry and Omar (2019).

3.5.6 Government Policies

This study was modified and used "lack of Industry 4.0 policy standards" to measure the challenges of Industry 4.0 adoption (Turkeș et al., 2019). Besides, this research also modified and adopted "I think a standard

regulation assists my company to adopt industry 4.0", "I think government should developed a policy framework for Industry 4.0 adoption", "I think my company have low perception of Industry 4.0 due to poor policy implementation", " I think current government policies is insufficient to solve the problem of poor implementation of Industry 4.0" as well as "I think shortage of government policies restricts company to implement industry 4.0" from studies of Liao, Loures, Deschamps, Brezinski, and Venancio, (2018); Manda and Dhaou, (2019); Australian Government, (2016).

3.5.7 Company's Business

Based on the Nikoloski (2014) state that the purpose of the commercial sector is to gain profit from the products and services. Technology used in Industrial Revolution 4.0 is very important for the business sector because it is one of the management tools to optimize the information process in order to produce goods and services for profit. Madhushree, Kumar, and Aithal (2018) has defined industry as a system that consists of manufactures and business with the purpose to produce goods and services for profit motivation.

3.5.8 Company Size

In the research done by Zadeh and Eskandari (2012) state that the firm size is measured by the number of employees. According to Becker, Kaen, Etebari, and Baumann (2010) state that the size of the firm in organization are measure by the number of employees or value added rather than sales or assets. Fiala and Hedija (2015) also state that the company can use the number of employees to estimate the firm size. They found that, the larger of the firm size growth slower than the smaller firm size.

3.5.9 Company Age

Company age refers to the number of years that have passed since the company's IPO (Loderer and Waelchli, 2011). According to Coad, Holm, Krafft, and Quatraro (2018) state that the firm age will affect the company performance through intermediary mechanisms. The performance of the company will decline as the firm grows older. Loderer and Waelchli (2011) state that the firm age is the best measurement for the listing age between 5 to 40 years. The listing age is defined as the moments in company life. Based on Pervan, Pervan, and Curak (2017) state that the profitability and productivity of the firms will be affected by the age of the firm.

3.6 Constructs Measurement

Industry 4.0 is known as a new industrial revolution which consists of complex systems that includes digital manufacturing technology, computer and automation technologies and other sectors (Zhou et al., 2015). Technology acceptance knowns as the willingness of users to use the technology for the jobs that they design to support (Teo, 2011). Awareness can be defined as a mindful that the technology is becoming readily accepted in the industries. Besides, financial resources can also define as a fund that use for the goods or services, or even use for the technologies development in a specific period of time. Skill is the ability or talent to carry out a task that adopt from education, training or practice (Petrillo, Felice, Cioffi & Zomparelli, 2018). Government policies are principle, goals and rules that want to provide better decision-making, and bring positive outcomes that can improve the communities and units (Pavitt & Walker, 1976).

3.6.1 Scale Measurement

Scale measurement is a method that use to classify and quantify variables in this research. The type of scale measurement use in this research are nominal, ordinal and Likert scale.

3.6.1.1 Nominal Scale

Nominal scale is one of the scale measurements that used for classification purpose which is used to help in classify the value of the objects and arrange the objects into different categories or classes in this research (Bhat, 2019). This scale is using in Section A for Question 1 in this research.

Table 3.3 Example of Nominal Scale

What is your gender?	
○ Male	○ Female

3.6.1.2 Ordinary Scale

Ordinary scale is used to allocate values of the variables or used as a comparison parameter according to the relative ranking between the variables in a set of data (Salkind, 2010). The ordinary scale is using in Section A in this research for Question 2, 5 and 6 which included age, company size and age of company.

Table 3.4 Example of Ordinary Scale

Age:
○ 24 years old and below
○ 25-34 years old
○ 35-44 years old
○ 45-54 years old
○ 55-64 years old
○ 65 and above years old

3.6.1.3 Likert Scale

Likert scale is a five or seven-point scale measurement that used to allows the respondent to indicate on how much the respondents agree or disagree with a specific statement (McLeod, 2019). This research is using five point Likert scale for Section B to G of the questionnaires.

Table 3.5 Example of Five-point Likert Scale

No.	Question	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1.	I think adopting Industrial 4.0 might be useful in the future.					

3.6.2 Origins of Constructs (Questionnaire)

Table 3.6 The Origins of Constructs of measurement in the research

Questions	**Sources**	**No. of item**
Demographic	Developed by researchers.	6
Industrial Revolution 4.0	Adopted and adjusted from Factors influencing cloud computing adoption in small medium enterprise. (Hassan et al., 2016)	6
Technology Acceptance	Adopted and adjusted from What drives the implementation of Industry 4.0? The role of opportunities and challenges in the context of sustainability. (Muller et al., 2018)	6
Awareness	Adopted and adjusted from Barriers to renewable/sustainable energy technologies adoption: Indian perspective. (Luthra et al, 2015)	6
Financial Resources	Adopted and adjusted from Industry 4.0: Securing the Future for German Manufacturing Companies. (Balasingham, 2016)	6
Appropriate competence and skill	Developed and adjusted from The Challenges and Role Played among Workers of Department Human Resources Management towards Industry 4.0 in SMEs.	6

	(Ismail et al., 2019)	
Government Policies	Developed and adjusted from The challenges and opportunities in the 4th Industrial revolution in developing countries. (Manda & Dhaou, 2019)	6

3.7 Data Processing

3.7.1 Data Checking

Data checking is the flow of checking the accuracy and quality of the questionnaire before it is used, imported or processed into data. Data checking is aimed to detect all the error free data or the erroneous data. The questionnaire must be understandable and clear before distributed to the targeted respondent. There is a possibility that the respondents will select a rating point of 4 for all the questions provided. In that situation, the researchers were able to analyze the answer pattern so as to determine the understanding of the respondents.

3.7.2 Data Editing

According to Statistics Centre (2017), data editing is a flow that involves checking and adjusting the survey data that has been collected. Data editing is aimed to make sure the integrity, conformity and readability of the data collected. The following are the objectives of the data editing process:

I. To ensure the accuracy of data collected.

II. To ensure consistency with the intent of the question and adjust them.

III. To ensure the information provided can access to the overall accuracy data.

IV. To ensure the data is collectible.

3.7.3 Data Coding

Based on Reading Craze (2014) stated that data coding is a driving code process from the observed data which can divide into two forms which are quantitative or qualitative form. Data coding is aimed to express the essence and meaning of the data collected from the targeted respondents. The data coder extracts the preliminary code from the data that has been observed. The data was then further filters and refines the preliminary code in order to obtain more concise and accurate code. The researcher was then assigned the value, percentage or other numerical codes in order to derive inferences in data evaluation.

Data coding in this study is classified into two sections. Section A require the respondent to tick one or more answers for each question. A 5-point of Liker Scale is provided from Section B to G and the scale is classified accordingly from 1 to 5 which represent strongly disagree, disagree, neutral, agree and strongly agree.

Table 3.7: Data Coding for Section A (Demographic Profile)

Question No.	Label	Coding
Q1	Gender	1 = Male 2 = Female
Q2	Age	1 = 24 years old and below 2 = 25 – 34 years old 3 = 35 – 44 years old 4 = 45 – 54 years old 5 = 55 – 64 years old 6 = 65 and above
Q3	Education Level	1 = High school or below 2 = Certificate or Diploma 3 = Bachelor's degree 4 = Postgraduate education 5 = Professional certificate
Q4	Types of business	1 = Mining 2 = Agriculture

		3 = Manufacturer 4 = Banking 5 = Others
Q5	Company Size	1 = 10 employees and below 2 = 11 – 50 employees 3 = 51 – 100 employees 4 = 101 – 250 employees 5 = 251 employee and above
Q6	Company Age	1 = 1 - 9 years 2 = 10 - 19 years 3 = 20 - 29 years 4 = 30 - 39 years 5 = 40 - 49 years 6 = 50 - 59 years 7 = 60 years and above

Table 3.8: Example of data coding for Section B, C, D, E, F, and G

Question	Coding
I think adopting Industrial 4.0 might be useful in the future.	1 = Strongly Disagree 2 = Disagree 3 = Neutral 4 = Agree 5 = Strongly Agree

3.7.4 Data Transcribing

According to Churcher (2017), data transcription is one of the significant and necessary components in this study. Data transcribing is the process to interpret or translate audio or video recordings into words that can be studied and coded. Data transcribing also help to transmit the encoded data that has been collected from the questionnaire into the software. Smart PLS software

is adopted in this study so as to transcribe the encoded data for statistical analysis.

3.8 Data Analysis

The Smart PLS software was used to examine those usable data that gathered from 385 respondents of the survey. The use of the Smart PLS software is to managing statistics data and proceeded to run the PLS-SEM analysis to study the factors that affecting the adoption of the Industry 4.0 technologies in Malaysia industry.

3.8.1 Descriptive Analysis

Descriptive statistics is a way that use to summarizes the sample and measure the data in order to help to briefly describe and understand the specific data set (Kenton, 2019). It helps to summarize or organize the data either through numerical calculation or graph and table. The common graph that will be displayed in this are mostly histogram, pie chart, bar chart and scatter plot (Donges, 2018).

3.9 Analyses

Partial Least Squares Structural Equation Modeling was utilized in this study, while Reflective Measurement Model is the measurement model of this research. PLS is beneficial tool for Structural Equation Modeling to use in the studies when there have limited targeted responded as well as data distribution is skewed (Wong, 2011; Bass, Jung & Berson, 2003; Henseler, Ringle, & Sinkovics, 2009; Chin, Marcolin, & Newsted, 2003).

3.9.1 Indicator Reliability

Indicator reliability is to develop the reliability and validity of the latent variable to accomplish the examination of the measurement model (Wong,

2013). Indicator reliability provide a sufficient measurement of the model, where describe the relationship between measurement and latent variable. Indicator reliability obtain reflective construct from outer loading and utilized both together. The outer loading of reflective construct should at least or greater than threshold value, 0.7.

3.9.2 Internal Consistency Reliability

Cronbach's alpha is applied to identify the internal consistency reliability. Prior literature recommended to use the composite reliability to examine the measurement model (Hair, Sarstedt, Ringle & Mena, 2012). By applied composite reliability, Partial Least Squares Structural Equation Modeling (PLS-SEM) will provide distinct indicator reliabilities. The minimum value of composite reliability should at least 0.7 and above.

3.9.3 Convergent Validity

Validity is also measured by using convergent validity as well as discriminant validity. Convergent validity is the extension to measure the positive correlate with alternative measure of same construct. The minimum value of AVE should at least 0.5 and above.

3.9.4 Discriminant Validity

Fornell and Larcker (1981) highlighted that the square root of AVE is to establish the discriminant validity in each latent variable. Discriminant Validity can be asses through two methods such as Heterotrait-Monotrait Ratio of Correlation (HTMT) and cross loadings. HTMT ratio should less than 1.00 (Gaskin, Godfrey & Vance, 2018). While the cross loadings with other latent variable should lower than indicator outer loading.

3.9.5 Checking Structural Model

By using SmartPLS, this study can generate T-Statistics to examine the inner and outer model through a bootstrapping process. A standard error is necessary involved in the bootstrapping to test the significant of the relationship between various construct in the structural path. Wong (2013) stated that there is insignificant relationship between various construct if the T-statistics value is lower than significant level.

3.10 Conclusion

Overall, chapter three explained the methodology used in this studied. There are several diagnostic test and model could be used to apply to this research. In addition, econometric model and methods also have elaborated in this research. Lastly, this research applied SmartPLS software to perform the data analysis.

CHAPTER 4: DATA ANALYSIS

4.0 Introduction

Referring to previous chapter 3, research methodology including research design, data collection method, sampling design, research instrument, variable measurement, construct measurement, and data processing method is discussed. In this Chapter 4, SmartPLS test will further examine for the accuracy and data trustworthiness. Meantime, this study will also record significant result of hypothesis in systematic order followed by conclusion.

4.1 Descriptive Analysis

This section shows the information collected from the respondents. The questionnaires were distributed and answered by the respondents of male and female at the management level of the companies. The demographic profile of the respondent that included in the questionnaires are gender, age group, education level, company's business, company size and company age. The results are shown in Table 4.1 below.

Table 4.1: Demographic Information of the respondents

		Frequency	Percentage (%)
Gender	Male	220	57.1
	Female	165	42.9
Age group	24 years old and below	4	1
	25 – 34 years old	57	14.8
	35 – 44 years old	154	40
	45 – 54 years old	120	31.2
	55 – 64 years old	43	11.2
	65 years old and above	7	1.8
Education Level	High school or below	30	7.8
	Certificate or Diploma	70	18.2
	Bachelor's degree	160	41.6
	Postgraduate education	117	30.4
	Professional certificate	8	2
Company Business	Mining	22	5.7
	Agriculture	33	8.6
	Manufacturer	45	11.7

	Banking	61	15.8
	Others:	224	58.2
	Hospitality	46	11.9
	Construction	26	6.8
	Financial Service	32	8.3
	Healthcare	47	12.2
	Property	27	7
	Investment trust	20	5.2
	Transportation	12	3.1
	Technology	3	0.8
	Energy	11	2.9
Company Size	10 employees and below	3	0.8
	11 – 50 employees	50	13
	51 – 100 employees	121	31.4
	101 – 250 employees	98	25.5
	251 employee and above	113	29.3
Company Age	1 - 9 years	26	6.8
	10 - 19 years	70	18.2
	20 - 29 years	92	23.9
	30 - 39 years	79	20.5
	40 - 49 years	55	14.3
	50 - 59 years	25	6.5
	60 years and above	38	9.8

Among the 385 respondents who take part in this study, male were 220 respondents (57.1%) and female were 165 respondents (42.9%) which male respondents are more than female respondents.

After that, the statistics details of age group for demographic variables, respondents who aged 24 years old or below were 4 respondents (1%) which is the lowest frequency group. Respondents who aged 65 years old or above is the second lowest frequency group which were only 7 respondents (1.8%). Respondents who aged 55 to 64 years old were 43 respondents (11.2%) and respondents who aged 25 to 34 years old were 57 respondents (14.8%). Respondents who aged 45 to 54 years old were 120 respondents (31.2%) which is the second highest frequency group. Thus, respondents who aged 35 to 44 years old is the highest frequency group which were 154 respondents (40%).

Furthermore, the statistics details of education level for demographic variables, the respondents who reached high school or below consists of 30 respondents (7.8%). Subsequently, there are 70 respondents (18.2%) achieved the education level of certificate or diploma. Then, respondents who graduated with Bachelor's degree and

Postgraduate education were 160 respondents (41.6%) and 117 respondents (30.4%) respectively. Respondents who received professional certificate were only 8 respondents (2%).

Moreover, the statistics details of company's business for demographic variables, the mining industry consists of 22 respondents (5.7%), agriculture industry consists of 33 respondents (8.6%), manufacturer industry consists of 45 respondents (11.7%), banking industry consists of 61 respondents (15.8%) and other industries consists of 224 respondents (58.2%). Other industries included hospitality (11.9%), construction (6.8%), financial service (8.3%), healthcare (12.2%), property (7%), investment trust (5.2%), transportation (3.1%), technology (0.8%) and energy industry (2.9%).

Next, for company size, there are only 3 respondents (0.8%) for those whose company size are 10 employees and below and 50 respondents (13%) whose company size are 11 to 50 employees. 98 respondents (25.5%) for those whose company size are between 101 to 250 employees and 113 respondents (29.3%) whose company size are 251 employees and above. There are 121 respondents (31.4%) whose company size were 51 to 100 employees which is the highest frequency group.

Lastly, the statistics details for company age, there are 26 respondents (6.8%) whose company age is between 1 to 9 years and 70 respondents (18.2%) whose company age is between 10 to 19 years. For whose company age is between 20 to 29 years have consists of 92 respondents (23.9%) which is the highest frequency group. Then, the respondents whose company age are between 30 to 39 years and 40 to 49 years were 79 respondents (20.5%) and 55 respondents (14.3%) respectively. There are 25 respondents (6.5%) whose company age is between 50 to 59 years and only 38 respondents (9.8%) whose company age is 60 years and above.

4.2 Analyses

4.2.1 Data Reliability

Figure 4.1 (by referring to Appendix 4.1) shows the final PLS factor loading measurement model. According to Chan and Idris (2017) have pointed out that a factor loading of less than 0.3 or 0.5 cannot be used. All the items in

this research are shown in Figure 4.2 (please refer to Appendix 4.2) which are more than 0.5 and greater than the cut-off values of 0.5.

4.2.2 Internal Consistency Reliability

The output of Cronbach's alpha and composite reliability test of the structural model has shown in Table 4.2. A score above 0.7 on Cronbach's alpha is generally sufficient. The constructed alpha coefficients are all greater than 0.70 and all the values for independent variables are between 0.793 to 1.000, which exceeds the acceptable value of 0.70. Hence, the results suggest that the items have high internal consistency.

In Table 4.2, all the composite reliability values are above 0.70, in order to achieve the acceptable level for explanatory research (Ab Hamid, Sami & Mohmad Sidek, 2017). In this research the composite reliability and Cronbach's alpha value are satisfactory.

4.2.3 Convergent Validity

According to Ahmad, Ain Zulkurnain, and Khairushalimi (2016) state that the Average Variance Extracted (AVE) value must be more than or equal to 0.5. The values of AVE of this research are all above 0.5 (Table 4.2), so there is no item needs to be removed.

Table 4.2: Reliability for Constructs

	Cronbach's Alpha	rho_A	Composite Reliability	Average Variance Extracted (AVE)
ACS	0.793	0.857	0.850	0.506
AW	0.924	0.961	0.942	0.740
FR	0.851	0.887	0.876	0.549
GP	0.866	0.934	0.854	0.501
IR	0.894	0.906	0.919	0.655
TA	0.887	0.908	0.911	0.633

4.2.4 Discriminant Validity

Cross loading and Heterotrait-Monotrait (HTMT) are two methods used to run the existence of discriminant validity in this research. The result of cross loading is shown in the Table 4.3 below. This means that the outer loading value of each indicator is larger than all its loadings on other constructs.

Table 4.3: Cross Loading for Constructs

	ACS	AW	FR	GP	IR	TA
ACS1	**0.829**	-0.438	-0.068	-0.194	0.498	-0.308
ACS2	**0.847**	-0.362	-0.018	-0.135	0.501	-0.238
ACS3	**0.828**	-0.17	0.193	0.017	0.453	-0.077
ACS5	**0.781**	-0.277	0.066	-0.07	0.447	-0.201
AW1	-0.324	**0.864**	0.19	0.403	-0.361	0.604
AW2	-0.382	**0.943**	0.274	0.437	-0.414	0.647
AW3	-0.379	**0.949**	0.257	0.442	-0.394	0.654
AW4	-0.401	**0.939**	0.262	0.444	-0.416	0.631
AW5	-0.351	**0.926**	0.269	0.446	-0.377	0.621
FR1	0.074	0.293	**0.841**	0.236	0.103	0.206
FR2	0.049	0.274	**0.834**	0.194	0.101	0.155
FR4	0.006	0.085	**0.69**	0.018	0.036	0.035
FR5	0.011	0.109	**0.805**	0.067	0.12	0.048
FR6	0.004	0.337	**0.748**	0.226	0.039	0.216
GP1	-0.048	0.314	0.156	**0.656**	0	0.229
GP2	-0.049	0.211	0.062	**0.707**	-0.071	0.161
GP3	-0.003	0.249	0.111	**0.753**	-0.068	0.227
GP4	-0.149	0.503	0.215	**0.896**	-0.233	0.397
GP5	-0.088	0.165	0.065	**0.623**	0.002	0.201
GP6	-0.13	0.29	0.103	**0.713**	-0.083	0.249
IR1	0.382	-0.055	0.239	-0.002	**0.676**	-0.101
IR2	0.398	-0.394	0.114	-0.169	**0.767**	-0.389
IR3	0.423	-0.345	0.11	-0.176	**0.805**	-0.304
IR4	0.475	-0.463	-0.019	-0.24	**0.84**	-0.473
IR5	0.522	-0.379	0.071	-0.166	**0.873**	-0.393

IR6	0.539	-0.343	0.124	-0.138	**0.877**	-0.323
TA1	-0.262	0.231	-0.104	0.12	-0.416	**0.638**
TA2	-0.074	0.454	0.129	0.246	-0.183	**0.816**
TA3	0.006	0.378	0.101	0.255	-0.136	**0.743**
TA4	-0.076	0.582	0.202	0.388	-0.256	**0.821**
TA5	-0.286	0.735	0.234	0.391	-0.408	**0.869**
TA6	-0.249	0.747	0.236	0.384	-0.366	**0.862**

Table 4.4 shows HTMT value of this research. All HTMT values should be lower than 0.85 for the constructs that are conceptually distinct and 0.9 for the constructs that are conceptually more similar in order to fulfil the rule of thumb. All the HTMT values that shown in the table 4.4 are lower than 0.90 and 0.85. This means that all the items in the construct had met the sufficient convergent validity after being tested by the three approaches.

Table 4.4: Heterotrait-Monotrait (HTMT) Values

	ACS	AW	FR	GP	IR	TA
ACS						
AW	0.445					
FR	0.168	0.305				
GP	0.166	0.438	0.181			
IR	0.641	0.421	0.146	0.155		
TA	0.286	0.717	0.222	0.368	0.400	

4.2.5 Assessment of Structural Model

The relationship between various construct in structural model has been tested with the hypothesis testing since the measurement of the construct has been confirmed as reliable and effective. This has included the strength and the direction of the Path Coefficient and the significant values as shown in Figure 4.3 (refer Appendix 4.3). SmartPLS software is used in this study

for the purpose of calculation and the 5,000 subsamples in the replacement value was adopted in the bootstrapping procedures. This is used to evaluate the statistical significance of parameter estimates to evaluate the path coefficient.

The critical value for two-tailed test is 1.65 when significance level is 0.10. When the significance level is 0.05 and 0.01, the critical value will be 1.96 and 2.57 respectively. Most of the researchers will use the level of significance of 0.10 to run the data because it depends on the objective and the field of the research (Hair et al., 2014). This study used 10% of significance level to test the data because there are only few researchers had studied on the topic of the challenges, barriers, obstacles and recommendations for action of Industry 4.0 in Malaysia and its barriers, obstacles, recommendation for actions. The R^2 value is 0.532 (Figure 4.1) which explained that they are 53.2% of variance in Industry 4.0.

Table 4.5: Inner VIF value

Construst	**Fourth Industrial Revolution**
Appropriate Competence and Skill (ACS)	1.230
Awareness (AW)	2.450
Financial Resources (FR)	1.119
Government Policies (GP)	1.297
Technology Acceptance (TA)	1.896

According to the Table 4.5 above, all the Inner VIF values for the independent variables (ACS, AW, FR, GP, TA) need to be tested under the lateral multi-collinearity and the result shown are less than 5. Hence, there is no multi-collinearity problem happen in this research.

4.3 Result and Discussion

Table 4.6: Bootstrapping Result

Hypothesis	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values	Decisions & Results
TA -> IR	-0.238	-0.235	0.053	4.473	0	**Significant**
AW -> IR	-0.045	-0.037	0.059	0.765	0.444	Insignificant
FR -> IR	0.175	0.169	0.062	2.839	0.005	**Significant**
ACS -> IR	0.424	0.426	0.044	9.703	0	**Significant**
GP -> IR	0.019	0.006	0.050	0.371	0.711	Insignificant
CB -> IR	0.022	0.022	0.035	0.625	0.532	Insignificant
CS -> IR	0.236	0.223	0.055	4.302	0	**Significant**
CA -> IR	0.112	0.115	0.053	2.124	0.034	**Significant**

Where the hypothesis describe as follows:

TA = Technology Acceptance

AW = Awareness

FR = Financial Resources

ACS = Appropriate Competence and Skill

GP = Government Policies

CB = Company's Business

CS = Company Size

CA = Company Age

4.3.1 The Impact of Technology Acceptance on Adoption of Fourth Industrial Revolution in Malaysia

Since the p-value (0.000) that obtained in this the analysis is lower than the significance level $\alpha = 0.10$, we reject H_0. So, there is sufficient evidence to conclude that there is a significant relationship between the technology acceptance and adoption of Industry 4.0 at $\alpha = 0.10$.

The finding of this study can be matched with the Theory of Technology Acceptance Model and the hypothesis development that have been discussed earlier in Chapter 2. This indicated that the users of the technologies will determine the perceived usefulness and the perceived ease of use of the new technologies before they decide to adopt it. The result in this study also match with the previous studies that discussed in literature review, which concluded that there is significant relationship between technology acceptance and Industry 4.0 adoption. According to Horvath and Szabo (2019), the company refuse Industry 4.0 adoption, because they cannot confirm whether the technologies can provide what benefits since they do not have the relevant previous experience. However, if the new technologies are able to provide a useful function for the enterprise, Industry 4.0 adoption will also increase. Furthermore, this result also consistent with the result of Orzes et al. (2018), which they mention that Industry 4.0 adoption is affected by the uncertainty on the beneficial of Industry 4.0 in majority of the SMEs. Hence, it is the strong barrier to the change in introduction of new technologies.

This result is inconsistent with those previous studies from Massod and Egger (2019) and Stentoft et al. (2019), which concluded that the lack of the technology acceptance does not have significant relationship with Industry 4.0 adoption and would not be an obstacle of Industry 4.0 adoption. The result is different from them is due to the previous studies done by them were having some limitation and used unstandardized regression model rather than standardized regression model. In this study, the limitation of the previous studies was considered and solved and the standardized regression model was adopted. The reason of using standardized rather than unstandardized regression is because it is more suitable to be used in this study. This is because the unstandardized regression model is suitable to use in

interpretation and the standardized regression model are more suitable when having comparison of the effects of independent variable on the dependent variable.

4.3.2 The Impact of Awareness on Adoption of Fourth Industrial Revolution in Malaysia

Since the p-value (0.444) obtained in this study is higher than the significance level $\alpha = 0.10$, we do not reject H_0. Thus, there have sufficient evidence to conclude that there is insignificant relationship between the variables of awareness and the adoption of Industry at $\alpha = 0.10$.

The result obtained in this study is not complied with the hypothesis developed earlier in Chapter 2 and it is also different from previous studies that done by Senarathna et al. (2018) and Sabi et al. (2016), which came out with the result of the having low awareness on the new technologies is one of the barriers that hinder the adoption of it. The awareness of technologies is referred to knowing the concept and the opportunities and benefits that might be brought by the new technologies and it is the first stage in every technologies adoption which influencing the perception and the intention of the technology users.

Moreover, it is also inconsistent with the result of Saeed et al. (2012), Ali, Soar and Yong (2016), Carcary et al., (2014) and Gorecky, Romero, and Kim (2019) stated that if the SMEs have the high awareness to the existence of the new technologies and have clear knowledge to handle it, the adoption of the new technologies will be increased. Meanwhile, if the SMEs do not aware the existence of the new technologies, it is not easy to persuade them to adopt it. Hence, the adoption rate of the new technologies will also remain low.

The result in this study showed that the awareness does not influence the adoption of Industry 4.0 in Malaysia which is different from others. It might mainly because the level of the awareness on the Industry 4.0 in Malaysia is have not reached the level that can be influenced the adoption of it. As mentioned in news report done by The Sun Daily (2017), the Second Minister of International Trade and Industry of Malaysia mentioned that Malaysia market still lag behind to inspire industry to automate. He stated that automate market size still under initial stage, which cannot

supply sufficient automate accessories to the company to adopt Industry 4.0. As the market is still lack of market size to incentive industry to adopt Industry 4.0 technology, thus poor degree of awareness in various industries in Malaysia. Major respondent might know Fourth Industry Revolution exist in the market, but the concept and benefit of the Fourth Industry Revolution are still vague. As a result, the level of awareness among the respondents still cannot influence the company to adopt Fourth Industry Revolution. Hence, the level of awareness did not impact the successful of Industry 4.0 adoption.

4.3.3 The Impact of Financial Resources on adoption of Fourth Industrial Revolution

Since the p-value of Financial Resources is 0.005 which is lower than the significance level, $\alpha = 0.10$, so we reject H_0. Therefore, there is sufficient evidence to conclude that there is significance relationship between Financial Resources and Industry 4.0 at significance level, $\alpha = 0.10$.

The result of this research are consistent with the finding of Balasingham (2016), Prause (2019), Horvath and Szabo (2019), Mishina et al. (2004), Pereshybkina et al. (2017), Kiel et al. (2017), Muller et al. (2017), and Dalenogare et al. (2018) on empirical studies where the shortage of financial resources have significance impact toward the adoption of Industry 4.0 as it will restrict the technology development opportunities of the companies. Besides, Resources-Based View theory (RBV) that stated in Chapter 2 have explained that this theory enables companies to understand their available competitive advantages and know their current resources such as the financial resources and innovation capabilities. However, the intention of some of the companies in adopting Industry 4.0 will be reduce if they understand their financial resources is insufficient to adopt Industry 4.0.

In addition, the study of Lin, Wu, and Song (2019) found that the implementation of Industry 4.0 may require a lot of financial resources and big companies usually need more funds to promote the Industry 4.0. Masood and Sonntag (2020) stated that the financial resources limitation is still the biggest problem when SMEs want to adopt Industry 4.0. Furthermore, a higher investment is needed to develop the labor force and technologies which will further causes companies unable to adopt

Industry 4.0 due to insufficient financial resources (Da Silva, Kovaleski, Pagani, Silva & Corsi, 2019).

However, companies that had financial obstacles in supporting the Industry 4.0 adoption may indicate as lack of necessary knowledge and management in the adoption of Industry 4.0, and also concern on the higher cost of technical talents in promote the implementation of technology innovation (Kim & Garrison, 2010). Agostini and Nosella (2019) concluded that financial resources are a key factor in the successful implementation of Industry 4.0 as companies with higher financial resources tend to have better chances of obtain the technologies development than those with limited resources.

4.3.4 The Impact of Appropriate Competence and Skill on adoption of Fourth Industrial Revolution

Since the p-value of Appropriate Competence and Skill is 0.000 which is lower than the significance level, $\alpha = 0.10$, so we reject H_0. Therefore, there is sufficient evidence to conclude that there is significance relationship between Appropriate Competence and Skill and Industry 4.0 at significance level, $\alpha = 0.10$.

The result of this study verifies that it is consistent with the findings of Huang et al. (2019), Klingenberg and Antunes (2017), Tortorella and Fettermann (2018), Ristuccia (2019), and Ismail et al. (2019) where lack of appropriate competence and skill have significance impact in implementing Industry 4.0. Besides, this result is also consistent with the hypothesis developed and the concepts of Human Capital Theory (HCT) as this theory include the skills and knowledge that can be used to create values to help organizations in implement the Industry 4.0. Moreover, this theory has a significant relationship with the Industry 4.0 adoption as it may require some skills that the individuals do not have due to the technological change rapidly.

In addition, the study of Norman and Alamsjah (2020) indicated that shortage of skilled labor has a significance impact toward promoting digital technologies as the transition to Industry 4.0 will require skill of software programming, digital performance management skills or other relevant skills. Besides, Matt, Modrak, and Zsifkovits (2020) claimed that shortage of skilled worker is still the potential

organizational problems in the implementation of Industry 4.0 because some companies did not provide more opportunities or enough effort on improving their workforce's skills and knowledge. However, Bag and Pretorius (2020) explained that there are uncertainty and complexity of investing the workers' skills and technology are a bigger issue among the companies. Therefore, companies unable to adopt Industry 4.0 technologies because they lack of professional skills to meet the requirement of Industry 4.0.

4.3.5 The Impact of Government Policies on Fourth Industry Revolution Adoption

Refer to the Table 4.6, the p-value (0.711) is higher than significant level $\alpha = 0.10$, therefore we do not reject H_0. As a result, there is sufficient evidence to posit that there is insignificant relationship between government policies and Industry 4.0 adoption at $\alpha = 0.10$ significant level.

In line with the result found in this study, where indicate there is inconsistent finding on empirical studies and hypothesis in Chapter 2. Cao et al. (2020), Novak (2019), Allen et al. (2020), Porter and Linde (1995) believed that government policies playing important role to promote development of industry 4.0. A series of fair of the law and regulation helped industries to enhance the progress of industry 4.0 adoption. Different result occur may due to the different perception of company on adopting Industry 4.0 Some company may adopt Industry 4.0 to increase their competitive advantage in the market. Major of these company position their business in international market, which require advanced technology to produce highest standard quality of product. Meantime, some companies may adopt Industry 4.0 simply because of following competitors. Therefore, they may not need government assist to implement Industry 4.0. Most of these companies come from the largest companies, and they can raise project funds from financial markets or financial institutions.

However, there is only a small percentage of company able to adopt industry 4.0 without assist from government. There are still many companies left behind from industry 4.0 adoption. Many respondents did not believe government policies will give a great impact on industry 4.0 adoption. Reich (2010) stated that a series of

fair of the rules and regulations able to assist domestic economy growth by transforming the sector structure and enhance business environment in the country. Many respondents did not understand the actual effect of government policies toward industry 4.0 adoption. They may think that the industry revolution depends on the ability of companies to adopt advanced technologies, and that external factors cannot affect Industry 4.0 adoption. The poor perception among respondents are caused by the lack of government policy in Malaysia. Kulkarni et al. (2020), Geissbauer et al. (2016), Huang et al. (2012), Kagermann et al. (2013) mentioned that improper standard of government policies are not able to give direct impact toward Industry 4.0 adoption, meanwhile it will reduce the progress of Industry 4.0 adoption.

As the poor standard of government policies on Industry 4.0 adoption, major respondents did not understand the actual effect of government policies toward Industry 4.0. They did not know how it work and what contribution of implement it. Hence, successful of industry 4.0 adoption did not depend on government policies.

4.3.6 The Impact of Company's Business on Fourth Industry Revolution Adoption

According to the Table 4.6, the p-value (0.532) is higher than significant level $\alpha = 0.10$, thus we reject H_0. As a result, there is sufficient evidence to conclude that there is insignificant relationship between company's business and Industry 4.0 adoption at $\alpha = 0.10$ significant level.

This result is in line with Soto-Acosta and Merono-Cerdan (2006) that found company's business does not have any impact on Industry 4.0 adoption. Their result indicates that no such differences between the type of business against Industry adoption. The intention to adopt Industry is based on the company management perception.

However, this result did not same with Hong and Zhu (2006). They reported that company business is significant effect the adoption of Industry 4.0. In line with their finding, result shows service industry is more preferring to adopt Industry 4.0

compare to manufacture and wholesale. This is because service industry has a higher degree level of migration as they dealing with intangible products. They can obtain benefit from big data analysis, Internet of thing, and cloud computing technology. Besides, Tortorella and Fettermann (2017) reported manufacturing sector will be more inclined to adopt Industry 4.0. They believe that companies that are highly dependent on production strongly inclined to adopt Industry 4.0 to improve productivity.

Different approaches to the concept of Industry 4.0 affect the company's business model (Ibarra, Ganzarain & Igartua, 2018). Company business type supposed not to be an important factor affecting the adoption of Industry 4.0, while company management's view is more important. As Industry 4.0 has a wide impact on a global scale, it brings different benefits to different industries (Ann, 2017; InvestKL, 2017; Davies, 2015; Azhar, 2015; Rosli, 2017). Iivari, Ahokangas, Komi, Tihinen, and Valtanen (2016) also pointed out that Industry 4.0 will promote industrial transformation from product models to a service mindset. Thus, it cannot posit that only one business sector will have higher probability to adopt Industry 4.0, while other business sector might also intend to adopt Industry 4.0.

4.3.7 The Impact of Company Size on the adoption of Fourth Industrial Revolution

Since the p-value of the company size is 0.000 which is lower than the significance level $\alpha = 0.10$, so we reject H_0. Hence, there is sufficient evidence to conclude that there is a significant relationship between company size and the adoption of Industry 4.0 at $\alpha = 0.10$ significant level.

The result is matches with the finding and hypothesis that developed in Chapter 2 which indicate a significant relationship between the company size and the adoption of Industry 4.0. This means that when Industry 4.0 adoption increase, the intention to use the technology will increases automatically. According to Lin et al. (2019) mentioned that the adoption of Industry 4.0 will be more effective for the large companies in order for them to increase their productivity process and the performance of the company. As a result, the companies size has a positive impact to the adoption of Industry 4.0.

By referring to Giunta and Trivieri (2007) highlighted that there is a positive correlation between company size and the adoption of Industry 4.0 because a large enterprise will have advantage where they can use the profit generated to invest in the new technology and hence have a good ability to absorb the new technologies. There is a strong connection between the company size and the implementation of Industry 4.0 because large enterprise is much more advanced in integrating production plants into higher-level IT systems (Jovanovski, Seykova, Boshnyaku & Fischer, 2019).

4.3.8 The Impact of Company Age on Fourth Industry Revolution Adoption

Since the p-value (0.034) is lowest than significant level $\alpha = 0.10$, therefore we reject H_0. As a result, there is sufficient evidence to conclude that there is significant relationship between company age and Industry 4.0 adoption at $\alpha = 0.10$ significant level.

Refer to the empirical result in chapter 2, which indicates that company age has significant effect on adoption of the Industry 4.0. This result is consistent with the hypothesis development in chapter 2, which company age has positive impact on fourth industry revolution. The empirical result posits that oldest company have meet the minimum requires of Industry 4.0 adoption. However, Dholakia and Kshetri (2004) mentioned that oldest company usually slow to adopt high technology compare to middle-aged company. This issue may because of the workforce age effect. The ratio of older workers could higher than the youngest worker in the oldest company. Previous empirical studies indicate that older workers are less likely and low qualified to utilize advanced technology compared to younger workers (Schleife, 2006; Koning & Gelderblom, 2006).

Another empirical study is also consistent with this result, Brandt and Zhu (2005) also stated that firm with different aspect in term of age, size, human resources, and capital intensity will affect the capability of firm to acquired new technology. The use of firm age always been ignored by the proxy of technology vintage, where the oldest firm might acquire advanced technology. Meyer (2009) stated that older firm will have more experience in revolution processes and acquiring new technology. Oldest company might have higher demand of new technology since their

equipment may out of date. Hollenstein and Worter (2004) said that the variable of company age should be controlled within the employee's tenure, because the age of the employee will get older with the company they work in.

CHAPTER 5: DISCUSSION, IMPLICATION AND CONCLUSION

5.0 Summary Research

There are several impacts and challenges that brings by Industrial 4.0 toward different business sectors in Malaysia. This study has chosen AW, TA, FR, ACS and GP as the independent variables to determine the challenges that hinder the development of Industry 4.0 in Malaysia. This studied is to investigate the impact of AW, TA, FR, ACS and GP on implementing Fourth Industry revolution in Malaysia.

This fact-finding is done by using quantitative method. Furthermore, cross-sectional data and primary data are utilized by this study which collected from 385 number of respondents in Malaysia. After the data were collected, it was generated by using SmartPLS 3 in an effort to figure out whether this model that developed in this study is suitable for identifying the respondents' perception on Industry 4.0 adoption by using AW, TA, FR, ACS and GP.

According to Partial Least Squares (PLS), it can be concluded that at least one interviewee has different opinions on the adoption barriers of Industry 4.0, either is, strongly agree, agree, neutral, disagree or strongly disagree can be set up.

Major finding that obtained from the SMART PLS 3 software include:

(i) Technology acceptance has positive impact on Fourth Industrial Revolution.

(ii) Financial resource has positive impact on Fourth Industrial Revolution.

(iii) Appropriate competence and skills have positive impact on Fourth Industrial Revolution.

This study found that TA, FR and ACS are having significant impact on Industry 4.0 adoption in Malaysia business sector. From the result, it can be said that most of the respondents agree with the TA, FR ACS are having a positive relationship toward the adoption of the Fourth Industrial Revolution, but there was an insignificant relationship between AW, GP and Fourth Industrial Revolution.

5.1 Contribution

Previous research has demonstrated several barriers of the Industry 4.0 adoption (Horvath & Szabo, 2019). This present work is designed to be the first to examine the barrier of Industry 4.0 adoption in developing country, Malaysia. This study introduces the idea from different research to examine the barrier hinder the developing countries from Industry 4.0 adoption. Present findings posit that the level of government intervention still unable to influence the development of Industry 4.0. The level of awareness also still unable to influence industry to automate. The empirical research demonstrated that the level of government policies and awareness must enough higher to influence the firm to adopt Industry 4.0. Previous research posit government policies has impact on Industry 4.0 adoption, but this result only can obtain from the advance countries where their government policies already at standard level. Besides, this research also utilized Partial Least Squares Structural Equation Modeling and Reflective Measurement Model. As the PLS is beneficial tool for Structural Equation Modeling to use in the studies when there have limited targeted responded as well as data distribution is skewed. Lastly, this research survey also exposing how deeply respondent understand the concept of Industry 4.0 and current trend and gap. The survey helping researchers to know the current understanding of the country toward Industry 4.0.

5.2 Policy Implication

According to Jayashree et al. (2019) has stated that most of the companies are lack of financial resources and they are forced to stop adopting the Industry 4.0. This is because acquire advanced technology requires a huge amount of fund. In order to solve and improve this problem, the government in Malaysia had taken some actions by undertaking some efforts through the implementation of automation and smart manufacturing in order to embrace the concept of Industry 4.0. Based on the Malaysia budget 2017, the government had given some new incentive packages to the companies that wish to speed up the progress of Industry 4.0 adoption. Supermax Corporation Berhad is one of the examples of Malaysia company that already adopted Industry 4.0. This company known as a glove industry where the

government continue to support that company by giving the incentive programs in order to help them to improve the growth of their industry (Tay et al., 2019).

Most of the Malaysia companies are not ready to adopt Industry 4.0 because they are lack of understanding on the concept and contribution. The understanding of the concept of Industry 4.0 is very important to the companies. In order to solve this issue, the Malaysian government needs to take some actions to raise the awareness of the people toward the adoption of Industry 4.0. The government should carry out an awareness program or organize a talk to share some information and knowledge about the important of industry 4.0 to the citizen so that they will comprehend better on the concept of Industry 4.0. Local government can adopt social media platforms to promote and educate the citizens because the mass media play a vital role in spreading innovation through interpersonal communication platform. The digital era is a feature of Industry 4.0 which affects all aspects of human life (Abdullah, Abdullah & Mohamad Salleh, 2017).

Moreover, government should provide funding to support the Research and Development (R&D) if companies do not have enough incentive to conduct the research and development. Government can provide the funding to the companies, non-profit research entities or to the colleges and university to done the research and development directly. Other than that, government also can provide a reduction on the taxes to the companies or organizations with depending on how much of the research and development have done in order to encourage them to contribute on it ("Principles of economics," n.d.)

For the technology acceptance of employee, companies themselves have to lead the employees by removing the unknown. The major problem that made employee refuse to accept the change is the fear of unknown. The fear can be eliminated if you can remove the unknown. Thus, the top management of the companies have to remove the unknown time to time. If top management can keep the employees in the know on all the things that top management are doing, the employees will more willing to accept the changes ("Construction World," 2017).

Skill challenge is one of the problems that faced by the company in Malaysia because most of the employees or employers have not ready to change their mindset on the adoption of Fourth Industry revolution. To solve this problem, the managers from different department such as IT managers, big data managers and data

exchange managers need to acquired "e-skills" (Balasingham, 2016), because this skill could improve the performance of the companies (Sima, Gheorghe, Subic & Nancu, 2020). Moreover, the government must continue to provide the education system so that the employees or employers of the organization can continue to learn, enhance and master the innovative skills such as the critical thinking, problem solving, communication skill, collaboration skill, creativity and innovation skills because these skills can help to improve the skills of the employees or employers in order to achieve the development of Industry 4.0 (Lase, 2019). They can also learn the skill through e-learning because e-learning is a combination platform where there is an interaction between the human and technology and face-to-face learning. Sharman (2019) stated that learners able to enhance their learning progress through E-learning compare to traditional learning method. As this method is more convenience for the international company as they cannot meet each other within a short period of time (Oke & Fernandes, 2020).

5.3 Limitation

This study was carried out through cross-sectional data only. Data collected for this study are only concentrated from the period of 18 June 2020 until 20 July 2020. However, cross-sectional method is used to analyse the data that collected at a specific point in time which will be difficult to determine the causal inference due to the short period of time. If this research change to another time frame, the results for this study may be different.

Moreover, data collected from different industries in Malaysia also one of the limitations of this study. It may not suitable for other developing countries to measures the challenges and obstacles to adopt Fourth Industry Revolution. As different countries may have distinct perceptions, obstacles and challenges on the Industry 4.0 adoption, thus this could influence the data reliability as well as data integrity.

Subsequently, questionnaires that designed to collect the data without providing the feedback section for respondents to deliver their arguments and opinions also one of the limitations of this study. Therefore, it may arise the possibility that the

respondents may contain the bias perceptions or misunderstand about the survey questions. Thus, it could influence the data reliability when the respondents incorrectly answer the questions.

5.4 Recommendation

This research would recommend the future researchers to conduct their research by using longitudinal data analysis, which is a panel data analysis as this method can use to illustrate the variables over a long duration. Therefore, this might assist the investigator to get more accurate and specific data to determine the causal inference for their research.

After that, this study would recommend the future researchers to focus on one particular industry to conduct their survey, so that researchers can have deep understanding on the obstacles or challenges that faced by each type of the industry in that country. Thus, this would increase the reliability of their data and to have more specific data to determine and analyse the factors that affect the adoption of Industry 4.0.

Lastly, this research would suggest the future researchers to include a feedback section in their questionnaires which allow the respondents to provide their inquiries and feedback. Thus, reduce the misunderstanding of the respondents on the survey might improve the reliability of the data. Hence, this also provide a chance for researchers to capture the potential issues accurately.

5.5 Conclusion

In research was conducted with the aim to study the variables that might hinder the implementation of the Fourth Industrial Revolution in Malaysia's business sector which included technology acceptance, awareness, financial resource, appropriate competence and skills as well as the government policies. After obtained 385 number of respondents from Malaysia industry and carried out several tests, where study outcome shows that awareness, government policies are insignificant affect on Fourth Industrial Revolution adoption. While technology acceptance, financial resource, appropriate competence and skills are significant affect on Fourth Industrial Revolution adoption. Hopefully, this result is able to a reference in order to assist or support to the others researchers or practitioners who would like to study and observe the implementation of the Fourth Industrial Revolution in future.

REFERENCES

Abdoullaev, A. (2011). Keynote: A smart world: A development model for intelligent cities. *11th IEEE international conference on computer and information technology (CIT)*.

Abdullah, D. B., Abdullah, M. Y., & Mohamad Salleh, M. A. (2017). A review on the concept of Fourth Industrial Revolution and the government's initiatives to promote it among youths in Malaysia. *Journal of Social Sciences and Humanities*, *14*(7), 1-8.

Ab Hamid, M. R., Sami, W., & Mohmad Sidek, M. H. (2017). Discriminant validity assessment: Use of Fornell & Larcker criterion versus HTMT criterion. *Journal of Physics: Conference Series*, *890*.

Abolfazli, S., Sanaei, Z., Tabassi, A., Rosen, S., Gani, A., & Khan, S. U. (2015). Cloud adoption in Malaysia: Trends, opportunities, and challenges. *IEEE Cloud Computing*, *2*(1), 60-68.

Adnan, H. (2016). Taking advantage of Big Data revolution. *New Straits Times.* Retrieved from https://www.nst.com.my/news/2016/05/143131/taking-advantage-big-data-revolution

Adolph, S., Tisch, M., & Metternich, J. (2014). Challenges and approaches to competency development for future production. *Journal of International Scientific Publications–Educational Alternatives*, *12*(1), 1001-1010.

Aghion, P., Angeletos, G. M., Banerjee, A., & Manova, K. (2010). Volatility and growth: Credit constraints and the composition of investment. *Journal of Monetary Economics*, *57*(3), 246-265.

Agolla, J. E. (2018). Human capital in the smart manufacturing and industry 4.0 revolution. *Digital Transformation in Smart Manufacturing*, 41-58.

Agostini, L., & Nosella, A. (2019). The adoption of Industry 4.0 technologies in SMEs: results of an international study. *Management Decision*.

Ahmad, A. R., Segaran, P., Soon, N. K., Md Sapry, H. R., & Omar, S. S. (2019). Factors Influence the Students‟ Readiness on Industrial Revolution 4.0.

International Journal of Recent Technology and Engineering (IJRTE), 8(2), 2277-3878.

Ahmad, N., Shamsuddin, A., & Abu Seman, N. A. (2018). Industry 4.0 Implications on Human Capital: A Review. *Journal for Studies in Management and Planning*, *4*(13), 221-235.

Ahmad, S., Ain Zulkurnain, N. N., & Khairushalimi, F. I. (2016). Assessing the validity and reliability of a measurement model in structural equation modeling (SEM). *British Journal of Mathematics & Computer Science, 15*(3), 1-8.

Ajibade, P. (2018). Technology acceptance model limitations and criticisms: Exploring the practical applications and use in technology-related studies, mixed-method, and qualitative researches. *Library Philosophy & Practice*.

Ajzen, Icek, & Martin Fishbein (1980). Understanding attitudes and predicting social behavior, Prentice Hall.

Ajzen, I. (1985). From intentions to actions: A theory of planned behavior. *Action Control*, 11-39.

Al Lami M. F. F., Maelah, R., & Ghassan, G. (2019). Management accounting information usefulness and cloud computing qualities among small-to-medium enterprises. *International Journal of Management Studies*, *26*(1), 1-31.

Ali, O., Soar, J., & Yong, J. (2016). An investigation of the challenges and issues influencing the adoption of cloud computing in Australian regional municipal governments. *Journal of Information Security and Applications*, *27*, 19-34.

Al-Jabri, I. M., & Sohail, M. S. (2012). Mobile banking adoption: Application of diffusion of innovation theory. *Journal of Electronic Commerce Research*, *13*(4), 379-391.

Aljifri, H. A., Pons, A., & Collins, D. (2003). Global e-commerce: a framework for understanding and overcoming the trust barrier. *Information Management & Computer Security*.

Allen, D. W., Berg, C., Markey-Towler, B., Novak, M., & Potts, J. (2020). Blockchain and the evolution of institutional technologies: Implications for innovation policy. *Research Policy*, *49*(1), 103865.

Andreasyan, T. (2020). *Tokyo: Fintechs welcome!* Retrieved from https://www.fintechfutures.com/2020/01/tokyo-fintechs-welcome/

Ann, C. S. (2017). Cover Story: The state of IoT in Malaysia. *The Edge Malaysia.* Retrieved from https://www.theedgemarkets.com/article/cover-story-state-iot-malaysia

Aripin, I. D. M., Ahmad Zawawi, E. M., & Ismail, Z. (2019). Factors Influencing the Implementation of Technologies Behind Industry 4.0 in the Malaysian Construction Industry. *MATEC Web of Conferences*, *266*, 4.

Australian Government. (2016). Digital Disruption: What do government need to do?. *Productivity Commission Research Paper.*

Ayisy, Y. (2018). MDEC believes digital technology would drive economy. *New Straits Times* [Kuala Lumpur]. Retrieved from https://www.nst.com.my/business/2018/02/339869/mdec-believes-digital-technology- would-drive-economy

Azhar, K. (2015). Malaysia's push for big data analytics. *The Edge Malaysia.* Retrieved from https://www.theedgemarkets.com/article/malaysia%E2%80%99s-push-big-data-analytics

Bag, S., & Pretorius, J. H. C. (2020). Relationships between industry 4.0, sustainable manufacturing and circular economy: proposal of a research framework. *International Journal of Organizational Analysis*.

Balasingham, K. (2016). Industry 4.0: Securing the Future for German Manufacturing Companies.

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*. Prentice Hall.

Barney, J. (1991). Firm resources and sustained competitive advantage. *Journal of management*, *17*(1), 99-120.

Basl, J. (2017). Pilot study of readiness of Czech companies to implement the principles of Industry 4.0. *Management and Production Engineering Review*, *8*(2), 3-8.

Bass, B., Avolio, B., Jung, D., & Berson Y. (2003). Predicting unit performance by assessing transformational and transactional leadership. *Journal of Applied Psychology*, *88*(2), 207-218.

Basu, M. (2016). *Dato' Yasmin Mahmood, CEO, Malaysia digital economy Corporation.* Retrieved from https://govinsider.asia/inclusive-gov/dato-yasmin-mahmood-ceo-malaysia digital-economy-corporation

Batista, L., Bourlakis, M., Smart, P., & Maull, R. (2018). In search of a circular supply chain archetype–a content-analysis-based literature review. *Production Planning & Control*, *29*(6), 438-451.

Becker-Blease, J. R., Kaen, F. R., Etebari, A., & Baumann, H. (2010). Employees, firm size and profitability of US manufacturing industries. *Investment Management and Financial Innovations*, *7*(2), 119-132.

Bhat, A. (2019). *Nominal Scale: Definition: Characteristics and Examples*. Retrieved from https://www.questionpro.com/blog/nominal-scale/

Bianchi, P., & Labory, S. (2019). Manufacturing regimes and transitional paths: Lessons for industrial policy. *Structural change and economic dynamics*, *48*, 24-31.

Binti Junid, N. A., Tuan Soh, T. M., Diyana Mahmud, S. N., & Iksan, Z. H. (2019). Science Teacher's Knowledge, Understanding and Readiness in Dealing with the Education Transformation of the 4th Industrial Revolution. *International Journal of Innovation, Creativity and Change*, *7*(11).

Birruntha. (2020). Malaysia's cyber-threat trend improves in 4Q19. *The Malaysian Reserve.* Retrieved from https://themalaysianreserve.com/2020/01/22 /malaysias-cyber-threat trend-improves-in-4q19-says-kaspersky/

Brandt, L., & Zhu, S. C. (2005). Technology adoption and absorption: the case of Shanghai Firms.

Breunig, M., Kelly, R., Mathis, R., & Wee, D. J. M. Q. (2016). Getting the most out of Industry 4.0. *McKinsey Global Institute*.

Briazkalo, A. (2016). Conceptualization of financial resources of local authorities. *Baltic Journal of Economic Studies, 2*(3), 29-36.

Brown, J. R., Fazzari, S. M., & Petersen, B. C. (2009). Financing innovation and growth: Cash flow, external equity, and the 1990s R&D boom. *The Journal of Finance, 64*(1), 151-185.

Cai, Z., Fan, X., & Du, J. (2017). Gender and attitudes toward technology use: A meta-analysis. *Computers & Education, 105*, 1-13.

Cao, J., Chen, X., Zhang, X., Gao, Y., Zhang, X., & Kumar, S. (2020). Overview of remanufacturing industry in China: Government policies, enterprise, and public awareness. *Journal of Cleaner Production, 242*, 118450.

Caramela, S., (2018). AT&T's Anne Chow on why small businesses shy away from early tech adoption. *Business News Daily*. Retrieved from https://www.businessnewsdaily.com/10742-anne-chow-atttech adoption.html.

Carcary, M., Doherty, E., & Conway, G. (2014). The adoption of cloud computing by Irish SMEs-an exploratory study. *Electronic Journal of Information Systems Evaluation, 17*(1), 3-14.

Carr, L. T. (1994). The strengths and weaknesses of quantitative and qualitative research: what method for nursing?. *Journal of advanced nursing, 20*(4), 716-721.

Chan, L. L., & Idris, N. (2017). Validity and Reliability of The Instrument Using Exploratory Factor Analysis and Cronbach's alpha. *International Journal of Academic Research in Business and Social Sciences, 7*(10), 400-410.

Chau, P. Y., & Tam, K. Y. (2000). Organizational adoption of open systems: a 'technology-push, need-pull' perspective. *Information & Management*, *37*(5), 229-239.

Chin, W. W., Marcolin, B. L., & Newsted, P. R (2003). A Partial Least Squares Latent Variable Modeling Approach for Measuring Interaction Effects: Results from A Monte Carlo Simulation Study and an Electronic Mail Emotion/Adoption Study. *Information Systems Research, 14*(2), 189-217.

Churcher, K. M. A. (2017). Data Transcription. *The International Encyclopedia of Communication Research Methods*, 1-2.

Coad, A., Holm, J. R., Krafft, J., & Quatraro, F. (2018). Firm age and performance. *Journal of Evolutionary Economics*, *28*(1), 1-11.

Construction World. (2017). *7 ways to reduce resistance to new technology*. Retrieved from https://www.constructionworld.org/managing-change-reducing-resistance-new-technology/

Cragg, P. B., & King, M. (1993). Small-firm computing: motivators and inhibitors. *MIS quarterly*, 47-60.

Da Silva, V. L., Kovaleski, J. L., Pagani, R. N., Silva, J. D. M., & Corsi, A. (2019). Implementation of Industry 4.0 concept in companies: Empirical evidences. *International Journal of Computer Integrated Manufacturing*, *33*(4), 325-342.

Dalenogare, L. S., Benitez, G. B., Ayala, N. F., & Frank, A. G. (2018). The expected contribution of Industry 4.0 technologies for industrial performance. *International Journal of Production Economics*, *204*, 383-394.

Danquah, M., & Amankwah-Amoah, J. (2017). Assessing the relationships between human capital, innovation and technology adoption: Evidence from sub-Saharan Africa. *Technological Forecasting and Social Change*, *122*, 24-33.

Davies, R. (2015). Industry 4.0. Digitalisation for productivity and growth. *European Parliamentary Research Service*, *10*.

Davis, F. D. (1986). A technology acceptance model for empirically testing new end-user information systems: Theory and results.

Davis, F. D., Bagozzi, R. P., & Warshaw, P. R. (1989). User acceptance of computer technology: A comparison of two theoretical models. *Management Science, 35*(8), 982-1003.

Development of SMEs in Malaysia. (2018). Retrieved from https://www.ukessays.com/essays/economics/overview-analysismalaysias-economy-2682.php

Dholakia, R. R., & Kshetri, N. (2004). Factors impacting the adoption of the Internet among SMEs. *Small Business Economics*, *23*(4), 311-322.

Donges, N. (2018). *Intro to descriptive statistics*. Retrieved from https://towardsdatascience.com/intro-to-descriptive-statistics252e9c464ac9

Donmez-Turan, A., & Kir, M. (2019). User anxiety as an external variable of technology acceptance model: A meta-analytic study. *Procedia Computer Science, 158*, 715-724.

Dzikowski, P., & Tomaszewski, M. (2014). The impact of firm size and its ownership on innovation cooperation in medium-high and high technology sectors in Poland. *Management*, *18*(1), 385-396.

Elnaz, M., & Baharak, M. (2014). A Survey on Cloud Computing Adoption among Malaysian SMEs. *Global Journal of Commerce & Management Perspective*, *3*(5), 1-5.

Erol, S., Jager, A., Hold, P., Ott, K., & Sihn, W. (2016). Tangible Industry 4.0: a scenario-based approach to learning for the future of production. *Procedia CiRp, 54*(1), 13-18.

Etikan, I., & Bala, K. (2017). Sampling and sampling methods. *Biometrics & Biostatistics International Journal*, 215-217.

Etikan, I., Musa, S. A., & Alkassim, R. S. (2016). Comparison of convenience sampling and purposive sampling. *American journal of theoretical and applied statistics*, *5*(1), 1-4.

Fan, Q. (2017). A longitudinal evaluation of e-government at the local level in greater western Sydney (GWS) Australia. *International Journal of Public Administration*, *41*(1), 13-21.

Fiala, R., & Hedija, V. (2015). The relationship between firm size and firm growth: The case of the Czech Republic. *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis*, *63*(5), 1639-1644.

Financial Times. (2019). Automation: Formula to Fortune 500. *Business Today*, *19*(6).

Fishbein, M., & Ajzen, I. (1975). *Belief, attitude, intention, and behavior: An introduction to theory and research*. Addison-Wesley.

Fong, V. (2017). *Fintech Malaysia report 2017*. Retrieved from https://fintechnews.my/12808/uncategorized/fintech-malaysia-report/

Fong, V. (2018). *What are Malaysia's top 5 banks doing about Fintech?* Retrieved from https://fintechnews.my/16580/banking/bank-fintech-malaysia/

Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research*, *18*(1), 39-50.

Fraser, J., Fahlman, D., Arscott, J., & Guillot, I. (2018). Pilot Testing for Feasibility in a Study of Student Retention and Attrition in Online Undergraduate Programs. *The International Review of Research in Open and Distributed Learning*, *19*(1).

Gantz, J. (1990). Outsourcing: threat or salvation?. *Networking Management*, *10*(90), 25-40.

Garikipati, R. (2019). *Korea makes steady headway in Industry 4.0*. Retrieved from https://www.theinvestor.co.kr/view.php?ud=20190701000594

Gaskin, J., Godfrey, S., & Vance, A. (2018). Successful system use: It's not just who you are, but what you do. *AIS Transactions on Human-Computer Interaction*, *10*(2), 57-81.

Geissbauer, R., Vedso, J., & Schrauf, S. (2016). *Industry 4.0: Building the digital enterprise*. Retrieved from https://www.pwc.com/gx/en/industries/ industries-4.0/landing page/industry-4.0-building-your-digital-enterprise-april-2016. pdf

Ghaz. (2017). Industry 4.0: Are Malaysian SMEs Ready? *BizPulse*, (17), 1-12.

Giunta, A., & Trivieri, F. (2007). Understanding the determinants of information technology adoption: evidence from Italian manufacturing firms. *Applied economics*, *39*(10), 1325-1334.

Gliem, J. A., & Gliem, R. R. (2003). Calculating, interpreting, and reporting Cronbach's alpha reliability coefficient for Likert-type scales. *Midwest Research-to-Practice Conference in Adult, Continuing, and Community Education*.

Gorecky, D., Romero, D., & Kim, D. Y. (2019). Accelerating Technological Advancement and Adoption of Industry 4.0 Technologies: Smart-Factory Labs, Digital Capability Centers and Lighthouses Networks. *International Congress and Conferences on Computational Design and Engineering*, *3*.

Greene, P. G., Brush, C. G., & Brown, T. E. (1997). Resources in small firms: an exploratory study. *Journal of Small Business Strategy*, *8*(2), 25-40.

Greiner, M. A., & Franza, R. M. (2003). Barriers and bridges for successful environmental technology transfer. *The Journal of Technology Transfer*, *28*(2), 167-177.

Hair, J. F., Sarstedt, M., Hopkins, L., & Kuppelwieser, V. G. (2014). Partial least squares structural equation modeling (PLS-SEM): An emerging tool in business research. *European Business Review*, *26*(2), 106-121.

Hair, J. F., Sarstedt, M., Ringle, C. M., & Mena, J. A. (2012). An assessment of the use of partial least squares structural equation modeling in marketing research. *Journal of the Academy of Marketing Science, 40*(3), 414-433.

Hall, B. H., & Lerner, J. (2010). The financing of R&D and innovation. Handbook of the Economics of Innovation. *North Holland, 1*, 609-639.

Hamid, H. A., & Yusof, M. M. (2015). State-of-the-art of cloud computing adoption in Malaysia: A review. *Jurnal Teknologi, 77*(18).

Hassan, H., Nasir, M. H., Khairudin, N. & Adon, I. (2017). Factors influencing cloud computing adoption in small medium enterprise. *Journal of Information and Communication Technology*, *16*(1), 21-41.

Hegeman, K. (2015). Are These Technologies the Future of the Construction Industry?.

Henderson, J. (2019). CyberSecurity Malaysia rolls out BlackBerry software. *Channel Asia.*

Retrieved from https://sg.channelasia.tech/article/666702/cybersecurity-malaysia-rolls-blackberry-software/

Henseler, J., Ringle, C. M., & Sinkovics, R. R. (2009). The use of partial least squares path modeling in international marketing. *New challenges to international marketing*, *20*, 277-320.

Hofmann, E. & Rusch, M. (2017). Industry 4.0 and the current status as well as future prospects on logistics. *Computers in Industry*, *89*, 23–34.

Hollenstein, H., & Worter, M. (2004). The Decision to Adopt Internet-based E Commerce. An Empirical Analysis Based on Swiss Firm-level Data: an empirical analysis based on swiss firm-level data. *KOF Working Papers*, *89*.

Hong Kong's manufacturing goes back to the future. (2019). Retrieved from https://hkglobalconnections.economist.com/hk-manufacturing-goes-back-to-the-future/

Hong, W., & Zhu, K. (2006). Migrating to internet-based e-commerce: Factors affecting e-commerce adoption and migration at the firm level. *Information & Management*, *43*(2), 204-221.

Horvath, D., & Szabo, R. Z. (2019). Driving forces and barriers of Industry 4.0: Do multinational and small and medium-sized companies have equal opportunities? *Technological Forecasting and Social Change*, *146*, 119-132.

Huang, B., Li, C., Yin, C., & Zhao, X. (2012). Cloud manufacturing service platform for small-and medium-sized enterprises. *The International Journal of Advanced Manufacturing Technology*, *65*(9-12), 1261-1272.

Huang, C. J., Chicoma, E. D. T., & Huang, Y. H. (2019). Evaluating the factors that are affecting the implementation of Industry 4.0 technologies in manufacturing MSMEs, the case of Peru. *Processes*, *7*(3), 161.

Hung, M. (2016). IoT Implementation and Management: from the Edge to the Cloud.

Iacovou, C. L., Benbasat, I., & Dexter, A. S. (1995). Electronic data interchange and small organizations: Adoption and impact of technology. *MIS quarterly*, 465-485.

Ibarra, D., Ganzarain, J., & Igartua, J. I. (2018). Business model innovation through Industry 4.0: A review. *Procedia Manufacturing*, *22*, 4-10.

Iivari, M. M., Ahokangas, P., Komi, M., Tihinen, M., & Valtanen, K. (2016). Toward Ecosystemic Business Models in the Context of Industrial Internet. *Journal of Business Models*, *4*(2), 42 -59.

Industry 4.0. (2020). Retrieved from https://www.industry.gov.au/funding-and-incentives/industry-40

International Telecommunications Union (2015). *The state of broadband report.* Retrieved from www.broadbandcommission.org/documents/reports/bbannualreport2015.pdf

InvestHK to hold Hong Kong Fintech week 2020 from November 2 to 6 in Hong Kong and Shenzhen (2020). Retrieved from https://www.hongkong-fintech.hk/en/news/investhk-to-hold-hong-kong-fintech-week-2020-from-november-2-to-6-in-hong-kong-and-shenzhen.html

InvestKL. (2017). *Malaysia Gets Serious on Developing IoT Ecosystem.* Retrieved from: https://www.investkl.gov.my/Relevant_News-@ Malaysia_Gets_Serious_on_Developing_IoT_Ecosystem.aspx

Ismail, F., Kadir, A. A., Khan, M. A., Yih, Y. P., & Al Hosaini, A. A. H. H. (2019). The Challenges and Role Played among Workers of Department Human Resources Management towards Industry 4.0 in SMEs. *KnE Social Sciences*, 90-107.

Ismail, I. (2019). *2020 budget: A boost for Malaysia's tech industry*. Retrieved from https://www.nst.com.my/lifestyle/bots/2019/10/529831/2020-budget-boost-malaysias-tech-industry

Jayashree, S., Malarvizhi, C. A., & Hassan Reza, M. N. (2019). The Impact of Organizational Readiness on IR 4.0 and Sustainability-A Theoretical Framework for SMEs in Malaysia. *Eurasian Journal of Analytical Chemistry*, *14*(1), 209–215.

Jia, F., Zuluaga-Cardona, L., Bailey, A., & Rueda, X. (2018). Sustainable supply chain management in developing countries: An analysis of the literature. *Journal of Cleaner Production*, *189*, 263-278.

Jovanovski, B., Seykova, D., Boshnyaku, A., & Fischer, C. (2019). The impact of Industry 4.0 on the competitiveness of SMEs. *International Scientific Conference*, *4*(5), 250-255.

Kache, F., & Seuring, S. (2017). Challenges and opportunities of digital information at the intersection of big data analytics and supply chain management. *International Journal of Operations & Production Management*, *37*(1), 10-36.

Kaczorowska-Spychalska, D. (2018). Digital technologies in the process of virtualization of consumer behaviour-awareness of new technologies. *Management*, *22*(2), 187-203.

Kagermann, H., Wahlster, W., & Helbig, J. (2013). Securing the future of German manufacturing industry: Recommendations for implementing the strategic initiative INDUSTRIAL 4.0. *Final report of the Industrial 4.0 Working Group*.

Kaminski, J. (2011). Diffusion of innovation theory. *Canadian Journal of Nursing Informatics*, *6*(2), 1-6.

Kana, G. (2017). *Maybank launches fintech sandbox*. Retrieved from https://www.thestar.com.my/business/businessnews/2017/06/07/maybank-launches-fintech-sandbox/

Kang, H. S., Lee, J. Y., Choi, S., Kim, H., Park, J. H., Son, J. Y., Kim, B. Y., & Noh, S. D. (2016). Smart manufacturing: Past research, present findings, and future directions. *International Journal of Precision Engineering and Manufacturing-Green Technology*, *3*(1), 111-128.

Karadayi-Usta, S. (2019). An interpretive structural analysis for industry 4.0 adoption challenges. *IEEE Transactions on Engineering Management*.

Karre, H., Hammer, M., Kleindienst, M., & Ramsauer, C. (2017). Transition towards an Industry 4.0 state of the LeanLab at Graz University of Technology. *Procedia manufacturing*, *9*, 206-213.

Kennedy, J., & Hyland, P. (2003). A comparison of manufacturing technology adoption in SMEs and large companies. *Proceedings of 16th Annual Conference of Small Enterprise Association of Australia and New Zealand.*

Kenton, W. (2019). *Descriptive statistics*. Retrieved from https://www.investopedia.com/terms/d/descriptive_statistics.asp

Kerr, W. R., & Nanda, R. (2015). Financing innovation. *Annual Review of Financial Economics*, *7*, 445-462.

Kiel, D., Arnold, C., & Voigt, K. I. (2017). The influence of the Industrial Internet of Things on business models of established manufacturing companies-A business level perspective. *Technovation*, *68*, 4-19.

Kiel, D., Muller, J. M., Arnold, C., & Voigt, K. I. (2017). Sustainable industrial value creation: Benefits and challenges of industry 4.0. *International Journal of Innovation Management*.

Kim, J. (2019). *Why South Korea is primed for Fintech growth*. Retrieved from https://internationalbanker.com/technology/why-south-korea-is-primed-for-fintech-growth/

Kim, S., & Garrison, G. (2010). Understanding users' behaviours regarding supply chain technology: Determinants impacting the adoption and implementation of RFID technology in South Korea. *International Journal of Information Management*, *30*(5), 388-398.

Klingenberg, C., & Antunes, J. (2017). Industry 4.0: what makes it a revolution?.*EurOMA 2017*, 1-11.

Koch, V., Kuge, S., Geissbauer, R., & Schrauf, S. (2014). Industry 4.0: Opportunities and challenges of the industrial internet. *Strategy & PwC*.

Koning, J. D., & Gelderblom, A. (2006). ICT and older workers: No unwrinkled relationship. *International Journal of Manpower*, *27*(5), 467-490.

Kostopoulos, K. C., Spanos, Y. E., & Prastacos, G. P. (2002). The resource-based view of the firm and innovation: identification of critical linkages. *The 2nd European Academy of Management Conference,* 1-19.

Kotze, T. G., Anderson, O., & Summerfield, K. (2016). Technophobia: Gender differences in the adoption of high-technology consumer products. *South African Journal of Business Management*, *47*(1), 21-28.

Krachtt, N. (2019). The workforce implications of industry 4.0: Manufacturing workforce strategies to enable enterprise transformation.

Krejcie, R. V., & Morgan, D. W. (1970). Determining sample size for research activities. *Educational and psychological measurement*, *30*(3), 607-610.

Kroll, H., Copani, G., Van de Velde, E., Simons, M., Horvat, D., Jager, A., ... & Naumanen, M. (2016). An analysis of drivers, barriers and readiness factors

of EU companies for adopting advanced manufacturing products and technologies.

Kulkarni, K., Bhattacharjee, R., & Narwane, V. (2020). Barriers to industry 4.0 adoption: Indian scenario. *SSRN Electronic Journal*.

Kuo, C. C., Shyu, J. Z., & Ding, K. (2019). Industrial revitalization via industry 4.0 – A comparative policy analysis among China, Germany and the USA. *Global Transitions*, *1*, 3-14.

Kyrylenko, O.P. (2006). Mistsevi finansy. Znannia, Kyiv, Ukraine, 677.

Lago, C. (2019). *The State of Cloud Computing in Southeast Asia*. Retrieved from https://www.cio.com/article/3397054/the-state-of-cloud-computing-in-southeast-asia.html

Lall, M., Torvatn, H., & Seim, E. A. (2017). Towards industry 4.0: Increased need for situational awareness on the shop floor. *Advances in Production Management Systems. The Path to Intelligent, Collaborative and Sustainable Manufacturing*, 322-329.

Lase, D. (2019). Education and Industrial Revolution 4.0. *Jurnal Handayani Pgsd Fip Unimed*, *10*(1), 48-62.

Lawrence, R., Lim, F. C., & Abdullah, H. (2019). Strengths and Weaknesses of Education 4.0 in the Higher Education Institution. *International Journal of Innovative Technology and Exploring Engineering*, *9*, 511-519.

Lee, I. & Lee, K. (2015). The Internet of Things (IoT): Applications, investments, and challenges for enterprises. *Business Horizons*, *58*(4), 431-440.

Liao, Y., Loures, E. R., Deschamps, F., Brezinski, G., & Venancio, A. (2018). The impact of the fourth industrial revolution: a cross-country/region comparison. *Production*, *28*.

Lim, W. C. (2019). Automation: Formula to Fortune 500. *Business Today*, *19*(6).

Lin, B., Wu, W., & Song, M. (2019). Industry 4.0: driving factors and impacts on firm's performance: an empirical study on China's manufacturing industry. *Annals of Operations Research*, 1-21.

Lin, K. Y., Tsai, M. H., Gatti, U. C., Je-Chian, J. L., Lee, C. H., & Kang, S. C. (2014). A user-centered information and communication technology (ICT) tool to improve safety inspections. *Automation in construction*, *48*, 53-63.

Loderer, C., & Waelchli, U., (2011). Firm Age and Governance. *SSRN Electronic Journal*.

Luff, P. (2017). The 4th industrial revolution and SMEs in Malaysia and Japan: some economic, social and ethical considerations. *Reitaku International Journal of Economic Studies*, *25*, 25-48.

Luthra, S., & Mangla, S. K. (2018). Evaluating challenges to Industry 4.0 initiatives for supply chain sustainability in emerging economies. *Process Safety and Environmental Protection*, *117*, 168-179.

Luthra, S., Kumar, S., Garg, D., & Haleem, A. (2015). Barriers to renewable/sustainable energy technologies adoption: Indian perspective. *Renewable and sustainable energy reviews*, *41*, 762-776.

Madhushree, R. R., Kumar, A., & Aithal, P. S. (2018). Business strategy of top Indian ITcompany: Mindtree. *International Journal of Case Studies in Business, IT and Education (IJCSBE)*, *2*(1), 22-36.

Mageswari, M. (2019). *Aiding SMEs in assessing IR4.0 readiness*. Retrieved from https://www.thestar.com.my/business/smebiz/2019/05/13/aiding-smes-in-assessing-ir40-readiness

Mahmood, Y. (2016). *The reality of today's digital economy*. Retrieved from https://www.thestar.com.my/business/business-news/2016/04/23/the-reality-of-todays-digital-economy/

Manda, M. I., & Backhouse, J. (2016). Towards a "Smart Society" through a connected and smart citizenry in South Africa: A review of the national broadband strategy and policy. *International Conference on Electronic Government*, 228-240.

Manda, M. I., & Dhaou., S. B. (2019). Responding to the challenges and opportunities in the 4th industrial revolution in developing countries. *ACM International Conference Proceeding Series*, 244–253.

Manda, M. I., & Dhaou, S. B. (2019). Responding to the challenges and opportunities in the 4th Industrial revolution in developing countries. *Proceedings of the 12th International Conference on Theory and Practice of Electronic Governance*, 244-253.

Mandel, R. (2019). *Industry Perspectives: Industry 4.0 - What is driving the fourth industrial revolution?*. Retrieved from: https://canada.constructconnect.com/dcn/news/technology/2019/05/industry-perspectives-industry-4-0-driving-fourth-industrial-revolution

Marginson, S. (2017). Limitations of human capital theory. *Studies in Higher Education*, *44*(2), 287-301.

Masood, T., & Egger, J. (2019). Augmented reality in support of Industry 4.0-Implementation challenges and success factors. *Robotics and Computer-Integrated Manufacturing*, *58*, 181-195.

Masood, T., & Sonntag, P. (2020). Industry 4.0: Adoption challenges and benefits for SMEs. *Computers in Industry*, *121*, 1-12.

Matt, D. T., Modrak, V., & Zsifkovits, H. (2020). Industry 4.0 for SMEs: Challenges, Opportunities and Requirements, 412.

McLeod, S. (2019). Likert Scale Definition, Examples and Analysis. *Simply Psychology*. Retrieved from https://www.simplypsychology.org/likert-scale.html

Meyer, J. (2009). Workforce age and technology adoption in small and medium-sized service firms. *Small Business Economics*, *37*(3), 305-324.

Mikulic, I., & Stefanic, A. (2018). The adoption of modern technology specific to industry 4.0 by human factor. *Proceedings of the 29th International DAAAM Symposium 2018*, 941-946.

Ministry of International Trade and Industry. (2019). Kuala Lumpur: MPH Group Printing (M) Sdn Bhd.

Mishina, Y., Pollock, T. G., & Porac, J. F. (2004). Are more resources always better for growth? Resource stickiness in market and product expansion. *Strategic management journal*, *25*(12), 1179-1197.

Mohabbattalab, E., von der Heidt, T., & Mohabbattalab, B. (2014). The perceived advantages of cloud computing for SMEs. *GSTF Journal on Computing*, *4*(1), 61-65.

Mokebe Maleka, M. B. (2011). A gender-based analysis of ICT adoption and usage in South Africa.

Mollenkopf, D., Stolze, H., Tate, W. L., & Ueltschy, M. (2010). Green, lean, and global supply chains. *International Journal of Physical Distribution & Logistics Management*, *40*(1-2), 14-41.

Momami, A. M., & Jamous, M. M. (2017). The Evolution of Technology Acceptance Theories. *International Journal of Contemporary Computer Research*, *1*(1), 51-58.

Moreira, C. F. (2019). *Malaysia's industry 4.0 journey – practical beginnings.* Retrieved from https://www.enterprisetv.com.my/malaysias-industry-4-0-journey-practical-beginings/

Morris, M. G., & Venkatesh, V. (2000). Age differences in technology adoption decisions: Implications for a changing work force. *Personnel psychology*, *53*(2), 375-403.

Muhammad, M. Z., Char, A. K., Yasoa', M. R., & Hassan, Z. (2009). Small and medium enterprises (SMEs) competing in the global business environment: A case of Malaysia. *International Business Research*, *3*(1).

Muhammad, M. Z., Leng, G. S., Lada, S., & Amboala, T. (2011). An exploration of Social Networking Sites (SNS) adoption in Malaysia using Technology Acceptance Model (TAM), theory of planned behavior (TPB) and intrinsic motivation. *Journal of Internet Banking and Commerce*, *16*(2), 1-27.

Muller, J. M., Kiel, D., & Voigt, K. I. (2017). What Drives the Implementation of Industry 4.0? The Role of Opportunities and Challenges in the Context of Sustainability. *Sustainability, 10*(1), 247.

Mustonen-Ollila, E., & Lyytinen, K. (2003). Why organizations adopt information system process innovations: a longitudinal study using Diffusion of Innovation theory. *Information Systems Journal, 13*(3), 275-297.

Mwai, P. M. (2019). Government Policies and Their Effects to Business in Kenya. *Open Access Library Journal, 6*(3), 1-14.

My Government. (2020). *Public Sector Big Data Analytics (DRSA).* Retrieved from https://www.malaysia.gov.my/portal/content/30734

Nagy, J., Olah, J., Erdei, E., Mate, D. and Popp, J. (2018). The Role and Impact of Industry 4.0 and the Internet of Things on the Business Strategy of the Value Chain-The Case of Hungary. *Sustainability, 10*(10), 3491.

Nijssen, E. J. & Frambach, R.T., (2001). Creating Customer Value Through Strategic Marketing Planning. Dordrecht, Netherlands: Kluwer Academic Publishers.

Nikoloski, P. K. (2014). The Role of Information Technology in the Business Sector. *International Journal of Science and Research (IJSR), 3*(12), 303-309.

Norman, F., & Alamsjah, F. (2020). Key Factors to Promote Industry 4.0 Readiness at Indonesian Textile and Clothing Firm. *Engineering, Mathematics and Computer Science (EMACS) Journal*, *2*(2), 33-43.

Novak, M. (2019). Crypto-friendliness: understanding blockchain public policy. *Journal of Entrepreneurship and Public Policy*.

Oke, A., & Fernandes, F. A. P. (2020). Innovations in Teaching and Learning: Exploring the Perceptions of the Education Sector on the 4th Industrial Revolution (4IR). *Journal of Open Innovation: Technology, Market, and Complexity*, *6*(2), 31.

Olatokun, W., & Bankole, B. (n.d.). Factors Influencing Electronic Business Technologies Adoption and Use by Small and Medium Scale Enterprises (SMES) in a Nigerian Municipality. *The Journal of Internet Banking and Commerce*, *16*(3), 1-26.

Ortiz, J. H., Marroquin, W. G., & Cifuentes, L. Z. (2020). Industry 4.0: Current status and future trends.

Orzes, G., Rauch, E., Bednar, S., & Poklemba, R. (2018,). Industry 4.0 implementation barriers in small and medium sized enterprises: A focus group study. *2018 IEEE International Conference on Industrial Engineering and Engineering Management (IEEM)*, 1348-1352.

Pack, H., & Saggi, K. (2006). The case for industrial policy: A critical survey. *The World Bank Research Observer*, *21*(2).

Pan, M., Sikorski, J., Kastner, C. A., Akroyd, J., Mosbach, S., Lau, R., & Kraft, M. (2015). Applying industry 4.0 to the Jurong island eco-industrial Park. *The 7th International Conference on Applied Energy*, *75*, 1536-1541.

Pandiyan, M. V. (2017). *Industry 4.0: The future is here*. Retrieved from https://www.thestar.com.my/opinion/columnists/along-the watchtower/2017/09/06/industry-40-the-future-is-here-malaysia-cannot-afford-to-lag- in-a-world-facing-swift-exponential-cha

Parveen, H. & Showkat, N. (2017). Data Collection

Pavitt, K., & Walker, W. (1976). Government policies towards industrial innovation: a review. *Research policy*, *5*(1), 11-97.

Perakovic, D., Perisa, M., & Zoric, P. (2019). Challenges and issues of ICT in Industry 4.0. *Design, Simulation, Manufacturing: The Innovation Exchange,* 259-269.

Pereshybkina, A., Castillo Conde, M. E., Kalyesubula, T., & Kirner, E. (2017). How will the industry 4.0 transformations affect SMEs in Germany by 2030?. *Hochscgule Furtwangen University*.

Pervan, M., Pervan, I., & Curak, M. (2017). The influence of age on firm performance: evidence from the Croatian food industry. *Journal of Eastern Europe Research in Business and Economics*, 1-9.

Petrillo, A., Felice, F. D., Cioffi, R., & Zomparelli, F. (2018). Fourth industrial revolution: Current practices, challenges, and opportunities. *Digital Transformation in Smart Manufacturing*, 1-20.

Phaphoom, N., Wang, X., Samuel, S., Helmer, S., & Abrahamsson, P. (2015). A survey study on major technical barriers affecting the decision to adopt cloud services. *Journal of Systems and Software*, *103*, 167-181.

PIKOM ICT job market outlook in Malaysia 2019. (2019). Retrieved from https://eduspiral.com/2019/09/12/pikom-ict-job-market-outlook-in-malaysia-2019/

Porter, M. E., & Linde, C. V. (1995). Toward a new conception of the environment-competitiveness relationship. *Journal of Economic Perspectives*, *9*(4), 97-118.

Prause, M. (2019). Challenges of Industry 4.0 Technology Adoption for SMEs: The Case of Japan. *Sustainability*, *11*(20), 5807.

Principles of economics. (n.d.). *How governments can encourage innovation*. Retrieved from https://opentextbc.ca/principlesofeconomics/chapter/13-2-how-governments-can-encourage-innovation/

Qozani, H. A., & Aleryani, A. (2018). The Impact of IoT on the Higher Education. *Saba Journal of Information Technology and Networking*, *6*(2).

Racheal, L. (2020). *Cover story: IR4.0 in Malaysia: The challenges.* Retrieved from https://www.theedgemarkets.com/article/cover-story-ir40-malaysia-challenges

Radu, S. (2018). *The Big Spenders in Research and Development.* Retrieved from https://www.usnews.com/news/best-countries/articles/2018-11-09/these-countries-are-the-top-spenders-on-research-and-development

Rafique, H., Anwer, F., Shamim, A., Minaei-Bidgoli, B., Qureshi, M. A., & Shamshirband, S. (2018). Factors affecting acceptance of mobile library applications: Structural equation model. *Libri*, *68*(2), 99-112.

Rao, S. K., & Prasad, R. (2018). Impact of 5G technologies on industry 4.0. *Wireless personal communications*, *100*(1), 145-159.

Reading Craze. (2014). *Data coding in research methodology*. Retrieved from http://readingcraze.com/index.php/data-coding-research-methodology/

Ristuccia, C. (2019). Industry 4.0: SMEs Challenges and Opportunities in the Era of Digitalization. ZEI Discussion Paper C 252/2019.

Rogers, E. M. (2010). *Diffusion of innovations* (4th ed.). Simon & Schuster.

Rosli, L. (2017). Banking on big data analytics. *New Straits Times.* Retrieved from https://www.nst.com.my/business/2017/10/294117/banking-big-data-analytics

Rubmann, M., Lorenz, M., Gerbert, P., Waldner, M., Justus, J., Engel, P., & Harnisch, M. (2015). Industry 4.0: The future of productivity and growth in manufacturing industries. *Boston Consulting Group*, *9*(1), 54-89.

Saarinen, T., & Vepsalainen, A. P. (1994). Procurement strategies for information systems. *Journal of Management Information Systems*, *11*(2), 187-208.

Saatçioglu, O. Y., Ozispa, N., & Kok, G. T. (2019). Scrutinizing the Barriers That Impede Industry 4.0 Projects: A Country-Wide Analysis for Turkey. *Agile Approaches for Successfully Managing and Executing Projects in the Fourth Industrial Revolution*, 294-314.

Sabi, H. M., Uzoka, F. M. E., Langmia, K., & Njeh, F. N. (2016). Conceptualizing a model for adoption of cloud computing in education. *International Journal of Information Management*, *36*(2), 183-191.

Sackey, S. M., & Bester, A. (2016). Industrial engineering curriculum in Industry 4.0 in a South African context. *South African Journal of Industrial Engineering*, *27*(4), 101-114.

Saeed, I., Juell-Skielse, G., & Uppstrom, E. (2012). Cloud enterprise resource planning adoption: Motives & barriers. *Advances in Enterprise Information Systems II*, *429*.

Sagita, M., & Khairunnisa, K. (2020). E-Learning for Educators in Digital Era 4.0. *Budapest International Research and Critics Institute (BIRCI-Journal): Humanities and Social Sciences*, *3*(2), 1297-1302.

Saieed, Z. (2018). *PM unveils four-pronged strategy to boost manufacturing*. Retrieved from https://www.thestar.com.my/business/business-news/2018/10/31/pm-unveils-four- pronged-strategy-to-boost-manufacturing

Sajjad, A., Eweje, G., & Tappin, D. (2015). Sustainable supply chain management: motivators and barriers. *Business Strategy and the Environment*, *24*(7), 643-655.

Sakinah, S. (2020). *Is Malaysia ready for Industrial Revolution 4.0?* Retrieved from https://www.easyuni.my/en/advice/is-malaysia-ready-industrial-revolution-2409/

Salkind, N. (2010). Ordinal Scale. *Sage Research Method*. Retrieved from https://methods.sagepub.com/reference/encyc-of-research-design/n294.xml

Sardroud, J. M. (2012). Influence of RFID technology on automated management of construction materials and components. *Scientia Iranica*, *19*(3), 381-392.

Schattner, P., & Mazza, D. (2016). Doing A Pilot Study: Why is it Essential? *Malaysian Family Physician 2006*, *1*(2), 9-30.

Schleife, K. (2006). Computer use and employment status of older workers: an analysis based on individual data. *Labour*, *20*(2), 325-348.

Schroder, C. (2016). The challenges of industry 4.0 for small and medium-sized enterprises. *Friedrich-Ebert-Stiftung: Bonn, Germany*.

Senarathna, I., Wilkin, C., Warren, M., Yeoh, W., & Salzman, S. (2018). Factors that influence adoption of cloud computing: an empirical study of Australian SMEs. *Australasian Journal of Information Systems, 22*.

Shamim, S., Cang, S., Yu, H., & Li, Y. (2016). Management approaches for Industry 4.0: A human resource management perspective. *2016 IEEE Congress on Evolutionary Computation (CEC).*

Shaouf, A., & Altaqqi, O. (2018). The impact of gender differences on adoption of information technology and related responses: A review. *International Journal of Management and Applied Research, 5*(1), 22-41.

Sharma, P. (2019). Digital Revolution of Education 4.0. *International Journal of Engineering and Advanced Technology (IJEAT), 9*(2), 3558-3564.

Sharmila, G. (2018). Are Malaysian SMEs ready for Industry 4.0? *Digital News Asia*. Retrieved from https://www.digitalnewsasia.com/digital-economy/are-malaysian-smes-ready-industry-40

Sharon, A. (2019). Malaysia's cybersecurity sector must be strengthened. *OpenGov Asia.* Retrieved from https://www.opengovasia.com/malaysias-cybersecurity-sector-must-be-strengthened/

Shiau, S., Huang, C., Yang, C., & Juang, J. (2018). A derivation of factors influencing the innovation diffusion of the OpenStreetMap in STEM education. *Sustainability, 10*(10), 3447.

Sila, I. (2013). Factors affecting the adoption of B2B e-commerce technologies. *Electronic commerce research, 13*(2), 199-236.

Silva, V. L., Kovaleski, J. L., & Pagani, R. N. (2019). Technology transfer and human capital in the industrial 4.0 scenario: A theoretical study. *Future Studies Research Journal: Trends and Strategies, 11*(1), 102-122.

Silvestre, B. S., Monteiro, M. S., Viana, F. L. E., & de Sousa-Filho, J. M. (2018). Challenges for sustainable supply chain management: When stakeholder collaboration becomes conducive to corruption. *Journal of Cleaner Production, 194*, 766-776.

Sima, V., Gheorghe, I. G., Subic, J., & Nancu, D. (2020). Influences of the Industry 4.0 Revolution on the Human Capital Development and Consumer Behavior: A Systematic Review. *Sustainability*, *12*(10), 4035.

Smith, P. (2014). BIM & the 5D project cost manager. *Selected Papers from the 27th IPMA (International Project Management Association).*

Soto-Acosta, P., & Merono-Cerdan, A. L. (2006). An analysis and comparison of web development between local governments and SMEs in Spain. *International Journal of Electronic Business*, *4*(2), 191-203.

Spottl, G. (2017). Skilled Workers: Are They the Losers of "Industry 4.0"?. In *Advances in Ergonomic Design of Systems, Products and Processes*, 73-87.

Statistics Centre. (2017.) *Statistical data editing guide*. Retrieved from https://www.scad.gov.abudhabi/MethodologyDocumentLib/5-%20Statistical%20Data%20Editing%20Guide.pdf

Stentoft, J., Jensen, K. W., Philipsen, K., & Haug, A. (2019). Drivers and barriers for industry 4.0 readiness and practice: A SME perspective with empirical evidence. *Proceedings of the 52nd Hawaii International Conference on System Sciences*, 5155-5164.

Sukamolson, S. (2007). Fundamentals of quantitative research. *Language Institute Chulalongkorn University*, *1*, 2-3.

Surendran, P. (2012). Technology Acceptance Model: A Survey of Literature. *International Journal of Business and Social Research*, *2*(4), 175-178.

Taherdoost, H. (2016). Sampling Methods in Research Methodology; How to Choose a Sampling Technique for Research. *International Journal of Academic Research in Management (IJARM)*, *5*(2), 18-27.

Tan, R. (2019). *SMEs still not ready for fourth Industrial Revolution*. Retrieved from https://www.thestar.com.my/business/business news/2019/04/05/smes-still-not-ready-for-fourth-industrial-revolution

Tan, S. T., Hemashwary, S., & Shahryar, S. (2019). Exploring Challenges of the Fourth Industrial Revolution. *International Journal of Innovative Technology and Exploring Engineering*, *8*(9), 27-30.

Tariq, Q. (2020). *Celcom and maxis: Shared 5G network a success, hit speeds above 1Gbps.* Retrieved from https://www.thestar.com.my/tech/tech-news/2020/01/17/celcom-and-maxis-shared-5g-network-a-success-hit-speeds-above-1gbps

Tay, S. I., Lee, T. C., Chan, S. W., Alipal, J., & Abdul Hamid, N. (2019). An Overview of the Rising Challenges in Implementing Industry 4.0. *International Journal of Supply Chain Management*, *8*(6), 1181-1188.

Teo, T. (2011). Technology acceptance research in education. *SensePublishers*, 1-5.

The Fourth Industrial Revolution Australian businesses in transition. (2019). *Australian Industry Group*.

The Race Towards Industry 4.0. (2018). *Malaysia Productivity Corporation website*. Retrieved from http://www.mpc.gov.my/wp-content/uploads/2018/11/The-Race-Towards-Industry-4.0.pdf

The Sun Daily. (2017). Low awareness, adoption of Industry 4.0 among Malaysian manufacturers. Retrieved from: https://www.thesundaily.my/archive/low-awareness-adoption-industry-40-among-malaysian-manufacturers-FTARCH492369

Thiemann, A. T., Bolton, P., Capobianco, A., Claessens, S., Trupia, G., & Vravosinos, O. (2019). Digital Disruption in Banking and its Impact on Competition. *OECD*.

Thompson, R. L., Higgins, C. A., & Howell, J. M. (1991). Personal computing: toward a conceptual model of utilization. *MIS quarterly*, 125-143.

Tjikongo, R., & Uys, W. (2013). The viability of Cloud Computing Adoption in SMME's in Namibia. *IST-Africa Conference & Exhibition*, 1-11.

Toh, K. I. (2019). *Digi continues 5G rollout*. Retrieved from https://www.thestar.com.my/business/business-news/2019/09/18/digi-continues-5g- rollout

Top 19 fintech startups in Hong Kong 2019. (2019). Retrieved from https://fintechnews.hk/top-20-fintech-startups-hong-kong/

Top 30 fintech startups in Singapore. (2019). Retrieved from https://fintechnews.sg/top-30-fintech-startups-in-singapore/

Tortorella, G. L., & Fettermann, D. (2018). Implementation of Industry 4.0 and lean production in Brazilian manufacturing companies. *International Journal of Production Research*, *56*(8), 2975-2987.

Townsend, A. M. (2013). *Smart cities: Big data, civic hackers, and the quest for a new utopia*. W. W. Norton & Company.

Trappey, A. J., Trappey, C. V., Govindarajan, U. H., Chuang, A. C., & Sun, J. J. (2017). A review of essential standards and patent landscapes for the Internet of Things: A key enabler for Industry 4.0. *Advanced Engineering Informatics*, *33*, 208-229.

Turkes, M. C., Oncioiu, I., Aslam, H. D., Marin-Pantelescu, A., Topor, D. I., & Capușneanu, S. (2019). Drivers and Barriers in Using Industry 4.0: A Perspective of SMEs in Romania. *Processes*, *7*(3), 153.

United Nations (2014). *United Nations e-government global survey*. Retrieved from http://unpan3.un.org/egovkb/en-us/Reports/UNE-Government-Survey-2014

Venkatesh, V., Morris, M. G., & Ackerman, P. L. (2000). A Longitudinal Field Investigation of Gender Differences in Individual Technology Adoption Decision-Making Processes. *Organizational Behavior and Human Decision Processes*, *83*(1), 33-60.

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *MIS quarterly*, 425-478.

Walker, H., Di Sisto, L., & McBain, D. (2008). Drivers and barriers to environmental supply chain management practices: Lessons from the public and private sectors. *Journal of purchasing and supply management*, *14*(1), 69-85.

Walsh, G. (2015). *Digital banking in Japan*. Retrieved from https://www.iedigital.com/blog/digital-banking-in-japan/

Wernerfelt, B. (1984). A resource-based view of the firm. Strategic Management Journal, *5*, 171-180.

Wijayanti, F., & Turgel, I. (2019). Industrial revolution 4.0: is Indonesia labor market ready or not?. *Book of Proceedings.*

Winter, S. G. (1984). Schumpeterian competition in alternative technological regimes. *Journal of Economic Behavior & Organization*, *5*(3-4), 287-320.

Woetzel, J., Seong, J., Wang, K. W., Manyika, J., Chui, M., & Wong, W. (2017). China's digital economy: A leading global force. Retrieved from https://www.mckinsey.com/featured-insights/china/chinas-digital-economy-a-leading-global-force#

Won, J. Y., & Park, M. J. (2020). Smart factory adoption in small and medium-sized enterprises: Empirical evidence of manufacturing industry in Korea. *Technological Forecasting and Social Change*, 157.

Wong, K. K. K. (2011). Book review: Handbook of partial least squares: Concepts, methods and applications. *International Journal of Business Science & Applied Management. 6* (2), 52-54.

Wong, K. K. K. (2013). Partial least squares structural equation modeling (PLS-SEM) techniques using smart PLS. *Marketing Bulletin, 24*(1), 1-32.

Wright, P. M., McMahan, G. C., & McWilliams, A. (1994). Human resources and sustained competitive advantage: a resource-based perspective. *International journal of human resource management*, *5*(2), 301-326.

Yap, C. S., Soh, C. P. P., & Raman, K. S. (1992). Information systems success factors in small business. *Omega*, *20*(5-6), 597-609.

Yatid, M. M. (2019). *Why is digital adoption by SMEs not taking off? New Straits Times.* Retrieved from https://www.nst.com.my/opinion/columnists/2019/01/453789/why-digital-adoption-smes-not-taking

Yeoh, A. (2019). *TM plans to slash Streamyx price, introduce wireless broadband*. Retrieved from https://www.thestar.com.my/tech/tech-news/2019/07/27/tm-streamxy-price-cut

Yurii, S.I., Fedosov, V.M. (2008). Finansy. Pidruchnyk. Znannya, Kyiv, 611.

Zadeh, F. O., & Eskandari, A. (2012). Firm size as company's characteristic and level of risk disclosure: Review on theories and literatures. *International Journal of Business and Social Science*, *3*(17), 9-17.

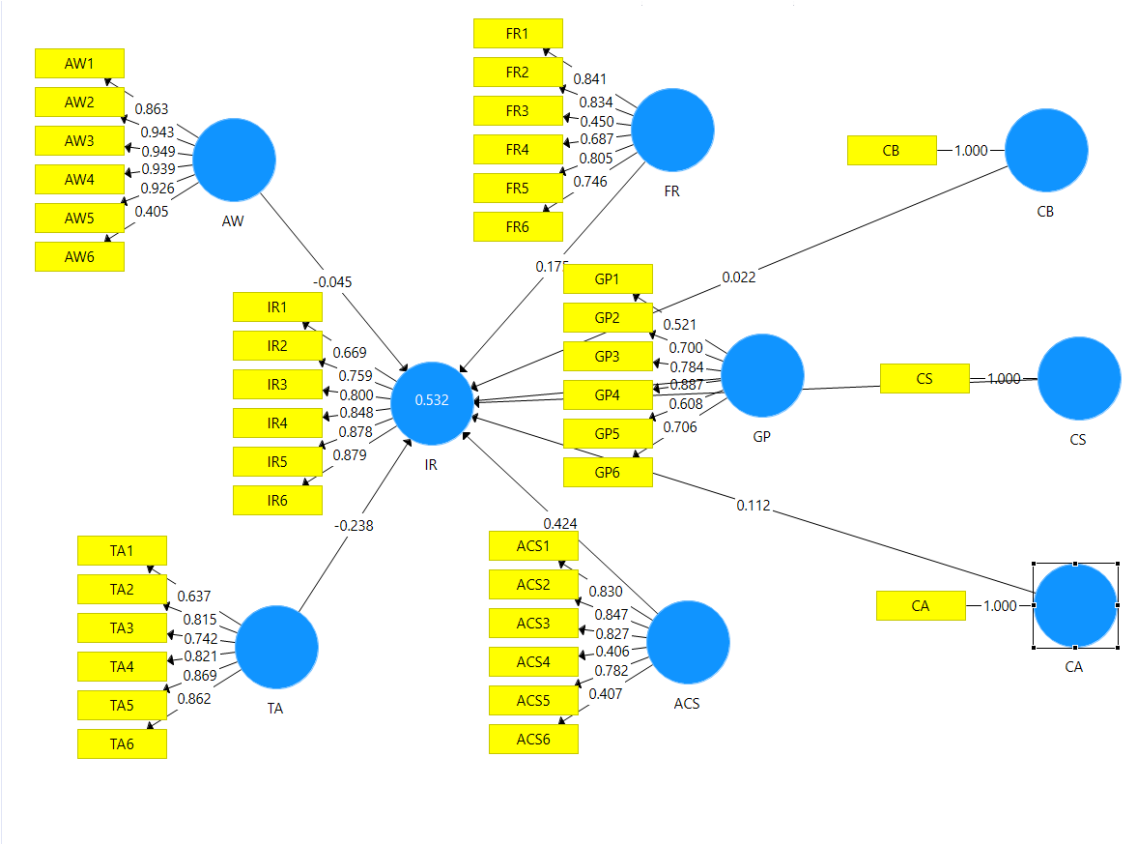
Zhao, S. (2008). Application of human capital theory in China in the context of the knowledge economy. *The International Journal of Human Resource Management*, *19*(5), 802-817.

Zhou, K., Liu, T., & Zhou, L. (2015). Industry 4.0: Towards future industrial opportunities and challenges. *12th International conference on fuzzy systems and knowledge discovery (FSKD)*, 2147-2152.

APPENDICES

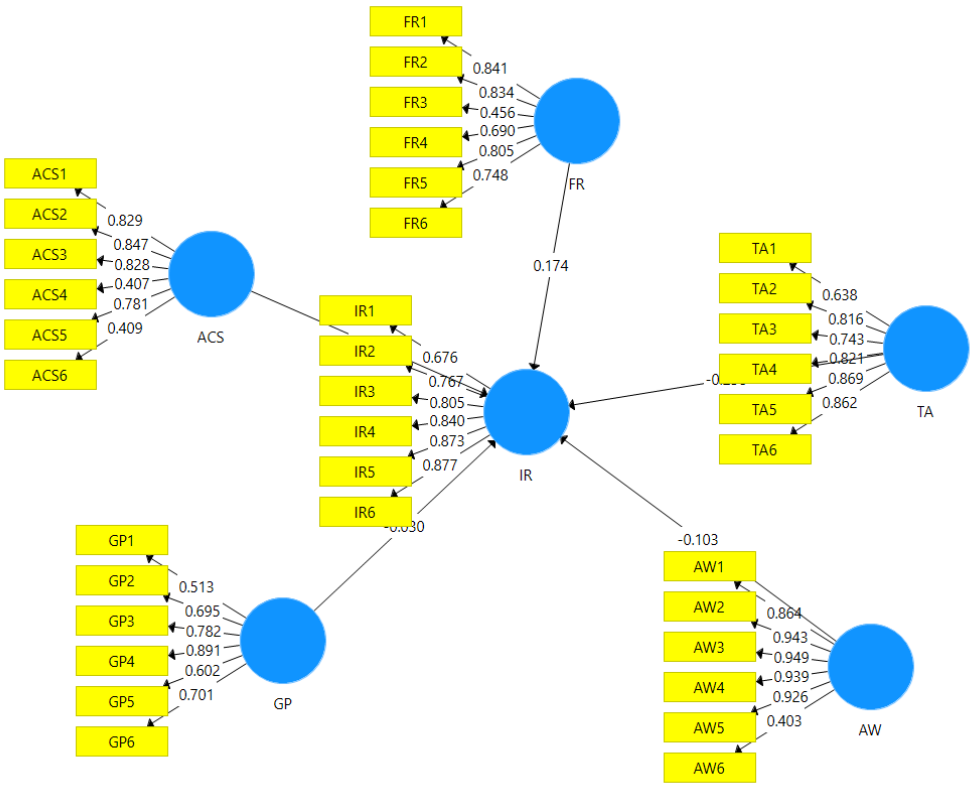
Appendix 4.1

Figure 4.1 Results of Measurement Model



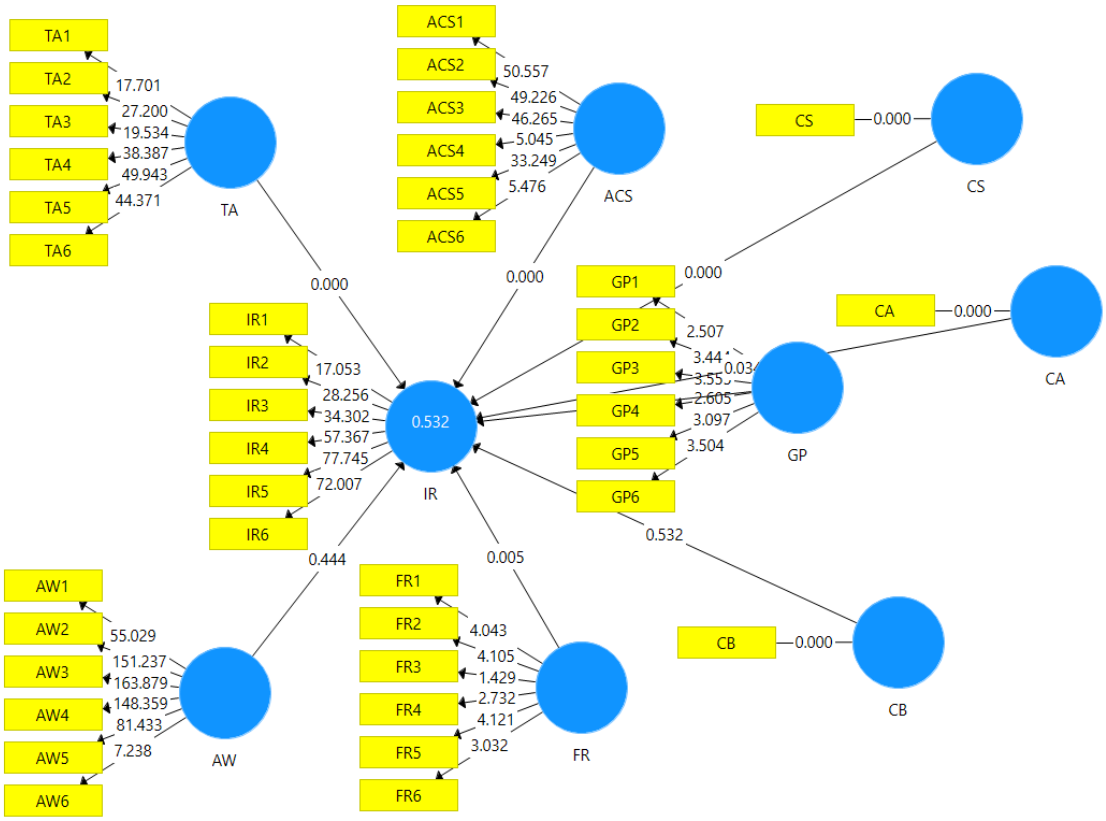
Appendix 4.2

Figure 4.2 Results of Structural Model



Appendix 4.3

Figure 4.3: Results of Bootstrapping and Path Coefficients



Appendix A: Questionnaire

The Industrial Revolution 4.0 in Malaysia: Challenges, Barriers, Obstacles, and recommendations for action.

Dear respondent,

We are final year undergraduate students of Bachelor of Business Administration (Hons) Banking and Finance. You are invited to take part voluntarily in a research study that involves sharing of information about the implementation of the Fourth Industrial Revolution. The purpose of this study is to determine the challenges, barriers and obstacles to the implementation of the Fourth Industrial Revolution in Malaysia. The criterion of the respondent is all the person who working in the management level or employer of the organization.

Industry 4.0 is the trend towards automation and data exchange in manufacturing technologies and processes such as cloud computing, big data and internet of things. Industrial revolution 4.0 that was triggered by the development of information and communication technology. This can be described as the revolution for increasing the information used and automation technologies in the manufacturing sector.

Your participation in this study is entirely voluntary. You may refuse to take part in the study, or you may stop participation in the study at any time, without a penalty or loss of benefits to which you are otherwise entitled. Your information will be kept confidential by the researcher and staff and will not be made publicly available unless disclosure is required by law. Data obtained from this study that does not identify your identity can published for knowledge purpose.

Please attempt this questionnaires by answering all the questions honestly with your best knowledge. All the information collected is private and confidential, and will only be used for academic purpose.

There are seven (7) sections in this questionnaires. Please answer ALL questions in ALL sections. This questionnaires would take you approximately 10-20 minutes.

Thank you for your participation.
*Required

1. I acknowledged and agreed to the terms and conditions stated above and I am willing to take part in this survey. *

   Mark only one oval.

   ◯ Yes
   ◯ No

Please answer each of the questions given below.

Section A: Demographic

2. Gender *

Mark only one oval.

- Male
- Female

3. Age group *

Mark only one oval.

- 24 years old and below
- 25-34 years old
- 35-44 years old
- 45-54 years old
- 55-64 years old
- above 65 years old

4. Educational background *

Mark only one oval.

- High school or below
- Certificate or Diploma
- Bachelor's degree
- Postgraduate education
- Professional certificate

5. Company's Business *

Mark only one oval.

- ◯ Mining
- ◯ Agriculture
- ◯ Manufacturer
- ◯ Banking
- ◯ Other: _____

6. Company Size *

Mark only one oval.

- ◯ 10 employees and below
- ◯ 11-50 employees
- ◯ 51-100 employees
- ◯ 101-250 employees
- ◯ 251 employee and above

7. Company Age *

Mark only one oval.

- ◯ 1-9 years
- ◯ 10-19 years
- ◯ 20-29 years
- ◯ 30-39 years
- ◯ 40-49 years
- ◯ 50-59 years
- ◯ 60 years and above

Section B: Fourth Industrial Revolution

Please provide your opinion about Industry 4.0 adoption. Please choose the correct numeric response to each question, to indicate how much you agree or disagree with each statement. For instance, 1 = Strongly Disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; and 5 = Strongly Agree.

8. I think adopting Industrial 4.0 might be useful in the future. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

9. I understand the benefits of implement Industrial 4.0. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

10. I believe that implementation of Industrial 4.0 can enhance employee productivity. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

11. Our organization considered to implement Industry 4.0. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

12. Our organization supports the implementation of Industrial 4.0. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

13. Our organization interested in adopting Industrial 4.0 in order to gain competitive advantages. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

Section C: Lack of Technology Acceptance

Please provide your opinion about the technology acceptance towards development of Industry 4.0. Please choose the correct numeric response to each question, to indicate how much you agree or disagree with each statement. For instance, 1 = Strongly Disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; and 5 = Strongly Agree.

14. Our employees do not trust Industry 4.0 technologies. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

15. Our employees afraid of dependence on Industry 4.0 technologies. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

16. We expect non-acceptance of Industry 4.0 by employees. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

17. Our employees fear of losing job after implemented Industry 4.0 technologies. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

18. Our organization fear to adopt Industry 4.0 technologies due to the unknown experiences. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

19. Our organization fear to adopt Industry 4.0 technologies due to the uncertainty of benefits. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

Section D: Lack of Awareness

Please provide your opinion about the awareness towards Industry 4.0 adoption. Please choose the correct numeric response to each question, to indicate how much you agree or disagree with each statement. For instance, 1 = Strongly Disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; and 5 = Strongly Agree.

20. Our organization is lack of awareness about Industry 4.0 technologies. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

21. Our organization were lack of information about Industry 4.0. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

22. Our organization have low knowledge on the concept of Industry 4.0. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

23. Our organization have low understanding of implementation of Industry 4.0. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

24. Our organization have poor research and development on Industry 4.0 adoption. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

25. Low level of adoption of Industry 4.0 technologies in the market in Malaysia. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

Section E: Lack of Financial Resources

Please provide your opinion about the financial resources towards development of Industry 4.0. Please choose the correct numeric response to each question, to indicate how much you agree or disagree with each statement. For instance, 1 = Strongly Disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; and 5 = Strongly Agree.

26. A large amount of financial are needed by a company to adopt Industry 4.0. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

27. A large company have to prepare large amount of financial before entering to Industry 4.0. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

28. Most of the companies do not have enough financial to invest in Industry 4.0. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

29. Insufficient of financial resources can hinder company in development project. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

30. Shortage of financial resources is a limitation in the adoption of Industry 4.0. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

31. Adoption of Industry 4.0 is expensive. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

Section F: Lack of Appropriate competence and skill

Please provide your opinion about the appropriate competence and skill towards development of Industry 4.0. Please choose the correct numeric response to each question, to indicate how much you agree or disagree with each statement. For instance, 1 = Strongly Disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; and 5 = Strongly Agree.

32. I know what skills are needed for organization to adopt Industrial 4.0. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

33. I have the skill that necessary to help organization in implementing Industrial 4.0. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

34. I always upgrade my skills and information of Industrial 4.0. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

35. Lack of competence and skilled worker is an obstacle in the implementation of Industrial 4.0. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

36. My organization have provided support and training for employees to develop new skills. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

37. Employees' disability to learn the required skills or knowledge is the obstacles for organization in implement Industrial 4.0. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

Section G: Government Policies

Please provide your opinion about the government policies towards development of Industry 4.0. Please choose the correct numeric response to each question, to indicate how much you agree or disagree with each statement. For instance, 1 = Strongly Disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; and 5 = Strongly Agree.

38. I think government should developed a policy framework for Industry 4.0 adoption. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

39. I think a standard regulation assists my company to adopt Industry 4.0. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

40. I think policy will guiding my company to develop Industry 4.0. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

41. I think my company have low perception of Industry 4.0 due to poor policy implementation. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

42. I think current government policies is insufficient to solve the problem of poor implementation of Industry 4.0. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

43. I think shortage of government policies restricts company to implement industry 4.0. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree