Readiness of Industry 4.0 in Manufacturing Industry

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DOI : https://dx.doi.org/10.47772/IJRISS.2024.808077

Received: 14 August 2024; Accepted: 23 August 2024; Published: 31 August 2024

ABSTRACT

Readiness of Industry 4.0 is about the capabilities in adapting the technologies in manufacturing industry which is absence in Malaysian manufacturing industries currently. By knowing the readiness level, an organization able to find out the barriers in implementation of Industry 4. The main purpose of this research study is to determine the readiness level to INDUSTRY 4.0 in manufacturing industry and to identify the barriers of Industry 4.0 in manufacturing industry. In Industry 4.0, there are three type of integration which is vertical integration, horizontal integration and end-to-end integration, each integration is focusing on some specific Industry 4.0 technology. For this research, the integrations were used to conduct the data collection with quantitative method and the main instrument used in data collection was descriptive analysis. A total of 60 online survey questionnaire was collected. Moreover, all two objectives were achieved. Based on this research, Malaysia manufacturing industries were not ready for the adaption of Industry 4.0 and the barriers was the most influence variable in Malaysian manufacturing industries since the data obtain has higher agreement for barriers. With the limitation of sample size and population, future researchers can investigate a bigger population such comparing different country for more rigorous findings and to able to generalize in a bigger context.

Keywords: Readiness level of Industry 4.0, barriers of Industry 4.0, manufacturing industry

INTRODUCTION

Industry 4.0 readiness is described as the level to which organizations are able to utilize advantage of Industry 4.0 technologies (Stentoft et al., 2019). In other words, it is about industries being digitally ready or prepared for Industry 4.0 technologies (Schwab et al., 2017, Vazire et al., 2018). The software and hardware side of organizations had change due to digital transformation (Haber et al.,2015, Wank et al., 2016). Moreover, Industry 4.0 readiness can also be studied from competitive, technological and organizational perspectives. Most of the studies classify Industry 4.0 as disruptive for the same reason(Wichmann, Eisenbart, &Gericke, 2019).

For better performance, industry had been making consistent endeavors to develop and re-develop self-assessment models that can assess the Industry4.0 readiness of organizations. In view of the models at that point, associations can have two terminal states, least ready or most ready(Wichmann, Eisenbart, & Gericke, 2019). There are numerous dimensions, which can likewise be filtered based on degree of complexity. The outcomes at that point can be utilized for benchmarking. Accomplishing this Industry 4.0 readiness is both an exceptionally huge and urgent interest and need of businesses now (Schaupp et al., 2017). Identification of these Industry 4.0 readiness models is essentially required as it will empower organizations to gauge points of precedents and antecedents in the digital transformation process which would then be able to prompt organization to change.

Research background

The 1990s saw Malaysia thrilled with it's a newly discovered affluence as it developed into a modern economy. Over the thirty years paving the way to the industrial revolution, Malaysia's economy achieved a change from relying upon essential products to one in which the manufacturing industry arose as the main financial development area.

In accordance with the normal changes, organizations are getting progressively inspired by the use of modern technologies to guarantee long-term competitiveness and empower them to adjust to powerfully changing environmental conditions, for example, shortening product lifecycles, expanding variety and changing customer desires (Adolph et al., 2014; Bauer et al., 2015; Lasi et al., 2014). With the expanding pressure, various variables can be distinguished that can help manufacturers in implementing Industry 4.0.

Furthermore, a few initiatives to encourage the adoption of modern technologies to local industry have knock up by the Malaysian government agencies. The Malaysian Industry-Government Group for High Technology (MIGHT) is acquainted with address the nation's requirements because of the impacts of globalization and trade liberalization on future economic development through the quickened utilization of high technology. Malaysia plans to be at the bleeding edge of the up-coming generation of advances in science and technology through the recently set-up Global Malaysia-Korea Robotics Collaboration and Development Program. In this manner, the improvement of automation and robotic industry can possibly lead Malaysia towards Industry 4.0 through key activities by government and industry player the same.

Problem statements

Manufacturing industries in Malaysia are facing problems in implementing Industry 4.0. Firstly, manufacturing industries need to know the capability of the organization from the readiness level of industry 4.0 for the adaption. After knowing the readiness level in industry 4.0, a manufacturing industry can implement the technology of industry 4.0 in the organization without any hesitation. Beyond the capability of an industry can bring lost to the organization, this is why the readiness level of Industry 4.0 in manufacturing industries is important to be known.

In Malaysia, production is still mainly dependent on foreign labor (Mohamad,2023).To embrace this new technology, a complete change of mindset is needed. This not only can increase productivity and efficiency but also can make use of digital platforms to expand the markets. In Malaysia, the aspects of the work environment and skills development are very well described and monitored. Nevertheless, this does not mean that these issues are dealt with or even solved. The major challenges to the implementation of Industry4.0 are the lack of skilled work force, and the requirement to retrain staff to fit changed circumstances in regard to the full implementation of Industry 4.0 since it requires the integration of the current work force with the digital technology (Tay, Alipal, & Lee, 2021).

However, the ways of data processing, storing and management of data for each organization start to face various future demands and challenges (Müller et al.,2018).Companies often faced problem related to insufficient of standard approach to manage the data due to the unnecessary data kept in different departments with various types of data renewal, minor enrichments and extensions. Transition into Industry 4.0 is not easy and has all sort of impacts on production system, especially in security. This is tale sign that there are barriers in order to implement Industry 4.0 within Malaysia’s manufacturing industry as well. Therefore, this research intends to measure the readiness level of manufacturing industry in Industry 4.0 and what barriers for Industry 4.0 in manufacturing industry.

Research questions

1. What is the readiness level to Industry 4.0 in manufacturing industry?
2. What are the barriers of Industry 4.0 in manufacturing industry?

Research objectives

1. To identify the readiness level of Industry 4.0 in manufacturing industry.
2. To determine the barriers of Industry 4.0 in the manufacturing industries.

LITERATURE REVIEW

Introduction

The adaption to technology of Industry 4.0 is known from the readiness level of Industry 4.0 in manufacturing industry. Implementing Industry 4.0 in manufacturing industry reduce time taken to complete a work. Theory of Industry 4.0 helps the organization in the production line with the components of Industry 4.0 from the integrations.

Concept of Industry 4.0

The expanding digitization of the whole supply chain is the term of "Industry 4.0", which makes it conceivable to associate systems and objects dependent on constant information trade (Dorst et al., 2015). As a result of this interconnection, products, processes and machines with computerized reasoning will have the option to adjust to changing natural variables (Hecklau et al., 2016). Roblek et al. (2016) characterized the five key components of Industry 4.0 as, customization of production and digitization streamlining, adaptation and automation, human–machine association, esteem included administrations and stores, and communication and automatic data exchange. These are some of additional feature that will increase the competitive advantage in the manufacturing industry thanks to Industry 4.0. Industry 4.0 can be integrated within a system by these methods based on the past researches.

Vertical integration

Vertical integration concerns the mix of different Information Technology systems at the diverse hierarchical levels inside an industry (Kagermann et al, 2013). The "internet of things" and services award quick admittance to IT and production systems through vertical integration (Chukalov, 2017). The vertical integration prerequisites of IoT applications including machine-to-machine, machine-to-worker and worker-to-worker interchanges (Al-Fuqaha et al, 2015). Wang et al.,2016 underscores the centrality of vertically integration the degrees of the automation pyramid, from sensors and actuators on the shop floor, up through the Manufacturing Execution System (MES) and further up to the Enterprise Resource Planning (ERP) level. Through vertical integration of information and data straightforwardly from the workplace by controlling and operating on a production and corporate level, the data is handled and accordingly, sufficient data about the management is returned. (Chukalov,2017).

Horizontal integration

Horizontal integration is the incorporation of value network to empower collaboration effort between corporations or organizations in the value chain (Foidl & Felderer, 2015). For the accomplishment of the business, more than one organization cooperates to convey superior products and services (Sindi & Roe, 2017). By inter-cooperation horizontal integration of organizations through digitization, another effective digitized ecosystem is made. Through the integration of the Network IT technologies and manufacturing systems a trade of information and data should be set up between the organizations and the geographically remote sites (Chukalov, 2017). One organization should both contend and help out numerous other related companies. By the inter-corporation horizontal integration, related firms can shape an effective environment. Finance, Information and material can stream smoothly among these firms. Subsequently, new value network just as business models may arise.

End-to-end engineering integration

End-to-end engineering integration (EEI) across the whole value chain will uphold the expanding requirements on the products customization. It includes cross-linking of stakeholders, products and equipment

along the product life cycle, from crude material securing to end of life. In EEI, a product-centric value creation process is upheld., a chain of duties is included in the manufacturing process, for example, consumer requirement articulation, product design and development, production planning, production engineering, services, production, maintenance and reuseare integrated (Saucedo, et, al., 2018).Via this way, a consistent and continuous product model can be reused by each stage. The impact of product design on production and service can be predicted utilizing the ground-breaking programming device chain so the customized products are enabled.

Definition of readiness in Industry 4.0

Maturation and readiness come hand in hand. Maturation process can start afterreadiness. Readiness appears if the organization is prepared to begin an advancement process (Schumacher et al. 2016). Readiness is the state wherein a substance is to achieve something, and maturity is the degree of advancement that an element is as for something. The company or organization is assessed dependent on these components by picking a fitting level of scale.

Current state of Industry 4.0 in Malaysian manufacturing industry

In Malaysia, there is just 30% of manufacturers having awareness of the idea of Industry 4.0 (Gilchrist, 2016). Despite the fact that the manufacturers are acknowledged of the significance of Industry 4.0 for future improvement and chances in competitiveness, the condition of readiness for its implementation varies broadly relying upon the nation, sector, or even an individual company. Nonetheless, significant quantities of Malaysian executives are keeping a hopeful mentality about entering the fourth industrial revolution (GE Reports, 2016). Regarding worldwide intensity, Malaysia is shutting the gap from 25th (2016-2017) to 23rd (2017-2018) out of 137 worldwide economies as revealed in Global Competitiveness Index 2017-2018 (Schwab, 2017). Latterly, the public authority of Malaysia dispatched Industry4RWD to help local manufacturer particularly the SMEs to keep in speed with the worldwide pattern, changing into Industry 4.0. Industry4WRD additionally expects to raise the innovation capacity and capability, last however not the least, grow all the more high-talented labor force in manufacturing industries from 18% to 35% (Zarina, 2018).

Barriers to Industry 4.0 implementation

Malaysia manufacturing companies having the same issues in adopting INDUSTRY 4.0, such as, limited understanding of manufacturing firms of required future abilities and mastery and own readiness to set out on Industry 4.0 change and Significant lack of required talents, skills and information for Industry 4.0, especially in the regions of IoT, robotics and AI (Industry, 2018). Low computerized appropriation and constrained utilization of automation by manufacturing companies (larger part of firms utilize less than half of automation), absence of incorporated and advanced way to deal with information assembling along manufacturing and supply chains and exposure to cyber threats with expanded availability and new innovations (technologies), particularly IoT and significant expense of speculation for usage of INDUSTRY 4.0. Another factor of barrier in adapting INDUSTRY 4.0 is advancement, developing client desires and interest for customisation of product and quicker conveyance speeds. In addition, less practice understanding likewise one of the issues to the usage of INDUSTRY 4.0, absence of an incorporated. Absence of mindfulness on the effect of and requirement for Industry 4.0 advances, both in terms of opportunities and plan of action disturbance in manufacturing industry. The qualifications and skills of the employees will turn into the way to achievement of a profoundly creative production line (A. Benešová, J. Tupa, 2017).

RESEARCH METHOD

Introduction

Research method is theoretical assessment of system that associated with a field of study. It incorporates explaining, predicting issues that strikes find an answer. Research process requires investigate procedures and data examination as a fundamental device to find ways.

Research design

The objective of this research is to verify the readiness level of Industry 4.0 in manufacturing industries. This research is conducted in selected manufacturing industries in Malaysia. Quantitative method is the only method used in this research due to short time frame of this research. Quantitative method is getting numerical data or data that can be altered into usable statistics to measure the issue (DeFranzo, 2011). It comprises cross-sectional studies with questionnaires for data collection with the intent of simplifying from a sample to a population (Rowler, 2008, as cited in Creswell, 2013).

Population, sample and sampling procedure

This research is conducted in manufacturing industries in Malaysia and it is specific to one particular department in the organization which is, the production department. After fixing the population, the sample size was determined. To make sure the accurate research findings to be obtained a larger sample is chosen to represent the population in this research. The samples are chosen because they are reachable to the researcher. Subjects are chosen because of their convenient availability and proximity to the researcher (Ahmad et al, 2014). The sample size of this research is only 60 employees as the sample taken from manufacturing industries.

Instrument

Close ended questionnaire has been chosen as the most suitable instrument for this research. The main purpose of choosing questionnaire as the instrument for this research is to collect the data from the organizations easily. The five-point Likert scale was used as follows specify the disagreement or agreement for each question. Based on the 5-point Likert scale in the questionnaires where the range differs from strongly disagree to strongly agree.

Pilot study

A pilot study can be characterized as a small study to test research conventions, sample recruitment strategies, data collection instruments and other examination techniques in preparation of a larger study (Zailinawati, Schattner and Mazza, 2006). Pilot study is a pre-test that is important to be run to assess the reliability and validity of the research. Pilot test is likewise an approach to pre-test the research instrument, which is the close-ended questionnaire. The pilot test is additionally to find that the respondents comprehend the poll that was given. Pilot study is use in limited scope before the real exploration is directed. The Cronbach's alpha value should be more than 0.7 to demonstrate that the survey is profoundly reliable and ready to be utilized to accomplish the research objectives. In this paper, the value for every variable were higher than 0.7 and it is considered reliable.

Validity and reliability

Validity refers to how much a research precisely evaluates or mirrors the particular idea that the researcher is attempting to measure (Ahmad et al, 2014). Other than that, reliability indicates to the stability, repeatability and consistency of results. For instance, if the result of a researcher obtained in identical situation but different circumstances is consistent then the result is highly reliable.

Construct measurement

In this research, there are 3 sections which include section A, section B and Section C. Section A is the respondent's detail, section B is the evaluation of the technology of IR4.0 used in Malaysian manufacturing industry and section C is evaluation of the barriers in implementing industry 4.0. Section A has 5 items which gender, age, length of service, salary, and type of manufacturing industry. Meanwhile section B consist questions regarding technology used in Malaysia manufacturing industry namely vertical integration, horizontal integration, end-to-end engineering integration and readiness towards industry 4.0. In this research, the researcher used SPSS software to analysed the quantitative survey. For SPSS software, section A used

nominal as the level of measurement and section B scale as the level of measurement. The scale used in this research is the Nominal Scale for demographics of respondent and Likert Scale for the independent variable. In this research, the 5-point Likert scale is being adapted to measure the agreement on the independent variables and the dependent variable. 5-Likert Scale is used because the rescaled 5-point scale produced more instances of higher scores as shown in Table 3.1.

Table 3.1: Measurement and Author used for each variable

Variables	Measurement	Scale of Measurement
Independent Variables		
Vertical integration	Interval	5-point Likert scale
Horizontal integration	Interval	5-point Likert scale
End-to-end engineering integration	Interval	5-point Likert scale
Readiness towards Industry 4.0	Interval	5-point Likert scale
Dependent Variable		
Barriers in implementing Industry 4.0	Interval	5-point Likert scale

Mean, mode and standard deviation

The range determined is based on the formula and as used by Hanson and Creswell (2005). According to these researchers, the mean scores of agreements range from 1.00 to 2.33 are construed as low, mean scores of agreements range from 2.34 to 3.67 are construed as moderate and mean scores of agreements range from 3.68 to 5.00 are construed as high.The part of barriers in this research was analysed based on the mean score, mode and standard deviation. The mode value will be showing which agreement level is the highest for each barrier.

Ethics of the study

Before collect the data from a particular industry, it is necessary to get permission from the industry. When the samples are chosen, all the chosen employees to be the respondents were clarified in brief on the objective of the research and the reason they are selected as the respondents. To be aware of whether they are intent in becoming the sample of this study is the core reason of explaining this information to them. Furthermore, the questions in the questionnaire were prepared to be appropriate questions and valid, related to the research only. The questions are not directed to a specific group of people, as it is a widespread set of questions that is required to accomplish this research in a proper way possible.

Data collection procedure

This study is merely based on the data gathered by using a survey basedquestionnaire. Employees from sixty manufacturing industries in Malaysia were chosen randomly for the data collection of this study. Convenience sampling is used in this research as the data collection procedure. The questionnaires are required to be completed by three days. Then will be arranged collectively in order to start with the analysis of data with a total of 60 questionnaires from the manufacturing industry.

Data analysis procedure

Analyse the collected data with IBM Statistical Package for the Social Sciences (SPSS) Software version 26.

To analyse the descriptive statistics the SPSS software was used. This software is suitable to analyse all the data gathered from the survey conducted on the readiness level of IR4.0 in manufacturing industry.

Descriptive statistics

Descriptive analysis is a lot of techniques for gathering, estimating, characterizing, computing, analyzing, describing and deciphering systematically accomplished quantitative data. This fundamental examination will be completed on the information gathered from section one of the survey which concentrated on the respondents' demographic profile.

Data Analysis

Introduction

The main findings of this study is based on the following results.

Reliability test

Table 4.1: Reliability test

Section	Content	No. of Items	Cronbach's Alpha Value
B	Technology of IR 4.0 Used by Malaysian Manufacturing Industry		
	i. Vertical Integration	8	0.86
	ii. Horizontal Integration	5	0.75
	iii. End-to-end Engineering Integration	6	0.801
	iv. Readiness of Industry 4.0	6	0.842
C	Barriers in Implementing Industry 4.0	15	0.961

The Cronbach's alpha value for each variable in the technology of Industry 4.0 used by Malaysian manufacturing industry was higher than 0.7 and barriers in implementing Industry 4.0 was 0.961 as shown in Table 4.1. The data gathered by using the research questionnaire is considered reliable.

Descriptive data analysis

Part A: Demographic analysis

a. Gender

Table 4.2: Frequency and Percentage of Gender

Gender	Frequency	Percent
Male	35	58.30%
Female	25	41.70%
Total	60	100%

Based on Table 4.2, there were 60 respondents involved in this study, this distribution shows that male respondents were more than female respondents in this study.

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS |Volume VIII Issue VIII August 2024

b. Age

Table 4.3: Frequency and Percentage of Age

Age	Frequency	Percent
20 years and below	1	1.70%
21 years - 25 years	4	6.70%
26 years - 30 years	8	13%
31 years - 35 years	28	46.70%
36 years and above	19	31.70%
Total	60	100%

Based on Table 4.3, the range of age between 31 years until 35 years is the highest compared to other range of age in the questionnaire. To be more specific, 28 respondents with 46.7%.

c. Length of Service

Table 4.4: Frequency and Percentage of Length of service

Length of Service	Frequency	Percent
Less than 6 months	1	1.70%
6 months - 1 year	4	6.70%
1 year - 3 years	4	7%
3 years - 5 years	26	43.30%
More than 5 years	25	41.70%
Total	60	100%

Based on Table 4.4, the length of service between 3 year until 5 years is the highest with 26 respondents which is 43.3%.

d. Salary

Table 4.5: Frequency and Percentage of Salary

Salary	Frequency	Percent
RM 1500 or below	1	1.70%
RM 1501 - RM 3000	8	13.30%

RM 3001 - RM 5000	25	42%
RM 5001 and above	26	43.30%
Total	60	100.00%

Based on Table 4.5, the range of salary between RM 5001 and above is the highest compared to other range of salary as shown in figure 4.4. To be more specific, 26 respondents selected the range of salary between RM 5001and above (43.3%).

e. Type of manufacturing industry

Table 4.6: Frequency and Percentage Type of manufacturing industry

Type of Manufacturing Industry	Frequency	Percent
Electronic	8	13.30%
Agro Processing	5	8.30%
Textile Industry	3	5%
Aerospace	2	3.30%
Automotives	5	8.30%
Automation	3	5%
IT	3	5.00%
Petro Chemical	2	3.30%
Seafood Processing	3	5.00%
Wood/Furniture	5	8.30%
Construction	6	10.00%
Logistic and Transport	5	8.30%
Commerce and Tourism	2	3.30%
Packaging	2	3.30%
Others	6	10.00%
Total	60	100%

Based on Table 4.6, the electronic manufacturing industry is the highest compare to other type of manufacturing industry which is 8 respondents with 13.3%.

Part B: Technology of Industry 4.0 used by Malaysian industry

Base on Table 4.7, the highest mean score is 2.94, shows that vertical integration is highly implemented compared to horizontal integration and end-to-end integration. The horizontal integration is the second highest, which is 2.86 of mean score. Therefore, it concluded that the readiness level towards technology of industry 4.0 is moderate.

Table 4.7: Mean score and standard deviation of each variable

Characteristics	Mean Score	Standard Deviation	Criteria
Vertical Integration	3	0.59	Moderate
Horizontal Integration	3	0.57	Moderate
End-to-end Engineering Integration	3	0.54	Moderate
Readiness of Industry 4.0	3	0.61	Moderate

a. Vertical integration

Based on table 4.8, "the company having automation equipment as, sensors in a good condition" has the highest mean score of 3.12 compared to other statements of vertical integration.

Table 4.8: Mean score and standard deviation of Vertical Integration

Questionnaire Items	Mean Score	Standard Deviation	Criteria
The "internet of things" and services grant immediate access to IT and production systems in the company very well.	3	0.79	Moderate
The data and information directly from the workplace by controlling and operating on a production and corporate level in a proper way.	3	0.83	Moderate
The company having automation equipment as sensors in a good condition.	3	0.76	Moderate
The company is implementing Manufacturing Execution System (MES).	3	0.85	Moderate
The company is implementing Enterprise Resource Planning (ERP).	3	0.88	Moderate
There is a good cooperation between machine and internet in the company.	2.93	0.82	Moderate
There is a good cooperation between machine and person in the company.	3.03	0.74	Moderate
There is a good cooperation between machine to machine in the company.	2.93	0.94	Moderate

b. Horizontal integration

Based on table 4.9, "There is continuous improvement across all participating organization is formed in the company" has the highest mean score of 2.95 compared to other technology of horizontal integration.

Table 4.9: Mean score and standard deviation of horizontal integration

Questionnaire Items	Mean Score	Standard Deviation	Criteria
The company having good facilitated inter-corporation collaboration where material flow fluently among these corporations.	3	0.78	Moderate
Continuous data flow along the horizontal value chain with integration of	3	0.81	Moderate

logistic service into internal IT.			
The integration of value networks to enable collaboration between corporations or organizations in the value chain of the company.	3	0.73	Moderate
The customer will be directly connected to the various elements in the supply chain due to the horizontal integrating digitized mechanism.	3	0.75	Moderate
There is continuous improvement across all participating organizations formed in the company.	3	0.9	Moderate

c. End-to-end engineering integration

Based on table 4.10, "Comprehensive smart products support in the production" and "The self-regulating mechanism will create a culture towards perfection and continuous improvement in the company" has the highest mean score of 2.85 compared to other technology of end-to-end engineering integration.

Table 4.10: Mean score and standard deviation of end-to-end integration

Questionnaire Items	Mean Score	Standard Deviation	Criteria
The company comprising real-time information along the entire value chain from sales forecasts to production planning and logistics.	3	0.63	Moderate
A continuous and consistent product model can be reused by every stage in the company.	3	0.85	Moderate
There is cross-linking of stakeholders, products, and equipment along the product life cycle in the company.	3	0.75	Moderate
Smart products move through the organization in a self-guided manner; the smooth flow must be designed without any interruption or delays.	3	0.7	Moderate
Comprehensive smart products support in the production.	3	0.78	Moderate
The self-regulating mechanism will create a culture towards perfection and continuous improvement in the company.	2.85	0.86	Moderate
4o mini			

d. Readiness of Industry 4.0

Based on table 4.11, the highest mean score is 2.98 for the company's data is well protected. Therefore, the security system for protecting the data in Malaysia manufacturing industries are in good level.

Table 4.11: Mean score and standard deviation of readiness of Industry 4.0

Questionnaire Items	Mean Score	Standard Deviation	Criteria
Digital feature of products implemented in the company.	3	0.67	Moderate
Equipment readiness for Industry 4.0 is prepared in the company.	3	0.8	Moderate
Employees of the company are having a lot of capabilities.	3	0.82	Moderate
Good in supply chain flexibility.	3	0.85	Moderate

IT is supporting the business of the company.	3	0.87	Moderate
Data of the company is well protected.	2.98	0.83	Moderate
4o mini			

Part C: Barriers in implementing IR4.0

Based on table 4.12, "lack of awareness on the impact of and need for Industry 4.0 technologies" and "lack of a centralised and easily accessible information platform" is having the highest mean score of 3.77 compared to other barriers in Malaysian manufacturing industries.

Table 4.12: Mean score, mode and standard deviation of barriers in implementing IR 4.0

Questionnaire Items	Mean Score	Mode	Standard Deviation
Lack of knowledge about Industry 4.0.	3	4	0.94
Lack of Internet coverage.	4	4	0.74
Lack of data protection (cyber security).	4	4	0.85
Lack of employee readiness.	4	4	0.8
Requires continued education of employees.	4	4	0.94
Lack of understanding of the strategic importance of Industry 4.0.	3.55	4	0.79
Lack of understanding the interplay between technology and human.	3.62	4	0.76
Too few financial resources.	3.42	4	0.79
Too few human resources (manpower).	3.62	4	0.83
Uncertainty about data security.	3.67	4	0.84
Lack of digital skills.	3.68	4	0.79
Lack of qualified workforce.	3.65	4	0.88
Lack of awareness on the impact of and need for Industry 4.0 technologies.	3.77	4	0.77
Lack of corporate culture.	4	4	0.77
Lack of a centralized and easily accessible information platform.	3.77	4	0.87

DISCUSSION

Introduction

The discussion and interpretation of the research outcomes, the entire descriptive and inferentialanalyses are summarized.

Summary of the research

The explanation of the background of the research, discussion of literature review, explores on the methodology and discussed the main findings.

Discussions of Main Findings

a. Discussion of objective 1

The readiness level of vertical integration in Malaysian manufacturing industry is having the highest mean score which means vertical integration is highly implemented compared to other integrations. The mean score of vertical integration is 2.94, consider there is still some part of the technology is not implemented completely in the companies. horizontal integration is still in moderate level of readiness in Malaysian manufacturing industries with mean score of 2.86. There are three levels to measure the readiness of industry 4.0 as stated in this study, the moderate level refers to the second level of readiness which mean the Malaysian manufacturing industries is approaching readiness. Based on the result shown, EEI and readiness of industry 4.0 is in moderate level of readiness and the mean score is 2.82. Malaysia manufacturing companies has moderate level of readiness, there are still most of the elements are not fully implemented in the company. The result shows that, technology of Industry 4.0 used in Malaysia manufacturing industries are in moderate level of readiness.

b. Discussions of objective 2

Based on the overall result, it shows that, all the 15 barriers are in high level since the mode is 4 which indicate the high range of agreement, it supposed to be in the lowest level. The barriers that having highest mean score is “lack of awareness on the impact of and need for Industry 4.0 technologies” and “lack of a centralised and easily accessible information platform” with the mean score of 3.77. The lowest mean score is 3.40 for the statement of lack of knowledge about Industry 4.0, however the mode value is still in high level which is 4, this shows Malaysian manufacturing industries not able to provide proper solution for this barrier.

Implication of study

This study was provided the information about the readiness level of industry 4.0 in Malaysian manufacturing industry. Industry 4.0 has various technology and knowledge that might improve the productivity of industry, part of it are vertical integration, horizontal integration, end-to-end engineering integration and readiness of Industry 4.0. The body of knowledge of this research can be as a reference about readiness level of industry 4.0 for other researcher in doing the related research. Other than that, the theory related to the study in this research might become a guideline for the readers to increase their understanding.

Based on the findings, barriers are still existing in Malaysia manufacturing industry to effect on implementation of industry 4.0 since the readiness level is low. Perhaps, manager can improve the technology used in the production line of the company to enhance their achievements and diminish the barriers.

Limitation of study

This research was meant to focus on only manufacturing industries. This research is expected to study the readiness of industry 4.0 in manufacturing industries only. Few manufacturing industries are selected to represent the study only from Malaysia. This study focuses only on vertical integration, horizontal integration, end-to-end integration, readiness of industry 4.0 and barriers in implementing industry 4.0. Besides, the data collection was done only based on the questionnaires.

RECOMMENDATION

By referring to the readiness level of industry 4.0 technology used in organization, organizations should consider and find out ways to ensure the technology is highly implemented. Manager should come out with a way to increase the level of readiness which develop the process of supply chain. Manager of organization may consider providing programs related to the adapting technology of industry 4.0 which make employees to be confident while using it. For instance, conduct a technology management program whose basic target is to diminish the barriers in implementing industry 4.0. By doing so, the research can be directed in a more detailed and precise way, while researchers are able to track the utmost significant level of readiness of

industry 4.0 in the targeted industry. This is what researcher can look deeper in and correct relevant information before further investigation is conducted. Whenever the readiness level in the manufacturing industry is higher, the barriers will become lower automatically.

CONCLUSION

Based on the results shown, the readiness level of industry 4.0 need to be improved in certain technology in Malaysian manufacturing industry. This study has attained research objectives with results acceptance. In spite of accomplishing the research objectives, there were few limitations that brought challenges throughout this research which need further development in future research. Though, the findings from this research can be useful for the future research particularly for the organizations that took serious about the readiness level of industry 4.0 which may lead to better productivity in industries. This study can help in enhancing the production system of the companies and in increasing many possibilities for achieve their goals.

REFERENCE

1. Benešová, J. Tupa, Requirements for education and qualification of people in industry 4.0, Proc. Manuf. 11 (2017) 2195–2202, https://doi.org/10.1016/j. promfg.2017.07.366.
2. 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.
3. Ahmad, R., Usop, H., Ismail, A. (2014). Conducting a research in Social Sciences and Management Studies, RS Publish House, Sarawak, Malaysia.
4. Al-Fuqaha, A., Khreishah, A., Guizani, M., Rayes, A., & Mohammadi, M. (2015). Toward better horizontal integration among IoT services. IEEE Communications Magazine, 53(9), 72-79.
5. Bauer, W., Hämmerle, M., Schlund, S., & Vocke, C. (2015). Transforming to a hyper-connected society and economy–towards an "Industry 4.0". Procedia Manufacturing, 3, 417-424.
6. Chukalov, K. (2017). Horizontal and vertical integration, as a requirement for cyber-physical systems in the context of industry 4.0. Industry 4.0, 2(4), 155-157.
7. DeFranzo, S. E. (2011). What's the difference between qualitative and quantitative research. Retrieved from SnapSurveys: https://www. snapsurveys. com/blog/qualitative-vs-quantitative-research.
8. Dorst, W. (Ed.). (2015). UmsetzungsstrategieIndustrie 4.0: Ergebnisbericht der PlattformIndustrie 4.0. Bitkom Research.
9. Foidl, H., &Felderer, M. (2015, November). Research challenges of industry 4.0 for quality management. In International Conference on Enterprise Resource Planning Systems (pp. 121-137). Springer, Cham.
10. GE Reports (2016). GE global innovation barometer 2016 Available at: http://www.gereports.com/innovationbarometer-2016/ [Accessed December 29, 2016]
11. Gilchrist, A. (2016). Introducing Industry 4.0. In Industry 4.0 (pp. 195-215). Apress, Berkeley, CA.
12. Haber, R. E., Juanes, C., del Toro, R., &Beruvides, G. (2015). Artificial cognitive control with self-x capabilities: A case study of a micro-manufacturing process. Computers in Industry, 74, 135-150.
13. Hanson, W. E., Creswell, J. W., Clark, V. L. P., Petska, K. S., & Creswell, J. D. (2005). Mixed methods research designs in counseling psychology. Journal of counseling psychology, Vol. 52, No. 2, pp. 224-228.
14. Hecklau, F., Galeitzke, M., Flachs, S., & Kohl, H. (2016). Holistic approach for human resource management in Industry 4.0. Procedia Cirp, 54(1), 1-6.
15. Industry (2018). Draft national industry 4.0 ministry of international trade and industry, National Industry 4.0 Policy Framework.
16. Kagermann, H., Helbig, J., Hellinger, A., and Wahlster, W. (2013). Recommendations for Implementing the strategic initiative INDUSTRIE 4.0: securing the future of German manufacturing industry; final report of the Industrie 4.0 working group. Forschungsunion.
17. Lasi, H., Fettke, P., Kemper, H. G., Feld, T., & Hoffmann, M. (2014). Industry 4.0. Business & information systems engineering, 6(4), 239-242.;

18. Mohamad, Mafuzah. (2023). Malaysian Dependency on Foreign Workforce: The Economic Implication Post Covid-19. 805-813. 10.15405/epfe.23081.73.
19. Müller, J. M., Kiel, D., & Voigt, K. I. (2018). What drives the implementation of Industry 4.0? The role of opportunities and challenges in the context of sustainability. Sustainability, 10(1), 247.
20. Roblek, V., Meško, M., & Krapež, A. (2016). A complex view of industry 4.0. Sage Open, 6(2), 2158244016653987.
21. Saucedo, J., Lara, M., Saucedo, J.A.M, Salais, T., & Vasant, P., (2018). Industry 4.0 framework for management and operations: a review. Journal of Ambient Intelligence and Humanized Computing. 9. 10.1007/s12652-017-0533-1
22. Schaupp, E., Abele, E., & Metternich, J. (2017). Potentials of digitalization in tool management. Procedia CIRP, 63, 144-149.
23. Schumacher, A., Erol, S., and Shin, W. (2016). A maturity model for assessing Industry 4.0 readiness and maturity of manufacturing enterprises. Procedia CIRP, 52, 161-166.
24. Schwab, K. (2017). The Global Competitiveness Report 2017–2018 Available at:http://ci.nii.ac.jp/naid/110008131965/
25. Schwab, K. (2017). The fourth industrial revolution. Currency.
26. Sindi, S., & Roe, M. (2017). The evolution of supply chains and logistics. In Strategic supply chain management (pp. 7-25). Palgrave Macmillan, Cham.
27. Stentoft, J., Jensen, K. W., Philipsen, K., & Haug, A. (2019, January). Drivers and barriers for Industry 4.0 readiness and practice: a SME perspective with empirical evidence. In Proceedings of the 52nd Hawaii International Conference on System Sciences.
28. Tay, S. I., Alipal, J., & Lee, T. C. (2021). Industry 4.0: Current practice and challenges in Malaysian Manufacturing Firms. Technology in Society, 67, 101749. https://doi.org/10.1016/j.techsoc.2021.101749
29. Vazire, S. (2018). Implications of the credibility revolution for productivity, creativity, and progress. Perspectives on Psychological Science, 13(4), 411-417.
30. Wank, A., Adolph, S., Anokhin, O., Arndt, A., Anderl, R., & Metternich, J. (2016). Using a learning factory approach to transfer Industrie 4.0 approaches to small-and medium-sized enterprises. Procedia CIRP, 54, 89-94.
31. Wang, S., Wan, J., Li, D., and Zhang, C. (2016). Implementing smart factory of industrie 4.0: an outlook. International Journal of Distributed Sensor Networks.
32. Wichmann, R.L., Eisenbart, B., Gericke, K. (2019) 'The Direction of Industry: A Literature Review on Industry 4.0', in Proceedings of the 22nd International Conference on Engineering Design (ICED19), Delft, The Netherlands, 5-8 August 2019. DOI:10.1017/dsi.2019.219
33. Zailinawati, A., Schattner, P., & Mazza, D. (2006). Doing a Pilot Study: Why is it Essential?, 1(2), 70-73. https://doi.org/10.1016/j.worlddev.2014.10.017
34. Zarina, Z. (2018). Malaysia's 13 strategies to transform manufacturing & services sector. New Straits TImes.