© Universiti Tun Hussein Onn Malaysia Publisher's Office

IJIE

Journal homepage: http://penerbit.uthm.edu.my/ojs/index.php/ijie
ISSN : 2229-838X e-ISSN : 2600-7916

The International Journal of Integrated Engineering

The Readiness of Automotive Manufacturing Company on Industrial 4.0 Towards Quality Performance

Rosmaini Tasmin[1*], Nurul Syahira Rahman[1], Ishaq Jaafar[2], Nor Aziati Abd Hamid[1], Yunos Ngadiman[1]

[1]Faculty of Technology Management and Business,
Universiti Tun Hussein Onn, Parit Raja, 86400, MALAYSIA

[2]Faculty of Business Administration,
Ahmad Bello University, Zaria, 810231, NIGERIA

*Corresponding Author

DOI: https://doi.org/10.30880/ijie.2020.12.07.018
Received 3 September 2020; Accepted 12 October 2020; Available online 31 October 2020

Abstract: This research is focusing on analyzing readiness of automotive manufacturing firm on Industry 4.0 towards quality performance. In the era of globalization, most manufacturing firms all over the world are constantly looking for ways to increase productivity. The manufacturing industry is mainly faced with the problem of Industry 4.0's awareness and implementation. Top and middle management of DRB-HICOM Automotive manufacturing firm from all departments have been selected as a sample study. The questionnaire has been used to get the feedback from top and middle management about readiness of Industry 4.0. There are three main objectives that were assessing the level of firm's characteristics, determining the level of Industry 4.0 readiness for DRB-HICOM Automotive manufacturing company, namely via variables of Applied Technology, Enterprise Resource Planning (ERP), Internet of Things (IoT), Cyber Physical System (CPS) and determining the relationship between the Industry 4.0 and quality performance. Quantitative method was used in this research which incoperates the distribution of 96 questionnaires to the respondents involving DRB-HICOM Automotive manufacturing firm. In terms of conducting the required data analysis, Statistical Package for Social Science (SPSS) version 22 was used. Result shows that all related constructs have a significant yet strong relationship between Industry 4.0 and quality performance. It is hoped that this initial Industry 4.0 work will help to spur future research about implementation of Industry 4.0, across the boards among many industrial sectors.

Keywords: Industry 4.0, Quality Performance, DRB-HICOM Automotive

1. Introduction

The term quality performance is referred to as a numerical measurement of the performance of a business organization, division, or process. In addition, the competitiveness of business in todays global economy is strictly adhered on the business capability to strategically operate in a very much capable and effective manufacturing setting by focussing on the least feasible cost structure, advance use of resources for maximium productivity, total quality, and consistency in the form of product delivery so as to attain the consumers'demand. Generally, the automotive industry is known to be highly demanding in terms of production rates that are accompanied by a relatively high grade of efficiency, ensuring high levels of customer satisfaction and competitive costs [1].

*Corresponding author: rosmaini@uthm.edu.my

1.1 Research Background

The current development in the manufacturing industry is heavenly shaped through industrial globalization, reductioion in product life cycle, clients'overwhemling demand for high quality and services, and rising production cost [2]. The conception of Industry 4.0 incorporates technologies of several limitations and makes major use of manufactured intelligence, simulation, automation, robotics, Internet of Things (IoT) technology, sensors, data collection systems, and networks towards advanced engineering and nicety machining [3].

The term Industry 4.0 denotes to the new technological developments that incorporate the use of internet and supporting technologies (e.g., embedded systems) that could aid toward the development of physical objects, human factors, intelligent machines, production lines and processes that are beyond organizational obstacle to form a new kind of intelligent, networked and brief value chain [4]. The substance of Industry 4.0 is basically centered on intelligent machines with related systems that tend to form an entirely set of digital value chain. More also, Industry 4.0 is likewise described as the Industry Internet of Things (IoT). In the Industry, Internet of Things, connecting smart devices have the capability to reconstruct in what manner manufacturing industries functions, buildings are monitored, and automobiles are kept and used. Internet of Things (IoT) has been categorized as a key enabler to Industry 4.0. Internet of Things denotes to the networked interconnections of devices that are built-in with universal intelligence. Research experts foresee that the up and coming industrial transformation will be instigated through means of the Internet, which allows communication among individuals and technologies in Cyber-Physical Systems (CPS) all through excessive networks [5].

1.2 Problem Statement

Nowadays, business organizations such as the manufacturing firms are currently facing substantial challenges all over the world due to the current environmental, societal, economic, and technological advancement toward quality performance. Most of the associated problems are related to ascertaining their state of development with regard to the Industry 4.0 vision [4]. The perception of most business organizations toward the notion of Industry 4.0 is extremely complex in nature, with no strategic guidance provided. Therefore business organization tends to be lacking in terms of ideas relating to Industry 4.0, and such has created a negative perception and uncertainty with regards to the benefits and outcomes. In addition, the manufacturer has unclear about the economic benefits of digital investments. Therefore, the business organization fails toward assessing their competences in Industry 4.0, which limits them from taking any coordinated measures.

The innovative potential that is related to the new methods of value creation and job employment begins. The underlining concepts of Industry 4.0 can lead to value addition by means of supporting both physical and mental abilities. Therefore for knowledge-based companies to maintain the knowledge and experience of employees with an exceptional amount of training, Industry 4.0 provides flexible and diverse career models in addition to management and specialist career paths. Such can be found present in the automation industry, as it requires a high level of difficulty and requires flexibility in managing the automotive assembly plant, which is demanding for current automation to manage. However, the manufacturer has to face the challenge of the absence of digital culture, the high financial investment needed [6]. According to [1], they reported that in an organization, to absorb new systems into new products required a substantial amount of expenses, and it takes a long time with flexible manufacturing, and it does not allow for higher cost reuse and faster platforms than the agile system. The process is still characterized by being labor comprehensive and producing uncertain quality results. Besides that, the current challenge faced by the automotive industry are as the of the ungoing technology developments that are upsetting the business enviroement. Therefore there is a need for automakers toward making a strategic change on now to shape the present industrial evolution. Cooperations such as the automotive industry are also faced with the growing challenge of improving the quality of the automobile and decrease product development (PD) time for new product introduction. Such has forced the automotive industry in general, toward utilizing various forms of attributes or criteria to understand the behavior of a vehicle [7].

As highlighted by the Ministry of International Trade and Industry (MITI), Malaysia requires additional contribution from the industrial companies in terms of improving the National Industry 4.0 plan so as to meet up with the targeted demand that is expected to be finalised by the opening quarter of its following year. The expected advantages to be realized from adopting Industry 4.0 technology by business corporations are enormous. The accomplishment that is been realized by some companies has shown us some factual results, where the implementation of high technology has helped them accomplish and gained in productivity and product variety and faster time to market within the first year of adoption [8]. The manufacturer should organize their enterprise in a team in conjunction with the current technological advancement by using the internet and immigrate to a digital program and computerization [9].

By choosing to be open to the latest form of technologies could serve as a key competitive differentiator that will end up benefiting business organizations alike in preventing such shortcomings that they may likely face in today's businesses. Business cooperations that are ready to embrace such technological innovation and infuse them into their daily strategy, development, and innovation process will lean toward much success in terms of profitability, enhanced energy management, and better yield in terms of productivity [8]. The expected benefit to be derived from the effective implementation of Industry 4.0 could assist in the construction of innovative factories, which would lead to supplying the much needed raw materials to the principal factory [10]. Figure 1 shows the barriers to the successful implementation of Industry 4.0 from the perspective of implementation for Industry 4.0.

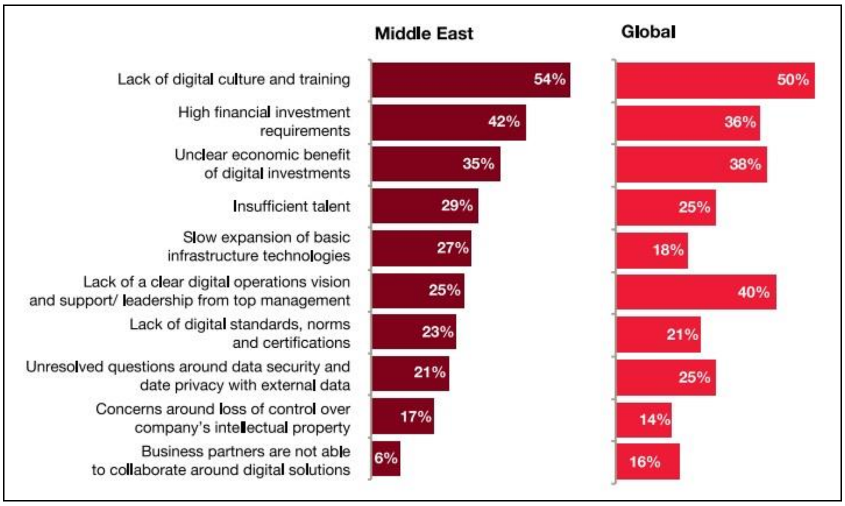

Fig. 1 - Barriers to the successful implementation of Industry 4.0

(Source: https://www.pwc.com/m1/en/publications/documents/middle-east-industry-4-0-survey.pdf)

1.3 Research Objectives

i) To assess the level of the company's characteristics.
ii) To assess the level of Industry 4.0 readiness for an automotive manufacturing company (applied technology, Cyber-Physical System (CPS), Internet of Things (IoT), Enterprise Resource Planning (ERP).
iii) To assess the relationship among Industry 4.0 and quality performance.

1.4 Research Question

i) What is the level of the company's characteristics?
ii) What is the level of Industry 4.0 readiness for an automotive manufacturing company (applied technology, Cyber-Physical System (CPS), Internet of Things (IoT), Enterprise Resource Planning (ERP))?
iii) Is there a significant relationship between Industry 4.0 readiness and quality performance?

1.5 Research Scope

The extent of this research is to determine the factors in the readiness of the manufacturing industry, focusing on the DRB-HICOM Automotive manufacturing company. The project has opted for a survey based on questionnaires. The respondents have been carefully chosen from the population with the aid of experts that were affected. This study is limited to automotive manufacturing; the findings and contribution of the study will represent only in the DRB-HICOM Automotive manufacturing company.

1.6 Significance of the Study

The rationale for executing this study is to examine the readiness of Industrial 4.0. of the manufacturing firm. By exposing these issues, the researcher knows that the level of readiness in the automotive manufacturing industry. Also, the study aims at exposing and acting as a source of knowledge for all university students to communicate with manufacturing industry experience. Given the relevance of the automotive industry, the research findings are expected to be helpful for future research with regard to the use of Industry 4.0 in such industry alike. The study furthermore is expected to make some practical contributions by essentially aiming at classifying issues that are related to industrialization, which could aid in improving the quality performance of this sector.

2. Literature Review

2.1 Characteristics of the manufacturer

There are those who view Industry 4.0 as a solution to the present-day issues in todays business enviroment and those who think that Industry 4.0 is only leading these issues. However, it is important since the course of Industry 4.0 has not been completely well-defined yet. The success or decline greatly depends on the development of those actions being taken.

2.1.1 Raw Material Handling Mechanism

It is reported that advanced material handling is an essential element of smart factories and precisely affects total manufacturing costs and manufacturing quality[11]. Material efficiency is considered complementary to energy efficiency in the effort to move towards sustainable manufacturing.

2.1.2 Workforce

According to [12], the decision demonstrates that the vast majority of business managers do believe that they can handle and manage their entire workforces for any eventuality in Industry 4.0. Such trust is built on the notion of the quality of the education system as it perfectly prepares and equips the workforce needed, and current employees can be retrained as needed.

2.1.3 Training

Based on [13], the testing application was built for the purpose of a simple interface, practical and related to potential to the actual assessment station, so as to be as perceptive as possible to the operatives. The application has two distinct functioning forms so as to boost training. The first one is known as the 'Test and AOI training' and the second form is reffered to as the 'Study Attribute Agreement Analysis.’

2.1.4 Capital

As indicated by [6], it was stressed that the issue isn't just one of "re-skilling" or developing new and better professions. Moreover, business firms must glance at leadership, organization structures, diversity, technology, and the general employee experience with novel and energizing ways. Robotics, Artificial Intelligence (AI), sensors, and cognitive computing have become fundamental, accelerative with the open talent economy. At that point, a business organization can never again believe that their workforces to be just the representatives on their monetary records yet should incorporate consultants, performance economy workers, and groups.

2.1.5 Maintenance

According to [14], it is reported that in European standard maintenance, the term maintenance referred to as a consolidation of the overall technical, administrative and managerial actions all along the life span of an inventory and designed to absorb it or refurbish it. As proposed in the British standard, the sequence of all technical and administrative actions includes supervision actions designed to maintain an item, otherwise reinstate it to a form in which it can carry out an appropriate task. Maintenance is a determined based on some formulated actions that are accomplished in order to keep an item in its with best operational quality with minimum cost attained. It is also reported that maintenance in its precise denotation consists of all accomplishments that are associated to keeping a convinced amount of obtainability and consistency of the system and its mechanisms and its capability to execute by a basic degree of quality [15].

2.2 Industry 4.0

According to [16], they reported that the main underlining concept of Industry 4.0 is centered on the Internet of Things (IoT) and smart manufacturing. Such forces business organizations from converting from a centralized factory control system to a more decentralized intelligence system. In line with the German Federal Ministry of Education and Research, Industry 4.0 is defined as the compliance that is in value-creating networks, which is improved by the role of Cyber-Physical Production Systems (CPPS).

The word Industry 4.0 was originally presented at the Hannover Fair at the presentation titled "Industry 4.0" in action. The fourth Industrial Revolution has been majorly emphasized via the utilization of Cyber-Physical Systems (CPS) and the Internet of Things and Services.

2.2.1 Applied technology

According to [12], it is reported that the shift to Industry 4.0 explains an organization's capability to adjust and incorporate both digital and physical technologies that could lead to improving its operations by becoming more productive and innovative. Innovation in manufacturing industries, especially in applied technology, has enabled firms to be more productive and competitive [17]. According to [6] stated that a variety of technologies, comprising of 3D printing, robotics, IoT, and analytics, have great importance for many businesses in concern and could improve the scope of digitization, forward with other innovative technologies that will assist in increasing integration and productivity too.

2.2.2 Enterprise Resource Planning (ERP)

According to [18], it is reported that Enterprise Resourcing Planning (ERP) is designed to overcome the deficiencies of MRPII. The term Manufacturing resource planning refers to a system that is designed for organizing and managing the entire business organization’s resources in a well-organized, creative, and profitable way. Hence, ERP systems are highly regarded as the key strength of the industrial unit of the future. According to [6], stated that the main emphasis would be on investments that would incorporate on advance digital technologies such as sensors or connectivity devices and software and applications that are mainly similar to manufacturing execution systems and Enterprise Resource Planning (ERP) platforms.

2.2.3 Internet of Things (IoT)

The industrial revolution of 4.0 in Germany has been mainly perceived as a strategy that will incorporate the use of the internet and the Internet of Things for the sole purpose of improving the medium of interactions between humans and machines that would lead to facilitating in smart manufacturing and creating the fourth industrial revolution. Some of the present technological development of IoT consist of radio frequency identification (RFID) appliances, infrared sensors, global positioning systems, laser scanners, and other information sensing devices and other arbitrary objects. IoT devices control all devices and systems and the network of these IoT to the central control system.

2.2.4 Cyber-Physical System (CPS)

Cyber-Physical Systems (CPS) are computerized systems that permit users to link the operations of the physical experience with computing and communication infrastructures [16]. CPSs are typically referred to as a system that incorporates computation and physical actuation abilities. Currently, some industries, such as the automotive manufacturing industry, are willing to embrace Industry 4.0, in which the numerous distinct data systems are linking within an intelligent Cyber-Physical System (CPS) environment.

2.3 Quality Performance

In manufacturing, a measure of greatness or a state of being free from the crack, failure, and significant variations. The measurement of quality performance can be evaluated through the estimation of physical items, statistical sampling of the yield of procedures, or through surveys of buyers of goods or services. As indicated by [19], the main techniques with reagrds to the quality performance consist of Quality, Cost, and Delivery (QCD). By utilizing these crucial procedures, organization in any business industry of the economy could be able to increase there level of productivity by getting things done precisely at the first time, distributing on time, encouraging individuals, improving stock turns, concentrating on value-added per individual, make the best use of floor space requirement, and the most interesting measure, improving the effectiveness of the equiptment in use.

2.3.1 Productivity

Productivity is referred to as the extent to which the effectiveness of an individual, device, industrial unit, the system in which it switches raw materials into useful finished goods. The term productivity is ascertained by dividing average productivity for each cycle by the overall costs derived or resources (investment, energy, raw material, human resources) absorb at that time.

2.3.2 Delivery

Delivery can be defined as a supply chain ordering and inventory management tool which controls the movement of raw materials to the producer and of the produced material to the initial category of business clients. According to [20], they stated that Industry 4.0 might empower a more efficient delivery of material.

2.4 Conceptual framework

For the overall research perspective, a conceptual research framework based on Figure 2 is formed, based on the literature review discussed in Section 2.

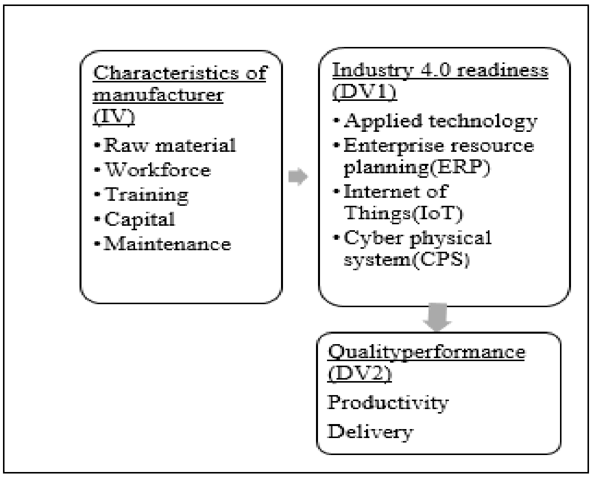

Fig. 2 - Conceptual research framework

3. Research Methodology

3.1 Research Design

This study is designed based on a typical study standard, as the objective is to determine the relationship between Industry 4.0 and quality performance. The sample of this research was drawn from the top and middle management from all departments in the DRB-HICOM company. In terms of quantifying and evaluating the problem of the results in the number of content, a quantitative survey was been utilized. The questionnaire relating to this research was designed in manner to which it could lead to ascertaining the readiness of automotive manufacturing on Industry 4.0 towards quality performance. This research questionnaire comprises of three sections; part A, B, C. Part A in this questionnaire is the highlights of the respondent and the respondent's demographics and company characteristics using descriptive analysis. Part B in this questionnaire is highlights of the level of Industry 4.0 readiness. In part C of this questionnaire is highlighting on quality performance.

3.2 Population and Sampling

The population relating to this research was made up of top management in all departments. Top and middle management have been selected from all departments in DRB-HICOM Automotive manufacturing. According to statistics of top and management of DRB-HICOM Automotive manufacturing, there are a total of 150 top and middle management members in each department. Then the sample for this study was about 117 workers. The researcher only managed to acquire 96 actual respondents.

3.3 Sampling Technique

Sampling is the strategic research decision from which researchers can get information about a population from some individuals to the population. The sampling technique that was used to collect data is stratified random sampling. The researcher has been assigned to collect data from the top and middle management in the DRB-HICOM Automotive manufacturing company in various departments.

3.4 Data Analysis

A statistical program termed as Statistical Package for Social sciences (SPSS) was employed for this study. Table 1 shows the statistical analysis applied for each research question.

Table 1 - Statistical analysis type

Research question	Statistical analysis
What is the level of the company's characteristics?	Descriptive analysis
What is the level of Industry 4.0 readiness for an automotive manufacturing company (applied technology, Cyber-Physical System (CPS), Internet of Things(IoT), Enterprise Resource Planning (ERP))?	Descriptive analysis
Is there a significant link amongst Industry 4.0 readiness and quality performance?	Correlation

3.4.1 Normality Test

There are two types of normality test of Kolmogorov-Smirnov (sample >50) and Shapiro –Wilk (sample <50). Value Sig. (p<0.050) is considered not normal and the Sig. (p>0.050).

3.4.2 Descriptive Analysis

Descriptive analysis of the study only focused on the minimum, maximum, standard deviation, and mean range, as shown in Table 2.

Table 2 - Extent level of mean

Mean Scale	Central Tendency Level
Strong Mean Ranking	3.68 to 5.00
Average Mean Ranking	2.34 to 3.67
Weak Mean Ranking	1.00 to 2.33

Source **:** *Tasmin & Woods (2008)* [21]

3.4.3 Spearman Correlation Test

Correlation analysis is a 'preliminary analysis.' The bivariate analysis used in the study to ascertain the level of the association among variables in concern. If (p<0.05) relationship exists between the variables and (p>0.05), there is no relationship between variables, as depicted in Table 3.

Table 3 - Correlation coefficient

Correlation Coefficient Value (r)	Strength
0.91 to 1.00 / -0.91 to -1.00	Very Strong
0.71 to 0.90 / -0.71 to -0.90	Strong
0.51 to 0.70 / -0.51 to -0.90	Moderate
0.31 to 0.50 / -0.31 to -0.50	Weak
0.01 to 0.30 / -0.01 to -0.30	Very Weak
0.00	No Relationship

Source : Bryman & Cramer (2005) [22]

4. Data Analysis

4.1 Demographic respondent

4.1.1 Gender

Table 4 - Frequency table for gender

		Frequency	Percentage
Valid	Male	42	43.8
	Female	54	56.3
	Total	96	100.0

Based on Table 4, it shows that the female respondents were the highest to take part in the survey covering 56.3% with the frequency of 54 respondents, while male respondents cover 43.8% answering the survey with 42 respondents.

4.1.2 Race

Table 5 shows that the majority were Malay respondents with 78 (81.3%) followed by Chinese 12 (12.5%), Indian with 4 respondents or 4.2%, and Bumiputera Sabah 2 respondents (2.1%) respondents from the overall race take part in the survey.

Table 5 - Frequency table for the race

		Frequency	Percentage
Valid	Malay	78	81.3
	Chinese	12	12.5
	Indian	4	4.2
	Bumiputera Sabah	2	2.1
	Total	96	100.0

4.1.3 Age

Table 6 - Frequency table of age

		Frequency	Percentage
Valid	20-35	80	83.3
	36-50	14	14.6
	51-65	2	2.1
	Total	96	100.0

According to Table 6 it confirms that the most of the respondent took part in the survey were aged between 20-35 years old with 80 respondents covering almost total respondent which is 83.3%, 14 respondent age 36-50 years old (14.6%), 51-65 years old with a frequency of 2 (2.1%).

4.1.4 Name of department

Table 7 - Frequency table for the department

		Frequency	Percentage
Valid	Sales and Marketing	8	8.3
	Human Resource	18	18.8
	Industrial Relation	6	6.3
	IT	10	10.4
	Production and Manufacturing	16	16.7
	Maintenance and Utilities	12	12.5
	Quality Assurance and Quality Systems	16	16.7
	Research and Development	6	6.3
	Testing and Validation	2	2.1
	Procurement and Vendor	2	2.1
	Total	96	100.0

Table 7 shows that the 18 respondents or 18.8% are from Human Resource, 16 respondents, or 16.7% from Production and Manufacturing and Quality Assurance and Quality Systems. It is next followed by Maintenance and Utilities, with 12 respondents (12.5%). Next, the IT department with 10 respondents covering (10.4%), 8 respondents with 8.3% from the Sales and Marketing department. There are 6 respondents (6.3%) coming from two departments, which are Industrial Relation and Research and Development. Testing and Validation department and Procurement and Vendor department had 2 respondent covering (2.1%).

4.1.5 Level of Education

Table 8 – Respondents' education level

		Frequency	Percentage
Valid	SPM	2	2.1
	STPM	4	4.2
	Diploma	22	22.9
	Degree	52	54.2
	Master	16	16.7
	Total	96	100.0

As shown in Table 8, it demonstrates that the respondents were degree holders which consist of 52 respondents that hold 54.2%—next followed by diploma holders with 22 respondents covering 22.9%. Next, the master holders had 16 respondents (16.7%). There are 4 respondents (4.2%) coming from the STPM background, and SPM background had 2 respondents covering 2.%.

4.2 Reliability of the Variables

Table 9 shows that maintenance has the most value in terms of Cronbach's Alpha value, which is 0.921. Therefore, maintenance has the highest internal consistency since it has the highest Cronbach's Alpha value. The second highest Cronbach's Alpha value is capital with 0.888. The internal consistency of capital is great. The next high ranking value of Cronbach's Alpha is training with 0.830 (good).

Meanwhile, the raw material handling mechanism has the lowest Cronbach's Alpha value, which is 0.717. Therefore, the raw material handling mechanism internal consistency is acceptable. Lastly, the second-lowest Cronbach's Alpha value falls to the workforce with 0.764 (acceptable).

Table 9 - Reliability test for company's characteristics

Item	Cronbach's Alpha	N of items	Level
Raw Material Handling Mechanism	0.717	4	Acceptable
Workforce	0.764	4	Acceptable
Training	0.830	4	Good
Capital	0.888	4	Good
Maintenance	0.921	4	Excellent
Applied Technology	0.872	4	Acceptable
Enterprise Resource Planning	0.813	4	Acceptable
Internet of Things	0.861	4	Acceptable
Cyber-Physical Systems	0.894	4	Acceptable
Productivity	0.850	4	Acceptable
Delivery	0.876	4	Acceptable

4.3 Descriptive Analysis

Based on Table 10, element maintenance has the highest mean, which is 4.25, whereas training is the element with the lowest mean, which is 3.70. The second-lowest mean is raw material handling with 3.86. The workforce is the second-highest mean, which is 3.93 and followed by capital, which is 3.90. This shows the element maintenance is the most encouraging element in quality performance.

4.3.1 Descriptive analysis of the company's characteristics

Table 10 - Descriptive analysis of the company's characteristics

	N Statistic	Mean Statistic	Std. Deviation Statistic	Level
Raw Material Handling Mechanism	96	3.86	0.53	High
Workforce	96	3.93	0.65	High
Training	96	3.70	076	High
Capital	96	3.90	0.57	High
Maintenance	96	4.25	0.70	High

4.3.2 Descriptive Analysis For Industry 4.0

Table 11 - Descriptive analysis for Industry 4.0

	N Statistic	Mean Statistic	Std. Deviation Statistic	Level
Applied Technology	96	3.98	0.63	Strong
Enterprise Resource Planning	96	3.84	0.60	Strong
Internet of Things	96	4.05	0.64	Strong
Cyber-Physical Systems	96	4.00	0.70	Strong

Based on Table 11, the element internet of things has the highest mean, which is 4.05, whereas enterprise resource planning is the element with the lowest mean, which is 3.84. Cyber-physical systems are the second-highest mean, which is 4.00 and followed by applied technology, which is 3.98. This shows that the element internet of things is the most encouraging element in Industry 4.0.

4.4 Normality test

Tables 12 and 13 analysis point out that all the significant value of Industry 4.0 and quality performance, p values <0.05. As a result, this study is not normally distributed. Consequently, in order to achieve the required objective of the study, Spearman's correlation test was employed.

Table 12 - Normality test for Industry 4.0

	Kolmogorov-Smirnov[a]		
	Statistic	df	Sig.
Applied Technology	0.136	96	.000
Enterprise Resource Planning	0.125	96	.001
Internet of Things	0.155	96	.000
Cyber Physical Systems	0.188	96	.000

Table 13 - Normality test for quality performance

	Kolmogorov-Smirnov[a]		
	Statistic	df	Sig.
Productivity	0.168	96	.000
Delivery	0.117	96	.002

4.5 Correlation

Table 14 shows the correlation between Industry 4.0 with quality performance. Spearman's Rho correlation coefficient value of 0.822 and the footnote (**) confirms that there is a positive correlation between the Industry 4.0 and quality performance. Since the result shows that the significance value for this test is 0.000, which is lesser than 0.050, it can be concluded that Industry 4.0 and Quality Performance has a strong relationship with 0.822. It also answers the third research question.

Table 14 - Correlations

			Industrial 4.0	**Quality Performance**
Spearman's rho	Industry 4.0	Correlation Coefficient	1.000	.822**
		Sig. (2-tailed)	.	.000
		N	96	96
	Quality Performance	Correlation Coefficient	.822**	1.000
		Sig. (2-tailed)	.000	.
		N	96	96

*Note: ** Correlation is significant at the 0.01 level (2-tailed).*

5. Summary of Findings

5.1 Research question 1: What is the level of the company's characteristics?

The first research question of the study was examined using descriptive analysis. The mean value is computed for every dimension in the company's characteristics tested, which is the 5 items questions for raw material handling mechanism, workforce, training, capital, and maintenance with an average mean of 3.86, 3.93, 3.68, 3.89 and 4.25 respectively. Maintenance has a high-level priority in the company's characteristics. In the item of improve quality and increase system reliability with the highest standard deviation, which is 0.870 the most of the respondents answer that item, so that means the maintenance is most important to this company to get a better quality performance.

5.2 Research question 2: What is the level of Industry 4.0 readiness for an automotive manufacturing company?

The second research question of the study was examined using descriptive analysis. The mean value is computed for each dimension in Industry 4.0 readiness tested, which is the 4 items questions for applied technology, Enterprise Resource Planning (ERP), Internet of Things (IoT), and Cyber-Physical System (CPS) with average mean 3.98, 3.84, 4.05 and 4.00 respectively. The Internet of things has a high-level priority in Industry 4.0 readiness. The item of RFID system gives the high capability of supporting multiple types of applications with a high standard deviation, which is 0.852 because most of the respondents answer that item, which means too important to their company for achieving good quality performance.

5.3 Research question 3: Is there a significant relationship between Industry 4.0 readiness and quality performance?

Lastly, the third research question of the study was explored by employing correlation analysis. The finding in this research shows that Industry 4.0 readiness has a strong relationship between quality performance with 0.822. This research also clearly shows that the existence of Industry 4.0 readiness between a quality performance where the value of significance is 0.000 smaller from the significant level that is set at 0.05 test correlation into two-tailed (0.008 < 0.05).

6. Conclusion

The findings of this research are to support the research objectives and to meet the research problems. As centered on the four-variable of readiness Industry 4.0, the outcome of the result confirms that readiness Industry 4.0 has a strong relationship with quality performance. Besides that, this research allows DRB-HICOM Automotive company to realize in awareness and readiness for Industry 4.0 in their company. In addition, the top and middle management in DRB-HICOM Automotive company are facing problems because some of them are unclear about Industry 4.0 since the system is newly initiated to be ready for implementation. Therefore, there should have some corrective actions to experience the problem in order to achieve good quality performance.

Acknowledgement

We would like to acknowledge the cooperation and collaboration of HICOM Automotive Manufacturers (Malaysia) Sdn. Bhd., located at DRB-HICOM Automotive Complex, 26607 Pekan, Pahang for rendering its sheer support on data collection for which this research was made possible. Certainly, huge thanks to their entire participative relevant respondents for the commitment rendered in answering our questionnaires.

References

[1] Costa, M. J. R., Gouveia, R. M., Silva, F. J. G., & Campilho, R. D. S. G. (2017). How to solve quality problems by advanced fully-automated manufacturing systems. International Journal of Advanced Manufacturing Technology, 1–23
[2] Hooi, L. W., & Leong, T. Y. (2017). Total productive maintenance and manufacturing performance improvement. Journal of Quality in Maintenance Engineering, 23(1), 2–21
[3] Benias, N., & Markopoulos, A. P. (2017). A review on the readiness level and cyber-security challenges in Industry 4.0. 2017 South Eastern European Design Automation, Computer Engineering, Computer Networks and Social Media Conference (SEEDA-CECNSM), 1–5
[4] Schumacher, A., Erol, S., & Sihn, W. (2016). A Maturity Model for Assessing Industry 4.0 Readiness and Maturity of Manufacturing Enterprises. Procedia CIRP, 52, 161–166. https://doi.org/10.1016/j.procir.2016.07.040
[5] Haddara, M., & Elragal, A. (2015). The Readiness of ERP Systems for the Factory of the Future. Procedia Computer Science, 64, 721–728
[6] GMIS, P. (2016). Industry 4.0: Building the Digital Industrial Enterprise. Retrieved from https://www.pwc.com/m1/en/publications/documents/middle-east-industry-4-0-survey.pdf
[7] Yadav, O. P., & Goel, P. S. (2008). Customer satisfaction driven quality improvement target planning for product development in automotive industry. International Journal of Production Economics, 113(2), 997–1011
[8] NST Business (2017, November 23). Industry 4.0: Where are our manufacturers now?. Retrieved from https://www.nst.com.my/business/2017/11/306732/industry-40-where-are-our-manufacturers-now#cxrecs_s
[9] The Star Online (2017, July 13). Proton's Tanjung Malim factory to pioneer Industry 4.0. Retrieved from https://www.thestar.com.my/business/business-news/2017/07/13/protons-tanjung-malim-factory-to-pioneer-industry-4pt0/
[10] The Star Online (2017, November 29). Automotive sector to undergo major changes under Industry 4.0. Retrieved from https://www.thestar.com.my/business/business-news/2017/11/29/automotive-sector-to-undergo-major-changes-under-industry-4pt0/
[11] Wan, J., Tang, S., Hua, Q., Li, D., Liu, C., & Lloret, J. (2017). Context-Aware Cloud Robotics for Material Handling in Cognitive Industrial Internet of Things. IEEE Internet of Things Journal, 4662(c).
[12] Renjen, P. (2018). The Fourth Industrial Revolution is here—are you ready? Deloitte Insights, (January 22). Retrieved from https://www2.deloitte.com/content/dam/insights/us/articles/4364_Industry4-0_Are-you-ready/4364_Industry4-0_Are-you-ready_Report.pdf
[13] Marques, C., Lopes, N., Santos, G., Delgado, I., & Delgado, P. (2018). Improving operator evaluation skills for defect classification using training strategy supported by attribute agreement analysis. Measurement: Journal of the International Measurement Confederation, 119(June 2017), 129–141
[14] Gopalakrishnan, M. (2016). Maintenance & Dependability Effective Maintenance Planning and Productivity Improvement Potentials. Retrieved from http://zoomin.idt.mdh.se/course/ppu420/Presentations/Maintenance Planning_Mahesh_Chalmers.pdf
[15] Al-Turki, U. M., Ayar, T., Yilbas, B. S., & Sahin, A. Z. (2014). Integrated maintenance planning in manufacturing systems. SpringerBriefs in Applied Sciences and Technology, (9783319062891), i–iv
[16] Shrouf, F., Ordieres, J., & Miragliotta, G. (2014). Smart factories in Industry 4.0: A review of the concept and of energy management approached in production based on the Internet of Things paradigm. IEEE International Conference on Industrial Engineering and Engineering Management, 2015–Janua, 697–701
[17] Tasmin, R. & Woods, P. (2007). Relationship between corporate knowledge management and the firm's innovation capability. International Journal of Services Technology and Management, 8(1), 62-79
[18] Barker, T., & Frolick, M. N. M. N. M. N. (2003). ERP implementation failure: A case study. Information Systems Management, 20(4), 43–49
[19] Nicholds, B. A., Mo, J. P. T., & O'Rielly, L. (2018). An integrated performance driven manufacturing management strategy based on overall system effectiveness. Computers in Industry, 97, 146–156

[20] Hofmann, E., & Rüsch, M. (2017). Industry 4.0 and the current status as well as future prospects on logistics. Computers in Industry, 89, 23–34
[21] Tasmin, R. & Woods, P. (2008, July). Linking knowledge management and innovation. Proceedings at the International Business Information Management Association (IBIMA2008), organized by IBIMA USA, Kuala Lumpur
[22] Bryman, A., & Cramer, D. (2005). Quantitative Data Analysis with SPSS 12 and 13: A Guide for Social Scientists. Psychology Press, (January 2002), 145–146