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Industry 4.0 Competencies for Production Equipment Manufacturers in Malaysia

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Abstract

Industry 4.0 refers to the revolution of the entire value chain process in manufacturing industrial bases on the basis of cyber physical production system. Industry 4.0 competency or the competency of manufacturers to react with the changes driven by Industry 4.0 is now become imperative for the manufacturers to sustain competitive advantage. Hence, the main objective for this study is to assess the Industry 4.0 competency levels, as well as to examine the relationship between Industry 4.0 competencies and Production Equipment Management (PEM) performance within production equipment manufacturers in Johor, Malaysia. This study views Industry 4.0 competencies from four different dimensions, which are Information and Communication Technologies (ICT) competency; Innovation Management competency; Organizational Learning competency and environment competency. The study is quantitative based via survey questionnaire and responded by 36 production equipment manufacturers. Through descriptive analysis, Industry 4.0 competencies and PEM performance of production equipment manufacturers in Johor are ranked as above average, and each dimension of Industry 4.0 competencies is significant and positively correlated with PEM performance. Furthermore, finding from the study also suggested that the Industry 4.0 competency of multinational companies is significantly higher than local companies in terms of ICT and environment competency. The main implication of this study is the strategy and initiatives of production equipment manufacturers in Johor in approaching Industry 4.0 need to be focused equally across all the four Industry 4.0 competencies.

Keywords: Industry 4.0, Competency, Production Equipment

Introduction

Production equipment manufacturers play a vital role in the overall development of manufacturing industrial in Malaysia by providing support to manufacturing industry in term

of production equipment design, fabrication, testing and maintenances base on customers need. Hence, the business nature of production equipment manufacturer tends to be support service based, whereby the strategy and practices are very much dependent on the requirement and direction demanded or shown by manufacturing industrial. As such, respond to customer needs and align business strategy to be in line with customer mission and vision become imperative for production equipment manufacturers in order to sustain competitive advantage.

Currently, the major impactful market trend that affecting manufacturer industrial is namely the Industry 4.0, the convergence of the classical manufacturing space with internet technologies and the increasing intelligence of devices (Howells, 2014). It is all about the digitization and automation of all the processes involving large amount of data exchange along entire value chain. Embracing Industry 4.0 means making a major transformation that involved almost all aspects of the business (Ostdick, 2017). Hence, in line with the Industry 4.0 development, production equipment manufacturers have to expand the scope of connectivity with manufacturing industrial beyond the traditional boundary that limited to business transaction activities. Instead, production equipment manufacturers need to embed more intelligence connectivity to leverage their knowledge of production equipment design, fabrication and maintenance in order to provide more additional value added services to the customer, particularly services than enhance Industry 4.0 development (Lackey, 2014). As such, This research aims to achieve 4 objectives: (1) To identify the Industry 4.0 competencies of Production Equipment manufacturers in Malaysia; (2) To assess the relationship between Industry 4.0 competencies and Production Equipment Management (PEM) performance; (3) To assess the difference on Industry 4.0 competencies based on company background.

Production Equipment

Production equipment refers to both standard and customized design tools, jig, fixture and machinery used in manufacturing and assembly activities to minimize assembly process variation, reduce the amount of labour-intensive works and assembly cost, with the ultimate aim to improve process repeatability and accuracy, as well as to increase the overall manufacturing productivity(Marcel, 2003; Katukoori, 2010).

Research done by the “Malaysia Industry-Government Group for High Technology” (MIGHT, 2017) reveals that Industry 4.0 affects almost every business facet and arenas, including production equipment manufacturers. Industry 4.0 will essentially not only change the products and services that will be offered, but also the processes and method that are used to generate the products or services. Hence, within the context of production equipment, the impactful changes that driven by Industry 4.0 are the tremendous demands of more intelligence built of production equipment in term of:

(a) Equipped with sophisticated sensor and alert devices
(b) Capable of process massive amount of data
(c) Greater agility and adaptability to respond to highly variable market demand.

Production Equipment Management

Production Equipment Management (PEM) involves developing knowledge of the different areas where production equipment can be used, including its construction, functions, related methods and technologies; planning, organizing and carrying out work in manual, and

automated production and peripheral equipment in accordance with applicable safety regulations; and maintaining, calibrating and checking its functions to improve the efficiency (The Manufacturing Institute, 2009; Yakimov and Woolsey, 2010; Bunse et al., 2014). Industry 4.0 emphasizes on cyber physical production system (CPPS) which works on the principle of linking information technology with mechanical and electronic components that communicate with each other via a network (Toro et al, 2015). Its central importance is it interfaces with other smart infrastructures across the value chain, such as smart logistic, smart mobility (Deloitte, 2015). Hence, PEM needs to share certain degree of community, or used of common IT module in order for it to interface with other smart production equipment as well as smart facilities in Industry 4.0. It is all about data; the data flows along the entire value chain acts as an important asset in Industry 4.0 which production equipment manufacturers have to manage data as the core of business model (Baarup et al, 2015).

Production Equipment Management Performance

Production equipment management (PEM) is one of the classifications under project management which the aspects of project management will be applied specifically to describe production equipment management. Production equipment management is a management philosophy embracing three major attributes – time, cost, and quality and the balancing of these three elements is crucial in achieving organizational success (Ho et al, 2016; Stansberry, 2016; Collins and Baccarini, 2004). In PEM, time management requires the production equipment to be designed, manufactured and delivered to customer within the scheduled timeframe as required by customer or expected internally. Cost generally refers to the budget allocated to the project and production equipment need to be manufactured using monetary resources available efficiently within the cost limit. Quality defined by International Organization for Standardization (1994) as "the totality of characteristics of an entity that bear on its ability to satisfy stated or implied needs." The stated and implied needs in PEM can refer to quality requirements from customers in product equipment specifications which determine the customer satisfaction. Measuring quality ensure the production equipment will meet customer expectations in order to lead to customer satisfaction, cost reduction, productivity increased and also better competitiveness (Stojčetović et al, 2014)

Industry 4.0 Competencies

In embracing Industry 4.0, production equipment manufacturers need to have a range of competencies to adopt to a series of changes in all aspects including manufacturing process and employees need to face transformed workflows as well as new technologies emerged. According to previous research done by Bermúdez and Juárez (2017), the competencies are categorized into four dimensions for the adoption of Industry 4.0 which included Information and Communication Technologies (ICT), Innovation Management, Organizational Learning, and Environment.

Information and Communication Technologies (ICT)

Information and Communication Technologies (ICT) refers to an extension of computer technologies that highlights the role of unified communications and the convergence of telecommunications, computers and other technologies that are able to access, store, transmit, and process data or information (Murray, 2011; Zhong et al, 2017). ICT undertakes and stresses data processing and communication which includes Internet, mobile phones, satellite systems or other communication mediums, and is crucial in intelligent

manufacturing, where production operations and decision-making heavily rely on the data. (Chaudhuri, 2016; Zhong et al, 2017). Its abilities can include understanding big data, cloud computing and new technologies, analysing data and also management of tools or software which vital to production equipment management (Bermúdez et al, 2017).

Innovation Management

Innovation management refers as the process of managing idea, transforming it into products or services and bringing them to the marketplace through the stages of developing the innovative product or service and creating business to promote the product or service. It is about ensuring the results of R&D activities are implemented and translated into practical use in the process of overcoming structural barriers and insuring the results are relevant to the organization's main activities (Danielsson and Strigård, 2012). The capabilities to manage innovation include external collaboration, adoption to new management practices, management of simulation systems (Bermúdez and Juárez, 2017).

Organizational Learning

Organizational learning defined as change in the organization's knowledge including both declarative knowledge or facts and procedural knowledge or skills and routines that occurs as a function of experience in opinions of most researchers (Argote, 2013). It also has been defined as the on-going process within organization in improving its capacity to accept, understand, and react to internal and external change while building, gaining and sharing knowledge. (Kasemsap, 2016; You et al, 2017). As an organizational theory that studies the ways and tools for organization to learn and adjust to the environment in enhancing decision making process and problem solving skill, it includes constantly develop employees skills and encourage participation in decision-making

Environment

Environment made up of a series of external conditions that hold the potential to affect the organization which may include market, regulatory and legal conditions, opportunities and threats (Ketchen et al, 2011; Dignum, 2009). The external environment of an organization can categorized into five which competitors, customers, suppliers, regulators, and strategic partners from economics, technology, social culture, political law and international dimensions while the internal environment comprises owners, board of directors, employees, physical environment and organizational culture (Griffin, 2001). Griffin also stresses the relationship between organization and its environment need to be aligned thoroughly as they affect each other in various means. To enable the production equipment manufacturers to adopt Industrial 4.0, having adaptive culture, social intelligence, transdisciplinarity are the competencies required for an organization (Bermúdez et al, 2017).

Research Framework

Figure 1 shows the research framework of this study while Industry 4.0 competencies as independent variables and Production Equipment Management (PEM) performance as dependent variable. 5 hypotheses are developed as follows:

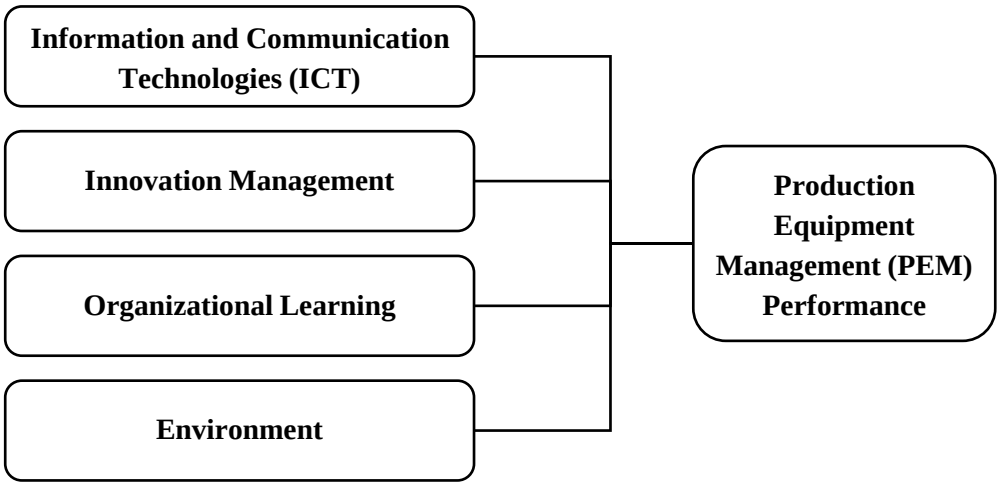

Figure 1. Research Framework

H1: Information and Communication Technologies (ICT) is positively correlated to Production Equipment Management (PEM) Performance
H2: Innovation Management is positively correlated to Production Equipment Management (PEM) Performance
H3: Organizational Learning is positively correlated to Production Equipment Management (PEM) Performance
H4: Environment is positively correlated to Production Equipment Management (PEM) Performance.
H5: There is difference on Industry 4.0 competencies based on company ownership (multinational and local).

Method

This study used quantitative research approach via questionnaire. The questionnaire is adapted from previous researchers (Lichtblau et al. (2015), PwC (2016), Reply (2018), Agca et al. (2017)). The population for this study are production equipment manufacturers in Johor. According to SME Corp (2018), the number of medium-sized production equipment manufacturers in Johor is 272. The calculation of the sample size was based on the '10-times rule' method which sample size is estimated to be 10 times the maximum number of arrows pointing at any latent variable in the research model or framework (Hair et al., 2013). Since there are four links or independent variables, which multiplied by 10 yields 40. However, considering the approximate response rate of 60%, dividing 40 by 60% to get a targeted sample size of 67.

Data Analysis and Finding

The total number of responded questionnaires is 36 where supported by Roscoe (1975) that a sample size of more than 30 was appropriate. It is contributed to the respond rate of at 53.73% (i.e. 36/67). All questionnaires are screened and there is no issue of missing value across all the 36 returned questionnaires.

Normality Test

Skewness and Kurtosis are used as the numerical means of assessing normality. The value of Skewness and Kurtosis test for all variables is within the range of -1.0 to +1.0 shown that data collected are normally distributed (Hair, 2013). In addition, Cronbach's Alpha coefficients for all variables are more than 0.7, or ranged from 0.894 to 0.928 which suggested data collected are with very good internal consistency (Sekaran and Bougie, 2010).

Descriptive Analysis

To address research objective 1, the mean score of each variable of Industry 4.0 competencies are analysed using descriptive analysis via SPSS. Table 1 summarize the result of analysis.

Table 1
Level of Industry 4.0 Competencies

No	Industry 4.0 Competencies	Mean	Level
1	Organizational Learning	3.9889	Above average
2	Innovation Management	3.9556	Above average
3	Information and Communication Technologies (ICT)	3.8194	Above average
4	Environment	3.5778	Average
Average	Industry 4.0 Competencies	3.8344	Above average

Based on analysis result of Table 1, the overall mean of Industry 4.0 competencies is 3.8344, while "Organizational Learning Competency" scored the highest mean of 3.9889 and environment competency has the lowest mean of 3.5778. In addition, the rest of Industry 4.0 competencies are suggested by responded with the mean of between 3.8194 to 3.9556.
Finding from descriptive analysis suggested that the Industry 4.0 competencies level of PE manufacturers in Johor could be rated as above average which is compatible with Malaysia's current status as reported by Ministry of International Trade and Industry that the sector is currently standing between Industry 2.0 and 3.0 but there are some industries are more advanced in embracing Industry 4.0. The ranking order of Industry 4.0 competencies of Production Equipment Manufacturers in Johor are as follows, Organizational Learning; Innovation Management; Information and Communication Technologies; and Environment. Finding from this study is in line with and support the research done by Bermúdez and Juárez (2017) which suggested Information and Communication Technologies (ICT); Innovation Management; Organizational Learning; and Environment as competencies to be involved with Industry 4.0.

Person Correlation

To address the research objective 2 (and hypotheses H1 to H4), Pearson Correlation analysis was used to examine the direction and strength of the relationship between Industry 4.0 competencies and PEM performance. The results of Pearson Correlation via SPSS are summarized in Table 2.

Table 2.
Correlation between Industry 4.0 Competencies and Production Equipment Management (PEM) Performance

Hypothesis	Industry 4.0 Competencies	Coefficient (r)	Sig number	Decision
H1	Information Communication Tech	.563	.000 (< 0.05)	Supported
H2	Innovation Management	.495	.002 (< 0.05)	Supported
H3	Organization Learning	.451	.006 (< 0.05)	Supported
H4	Environment	.451	.009 (< 0.05)	Supported

As refer to Table 2, the coefficient for all hypotheses are having positive value and the significant levels (i.e. sig) of all hypotheses are below 0.05 suggested that all Industry 4.0 competencies dimensions are positively and significantly correlated with PEM performance. Hence, H1, H2, H3 and H4 are supported. Finding from hypothesis 1 (H1) is in line with study done by Cuevas-Vargas et al (2016), Liu and Xu (2016) and Camisón and Villas-López (2014) which suggested that ICT determines business performance as it support an organization's operation and administrative management. In addition, result of H2 is also echoed study done by Ibarra et al (2018) and Cuevas-Vargas et al (2016) which revealed that innovation management is one of the essential elements for organization performance improvement. In addition, the significant correlation of H3 and H4 are also support research done by Bermúdez and Juárez (2017) and Müller et al (2018) respectively. Study done by Bermúdez and Juárez (2017) found that organization learning competency could enhance organizational survival in transforming organizational innovation into capabilities. While study of Müller et al (2018) concluded that environment can be one of the determiners in enabling an organization to have competencies in performing well.

Independent Samples t-test

Independent t-test is used to test if there is significant different on Industry 4.0 competencies based company ownership in term of multinational and local (H5). Table 3 shows the summary of Independent t-test via SPSS.

Table 3
Difference on Industry 4.0 Competencies based on Company Ownership (Summary of the Independent t samples)

Hypothesis	Industry 4.0 Competencies	Significant	Mean Difference*	Decision
H5(a)	Information Communication Tech.	.005 (< 0.05)	-.72500	Supported
H5(b)	Innovation Management	.083 (> 0.05)	-.39250	Not Supported
H5(c)	Organizational Learning	.148 (> 0.05)	-.29500	Not Supported
H5(d)	Environment	.012 (< 0.05)	-.70250	Supported

*Mean difference = Mean of Local companies – Mean of Multinational company

As refer to Table 3, analysis result from independent test reveals that there are significant differences on Information and Communication Technologies (ICT) and Environment competency based on company ownership; hence H5(a) and H5(d) are supported. Whereas the differences between multinational and local companies in term of Innovation Management competency and Organizational Learning competency.

The mean difference for Information and Communication Technologies (ICT) of -0.72500 suggested that competency level of multinational company in ICT is 0.72500 higher than local company. In addition, the mean difference of -0.70250 in term of Environment competency once again reflects that multinational companies secured higher Environment competency than local companies. Perhaps, this is because of multinational companies are relatively more capable in term of internationalization and investments which lead them to have integrated and digital approach to data gathering along manufacturing and supply chains as described by previous study (Shah et al, 2016). However, in term of Innovation Management and Organizational Learning competency, finding from this study suggested that multinational companies has no significant advantage over local company. Perhaps, this is because of local companies are aware of the strategic potential of combining organizational innovation and innovation capabilities in embracing digitization (Camisón and Villas-López, 2014).

Conclusion

In summary, the finding from the study reflects that both Industry 4.0 competencies and PEM performance level among PE manufacturers in Johor are above average. In addition, all the dimensions of Industry 4.0 competencies i.e. Information and Communication Technologies (ICT); Innovation Management; Organizational Learning; and Environment are significantly and positively correlated to Production Equipment Management (PEM) Performance. The main implication of this study is the current practices of production equipment manufacturers in Johor in approaching Industry 4.0 need to be focused equally across all the four Industry 4.0 competencies. In addition, finding from the research reveals that multinational company has significantly greater competency level than local company in terms of Information and Communication Technologies (ICT) and Environment. Hence, local company has to strive and balance themselves in investments and inventory utilization to be on par or even exceed competencies of multinational company. Local government also can review the policies related or incentives to give support to local production equipment manufacturers to have mutual benefit from increased productivity, efficiency, quality and even economics

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