INDUSTRIAL REVOLUTION 4.0: TOWARDS A CONCEPTUAL FRAMEWORK ON THE IMPLEMENTATION CHALLENGES IN MALAYSIAN MANUFACTURING SECTOR

Lee Eng Keong[a*], Peter Yacob[b*], Cik Hayati Binti Yusof [c*] Premkumar a/l Nadarajan[d*],

[a,b,c,d] Faculty of Business and Finance, UniversitiTunku Abdul Rahman, Malaysia,
Email: leeek@utar.edu.my*

Abstract

The fourth industrial revolution, also called Industry 4.0 (I4.0) involves digitization of the manufacturing sector, with sensors (chips) in virtually all product components and manufacturing equipment, widespread cyber physical systems (CPS), and analysis of all relevant data. Industry 4.0 influences essential applications in manufacturing processes, the transformation is to be far-reaching but the pace of change to be slower than in the digital disruption of the consumer Internet. Due to long investment cycles, companies tend to be cautious in their decision making when it comes to significant disruptions. With expected Investments of US$ 907B by 2020, the world is definitely moving toward a new industrial phase, but are the Malaysian Manufacturing Companies ready for it? The aim of the study is to propose a conceptual study investigating the association of three challenges which consists of unqualified employees, high costs, vague return on investment are challenges towards Industry 4.0 revolution in Malaysian manufacturing sector. The novelty of the proposed conceptual framework shall increase the understanding that manufacturing sector should act along three challenges to overcome the implementation changes towards embracing Industry 4.0; which drives the next level of operational effectiveness, adapt business models to capture shifting value pools, and build the foundations for digital transformation.
.

Keywords: Industry 4.0 (I4.0), Cyber physical system (CPS), Malaysian manufacturing sector, Internet of things (IoT), Unqualified employees, High costs, Vague return on investment.

INTRODUCTION

Industry 4.0 (I 4.0) is also known as the fourth industrial revolution. Industry 4.0 started from a project that was part of the German's high technological strategy. It is now a widely debated topic in Germany. The key issue is the integration of cyber-physical systems (CPS) in production and logistics. It also requires the application of internet of things (IoT) and connectivity in the manufacturing processes. This includes the fruits of value creation, new business models, marketing services and new organizational structures. (FRIEDRICH-EBERT-STIFTUNG, 2017). Great economic value is attributed to the IoT technology in industry.

Readiness of Malaysia for IoT

Malaysia has an excellent environment and has a good start to encourage and catapult by IoT in the domestically market because of the following:

• High mobile usage at 143.7 percent and impressive multiple handheld devices ownership

• 65.8 percent of Malaysians use the Internet with 59 percent active users

• Social media penetration in Malaysia is 45 percent

• Domestic ICT consumption is projected at RM118.6 billion in 2015 and estimated to be RM117.6 billion by 2020 with a (Compound Annual Growth Rate) CAGR of 8.32 percent (Mosti, 2015)

The present report shall thus focus on the main challenges for manufacturing companies regarding Industry 4.0 and how the relevant framework needs to be custom made to support them in meeting these challenges. So, we need to make clear how Industry 4.0 is a growth catalyst and what its economic potential is possible.

The application of IoT technologies in intermediate and end products gives rise to cross-sectoral potentials for additional business support services (business-to-business) and for household services (business-to-consumer).

LITERATURE REVIEW

The new changes and perspectives of "Industry 4.0", with cloud computing, cyber-physical systems and smart factory, causes complexity, in particular for manufacturing firms. (Stock T. &., 2016) These changes and approaches related to the vision of Industry 4.0 and Smart Factories can help to remain competitive. The stable trends of miniaturization and the dropping of prices for sensors, information and communication technologies as well as the constant trend towards servitization enable approaches related to the vision of Industry 4.0 (I4.0) and Smart Factories. Challenges facing manufacturing firms are the development of novelty fitting business models and employee training. Manufacturing firms need specially designed information and implementation solutions that fit their needs and size. The barriers for adopting I4.0 approaches and technologies are very high. For manufacturing firms it is difficult to find suitable research partners and acquire the necessary administrative knowledge to apply for funding from public research programs. The term Cyber- Physical Systems refers to the close conjoining of and coordination between the physical assets and their computational capabilities, where hardware and software components are deeply interconnected, demonstrating multiple and distinct behavioural modalities, and interacting with each other in diverse ways that change with context. Therefore, new ways, methods and tools are required to connect manufacturing firms and research institutions, in order to support manufacturing firms in the development and of new products and services with elements in the physical and digital world (Cyber-Physical System or CPS) along with new business models enabled by these technologies. (Faller, n.d.) Digitization enters many different areas of life. The automotive industry is working hard on autonomous driving and the consumer industry offers a variety of solutions on the way of smart homes, autonomous cars. About 6.573 billion things were connected via the internet in the year 2014. This number will on the increase to over 25 billion in 2020. This development has a tremendous impact on future manufacturing. It offers possible solutions to well-known and frequently described challenges like the explosion of variants and ever increasing complexity in manufacturing due to technological progress and increasing rate of changes, Acatech, the German National Academy of Science and Engineering, puts the smart factory in the center for the analysis of opportunities and challenges of digitization and connection of humans, objects and systems in manufacturing. This new level of organization and control of the whole value- adding system considering the complete product life cycle with the goal of fulfilling individual customer needs also known as Industry 4.0.

THE EVOLUTION OF EMBEDDED SYSTEMS INTO THE INTERNET OF THINGS, DATA AND SERVICES

|

VISION : INTERNET OF THINGS, DATA AND SERVICES eg Smart City

|

CYBER-PHYSICAL SYSTEMS eg intelligent networked road junction

|

NETWORKED EMBEDED SYSTEMS eg autonomous aviation

|

EMBEDED SYSTEMS eg airbag

Source: acatech 2011 (GTAI, ND)

The realization of Industry 4.0 requires an ongoing coalescence of the digital and the physical domain. The technical realization is called cyber-physical systems (CPS) or more precisely for the field of manufacturing: cyber-physical production systems (CPPS). Therefore, not only to connect physical objects like components, machines or sensors to the cyber domain but also the application of software services to provide additional functionality to the user in manufacturing is required. One of the key enabler is the smart use of data with latency as short as possible aiming at a digital real-time image of the physical production (Landherr, 2016). Especially manufacturing firms in Malaysia have the difficulty to be highly skilled in applications and technologies of Industry 4.0. This is caused by the fact that those companies usually don't have the skilled manpower to look ahead and beyond their own product and production range to enter new areas and they usually don't have the possibility to invest in emerging technologies as an early adaptor in order not to lose money by focusing on the wrong technologies. However, those companies need to be trained in demanding technologies to be able to produce efficiently to survive in the globalized environment. Therefore areas with traditionally small manufacturing firms need the support and knowledge to develop those skills in an effective way (Faller C. , 2015).

CONCEPTUAL FRAMEWORK

Current key factors of competitiveness are time to market and customer responsiveness. So companies are investing in automation and robotics technologies that have the potential to reduce labor cost levels. Companies are redesigning their manufacturing networks and moving closer to their customers and R&D centers (Cheng et al., 2015). The pressure on companies continues to increase, and many are looking for more opportunities to increase productivity. The disruptive technologies of Industry 4.0, such as IT-driven manufacturing and increased computing capacity, give birth to the promise of smart factories that are highly efficient and data integrated. Data is the main driver and leaders across industries are leveraging data and analytics to achieve a step change in value creation. A big data/advanced analytics approach can result in a 20 to 25 percent increase in production volumes and up to a 45 percent reduction in downtime (Gallaher et al., 2016).

For the purpose of this study, we define all digitally enabled disruptive technologies that are likely to have a significant impact on manufacturing within the next 10 years as Industry 4.0 relevant. Some of these technologies are novelty innovations, such as augmented reality, while others like big data and advanced analytics have already been applied in manufacturing for some time now. At this point, the question arises: What is the novelty here? Is Industry 4.0 just another duplication of what has been known as manufacturing execution systems (MES) in the 1990s? We believe on the contrary. Research shows that all of the following technologies, for numerous reasons, are at a tipping point today and are on the verge to disrupt the manufacturing value chain (Thiesse et al., 2015). To be more precise, there are three challenges need to be examined.

Unqualified Employees

"Lack of qualified employees is the main challenge in implementing Industry 4.0" is the input when asked by The Business Development Bank of Canada's (BDC) study. The study asked the Canadian companies about the biggest challenges they are facing in the implementation of digital technologies. While "huge costs" and an "unclear return on investment" are part of the top 3 challenges, "lack of qualified employees" is the main reported challenge. (Bédard-Maltais, 2017)

Dr. Reinhard gave his views regarding talent in the PwC's 2016 Global Industry 4.0 ie. Survey of industrial companies is the biggest survey of its kind studying Industry 4.0 to date. Develope strategies for attracting people with the right digital skills. Your success with Industry 4.0 will depend on skills and knowledge. Your biggest constraints may well be your ability to recruit new employees or train existing ones who can put digitisation into place. You need to introduce new roles in your company, like data scientists, user interface designers, or digital innovation managers. And you'll probably need to update existing job profiles to take into account new digital skills. (Dr. Reinhard Geissbauer, 2016)

There is also an issue of trade unions striking against implementation of the new technology out of the fear of losing jobs in the study on Indian Manufacturing Industry by Aravind Anil. This is a big headache that the organisations will have to go through during their transition phase from the legacy systems to IoT enabled systems. (Anil, 2017)

High Cost

According to Dr Reinhard in the survey," 2016 Global Industry 4.0 Survey", Industrial sectors are planning to commit US$907 billion p.a. to Industry 4.0. Investments in Industry 4.0 capabilities are expected to reach around 5% of annual revenues p.a. The good news: more than half of companies expect a return on investment within two years. And the payoff will potentially be enormous, as competitive landscapes get redefined. (Dr. Reinhard Geissbauer, 2016)

Dr. Reinhard further added, within the next five years, advanced implementation of Industry 4.0 will become a 'qualifier to compete' and is also likely to be seen by investors as a 'qualifier for funding'. Companies who have not kept up will not only find themselves struggling to maintain market share but are also likely to face higher capital funding costs. (Dr. Reinhard Geissbauer, 2016)

Large investments are needed if enterprises are to make the move to Industry 4.0; these are projected to be €40 billion annually until 2020 for Germany alone (perhaps as much as €140billion annually in Europe). So far firms are cautious: even in Germany (a leader in manufacturing), only roughly one in five companies uses interconnected IT systems to control its production processes, although almost half intend to do so. Critics say that systems are too costly, not reliable and oversized, and that the Industry 4.0 approach is being led largely by equipment producers instead of customer demand. (Davies, 2015)

Vague Return On Investment

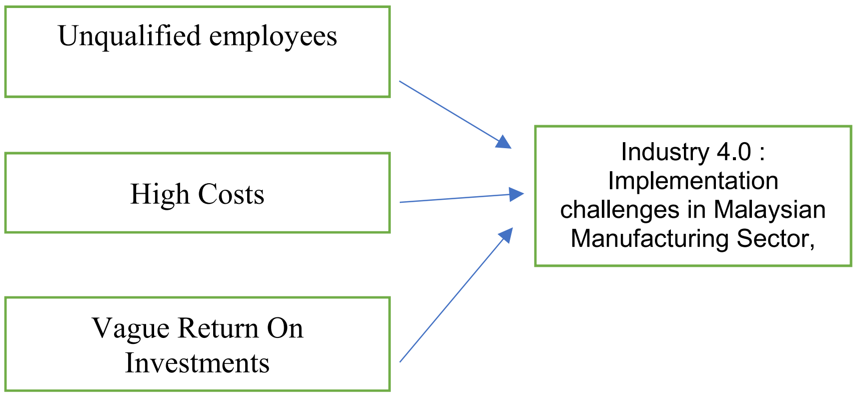
Dr. Reinhard mentioned in his paper that Industry 4.0 investments are already significant and their research suggests that global industrial products companies will invest US$907bn per year through 2020. Major focus of this investment will be on digital technologies like sensors or connectivity devices, as well as on software and applications like manufacturing execution systems (MES). In addition, companies are also investing in training employees and driving organisational change. More than half of respondents expect their Industry 4.0 investments to yield a return within two years or less, given investments of around 5% p.a. of their annual revenue. (Dr. Reinhard Geissbauer, 2016)

In a survey conducted by Arcadis (Arcadis Industrial Capital Expenditure Survey) reveals better returns and improved speed to market. Not surprisingly, 80% of respondents say that return on investment (ROI) is a significant factor in how they evaluate capital projects and 'profitability' is the most commonly used performance metric, according to 62% of executives.

An emphatic 88% of participants say they are confident that they can demonstrate the value that capital investment projects bring to their wider business. This confidence extends to the performance of their asset portfolio in ROI, which 66% rate as 'good' or 'very good', led by the chemicals sector, in which a overwhelming 89% of companies reported the ROI of their built asset portfolio as 'good' or 'very good'.

But, no companies in the heavy industrials sector rated their ROI performance as 'good', and a significant 33% of respondents in this sector were unsure of the ROI performance of their built asset portfolios. This may be attributed to high capital intensity, combined with the major influence of prices of commodities. So, balancing their ROI with their processing of orders should be the answer. The uncertainty discovered in this research could highlight a need for their operating teams to better report or communicate performance back to the capital program teams in this sector.
(Arcadis Industrial Capital Expenditure Survey , 2017)

Figure 1: Proposed Conceptual Framework



CONCLUSION

Embracing Industry 4.0 as the way to the future of manufacturing will allow firms to do more than just upgrading their equipment and being efficient to increase their operational effectiveness. It will also give them the freedom to make the right strategic decisions and revamp their business model, preparing them to maintain competitive advantages in the global manufacturing market of the future. This conceptual study reviewed and summarized the literature pertaining to adoption of Industry 4.0 in manufacturing sector and had identified the three challenges that need to be examined. Therefore, this study shall contribute to a new body of knowledge, where it will provide valuable observations on adoption of Industry 4.0 is significant and justifies a systematic study. In addition, this conceptual study may help and give ideas to managers of manufacturing firms to reassess their overall business strategy by combining Industry 4.0 into their business models, core beliefs and operations.

REFERENCES

Avram, M. G. (2014). Advantages and challenges of adopting cloud computing from an enterprise perspective. *Procedia Technology*, *12*, 529-534.

Beata. (2017). Towards Lean Production in Industry 4.0.

Cheng, Y., Johansen, J., & Hu, H. (2015). Exploring the interaction between R&D and production in their globalisation. *International Journal of Operations & Production Management*, *35*(5), 782-816.

Davis. (2015). Retrieved from. http://www.europarl.europa.eu/RegData/etudes/BRIE/2015/568337/EPRS_BRI(2015)568337_EN.pdf

Faller, C. (2015). Industry 4.0 Learning Factory for regional SMEs.

Gallaher, M. P., Oliver, Z. T., Rieth, K. T., & O'Connor, A. C. (2016). Smart Manufacturing.

Gao, R., Wang, L., Teti, R., Dornfeld, D., Kumara, S., Mori, M., & Helu, M. (2015). Cloud-enabled prognosis for manufacturing. *CIRP Annals-Manufacturing Technology*, *64*(2), 749-772.

Gorecky, D., Schmitt, M., Loskyll, M., & Zühlke, D. (2014, July). Human-machine-interaction in the industry 4.0 era. In *Industrial Informatics (INDIN), 2014 12th IEEE International Conference on* (pp. 289-294). IEEE.

GTAI,(nd).https://www.gtai.de/GTAI/Content/EN/Invest/_SharedDocs/Downloads/GTAI/Broachers/Industries/Industrie4.0-smart-manufacturing--for-the-future-en.pdf

Harboe, G., & Huang, E. M. (2015, April). Real-world affinity diagramming practices: Bridging the paper-digital gap. In *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems* (pp. 95-104). ACM.

Http://ljournal.ru/wp-content/uploads/2016/08/d-2016-154.pdf. (2016). doi:10.18411/d-2016-154

Industry 4.0. (2017). PwC. Retrieved 30 September 2017, from http://www.pwc.com/gx/en/industries/industry-4.0.html.

I-Scoop.eu, (nd). https://www.i-scoop.eu/industry-4-0/.

Katzenbach, J. R., & Smith, D. K. (2015). *The wisdom of teams: Creating the high-performance organization*. Harvard Business Review Press.

Landherr, M. (2016). The Application Centre Industry 4.0. El Sevier.

Lee, J., Kao, H. A., & Yang, S. (2014). Service innovation and smart analytics for industry 4.0 and big data environment. *Procedia Cirp*, *16*, 3-8.

Peppard, J., & Ward, J. (2016). *The strategic management of information systems: Building a digital strategy*. John Wiley & Sons.

Reinhard (2016). Industry 4.0. Retrieved September 30, 2017, from http://www.pwc.com/gx/en/industries/industry-4.0.html

Ramalingam, B., Hernandez, K., Prieto Martin, P., & Faith, B. (2016). Ten Frontier Technologies for international development.

Schwab, K. (2016, Jan). https://www.weforum.org/agenda/2016/01/the-fourth-industrial-revolution-what-it-means-and-how-to-respond/.

Stock, T., & Seliger, G. (2016). Opportunities of Sustainable Manufacturing in Industry 4.0. Procedia CIRP, 40, 536-541. doi:10.1016/j.procir.2016.01.129

Tashev, I. (2013). Kinect development kit: A toolkit for gesture-and speech-based human-machine interaction [best of the web]. *IEEE Signal Processing Magazine*, *30*(5), 129-131.

Thiesse, F., Wirth, M., Kemper, H. G., Moisa, M., Morar, D., Lasi, H., & Minshall, T. (2015). Economic Implications of Additive Manufacturing and the Contribution of MIS. *Business & Information Systems Engineering*, *57*(2), 139-148.

Truschzinski, M., Dinkelbach, H. Ü., Müller, N., Ohler, P., Hamke, F., & Pretzel, P. (2014, October). Deducing human emotions by robots: Computing basic non-verbal expressions of performed actions during a work task. In *Intelligent Control (ISIC), 2014 IEEE International Symposium on* (pp. 1342-1347). IEEE.