

TECHNOLOGICAL CAPABILITY IN INDUSTRY 4.0: A LITERATURE REVIEW FOR SMALL AND MEDIUM MANUFACTURERS CHALLENGES

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Abstract

Technological capabilities work as a basis for one to adapt and compete with the rapid pace of Industry 4.0 as without it worried the industry would get left behind hence this paper intends to give the low-down on the issues encountered regarding the technological capabilities in small and medium manufacturing enterprise (SME) due to the rise of Fourth Industrial revolution in manufacturing industry. Methods used are by reviews the literature on technological capabilities in the manufacturing sector based on journal articles, online news and books that strictly related to the keywords and research area. The concerns encountered in this paper are regarding the components of technological capabilities, and the challenges of technological capabilities face by manufacturers SME in Malaysia. Although a lot of researches uncover only the ground of technological capabilities hence there is a need to hit the books on the research area. Both empirical and non-empirical must carry out to discover more issues related to technological capabilities, and the study only covers the small and medium manufacturing enterprises in Malaysia.

Keywords--- Technological capabilities, Industry 4.0, SMEs

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INTRODUCTION

Fourth industrial revolution known as an era for the manufacturing industry to utilize full automation, the usage of electronics and information technologies (IT) as well as transform the information gained and created into a digital format (Roblek, Mesko, & Krapez, 2016a). Small and medium manufacturing enterprise (SME) crowned as a big winner from the transformation of the industry caused by Industry 4.0 (Othman, 2016).

The manufacturing industry in Malaysia has been introduced and practised the manufacturing automation since 1983 by Tun Dato' Seri Dr Mahathir Bin Mohamad (Othman, 2016). Malaysia is excited and thrilled with the idea to leap in into the world of Industry 4.0 (Ahmad, Ishak, Ishak, & Rajab, 2016), but there are clouds on the horizon where manufacturing SME in Malaysia believe that Industry 4.0 has yet to be a great relevance towards the industry due to the absence of information on the rise of digitization world in manufacturing industry (Othman, 2016).

Although manufacturing firm benefit with the performance enhancement through the help of technological advancement however manufacturing firm is on thin ice due to the unclear state of firm technological capabilities that assumed the emergence of risks and possibilities in manufacturing industry (Olechowski, Eppinger, & Joglekar, 2015).

A manufacturing firm that shield with premature technological utilization predicted to encounter with a perfect storm such as performance shortcomings which would affect the overall performance of the manufacturing firm (Olechowski et al., 2015).

The firm must develop new outputs that are nested in new technologies explain why manufacturing firm technological capability is becoming exceptionally important for the firm to compete and survive in the intense technologies development that arises instantaneously along with satisfying the dynamic market needs (Tzokas, Kim, Akbar, & Al-Dajani, 2015).

Manufacturing firm technological capabilities believed will become critical in the coming times to enable the firm to compete with the rapid pace of Industry 4.0 (Laugsand, 2017). However,

Industry 4.0 threaten manufacturing industry with its emergence at a fast rate which inflates the competitive pressure for the firm to achieve the standard set of technological capabilities made by the world (Laugsand, 2017).

Manufacturing firm performance will not be affected if the firms were able to compete with the technological advancement created by Industry 4.0 however the performance will seriously be affected due to the limited utilization of manufacturing firm technological capabilities (Tzokas et al., 2015).

Manufacturing firms demanded to prepared with the transformation that would take place in the manufacturing industry (Stein, 2015). However, the result either the firm can use the technologies and skills comprehensively to race with the fast pace of technology advancement are still not certain (Misrahi, 2012).

THE EMERGENCE OF INDUSTRY 4.0

The government of Germany is the first to introduce Industry 4.0 during Hannover fair back in 2011 hence created the emergence of Industry 4.0 in the whole universe (Ustundag & Cevikcan, 2018). The fourth industrial revolution named as Industry 4.0 known as the digitization world after the first three industrial revolutions approaching through electricity, mechanization and IT (Gilchrist, 2016). Industry 4.0 acknowledged as an era of digitization arisen from pair of different technologies categories as physical technologies and digital technologies suchlike cloud computing, augmented reality, artificially intelligent and additive manufacturing (Zhong, Xu, Klotz, & Newman, 2017).

Industry 4.0 introduced the technologies advancement to the world and, it created technologies such as 3D printing and online sales services (Roblek, Mesko, & Krapez, 2016b). It captivated the industry attention with the potential of technology advancement and development created by Industry 4.0 hence the potential proven surge the public interest along with their fears on the impacts produced (International Federation of Robotics, 2017). The discovery of Industry 4.0 created uncertainty that required an answer sought by education institutions, government and business enterprises (Ahmad et al., 2016).

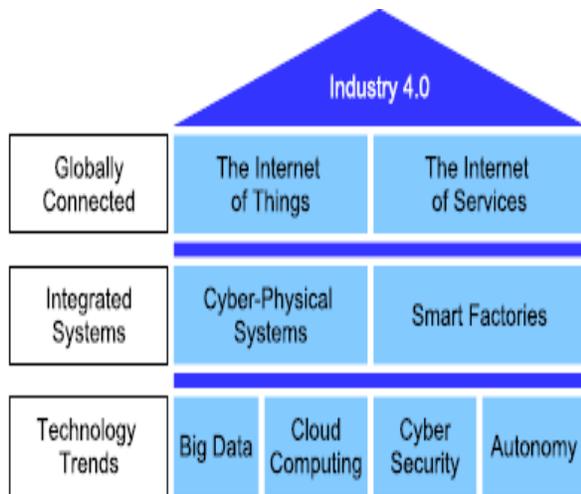


Figure 1. A vision of Industry 4.0
Sources: (Flynn, Dance, & Schaefer, 2017)

Industry 4.0 created through the combination of industrial manufacturing optimization from the transformation of the manufacturing process and internet technologies (Z. Li, Wang, & He, 2016). It introduces the digitization manufacturing into the environment; it anticipated to shift the old traditional mass manufacturing into highly flexible manufacture system for the coming times (Madsen, Bilberg, & Hansen, 2016). The world of digitization presumed that small and medium-sized enterprises expected to undergo the impact of changes occurred which, triggered the industry to confront with transformation created by Industry 4.0 (Roblek et al., 2016b). There was a sea change in the manufacturing industry after the emergence of Industry 4.0 as it modernizes the manufacturing systems in firms (Zhong et al., 2017). Industry 4.0 produced the production efficiency in firm benefit the manufacturing industry and indirectly enhanced the economy growth (MIDA Newsletter, 2016). Manufacturing firm demanded to seize the opportunities of digitalization in the firm production stages (Ustundag & Cevikcan, 2018) and Industry 4.0 plays a crucial role to find out the outcome of the strategy applies by the manufacturing firm (Ustundag & Cevikcan, 2018). Industry 4.0 is an interesting discovery which breaks the new ground in the manufacturing industry as it works

as a recent industrial revolution by providing internet development and Internet of Things (IoT) that give rise to the technology advancement in the manufacturing sector (Roblek et al., 2016b).

The revolution of fourth industrial production explains that Industry 4.0 is not solely on new technologies adoption in a whole new level; it is beyond that (Laugsand, 2017). Industry 4.0 introduced a world of intelligent manufacturing in manufacturing industry hence required firms to apply the functions of smart factories in this world of digitization (Zhong et al., 2017). The other industrial nations suchlike India, European Union, China and Asian countries have embraced the adoption of conceptual ideal regarding Industry 4.0 in their nations (Gilchrist, 2016). Manufacturing Industry in Malaysia has been encouraged to embrace the world of digitalization as it boosted country competitiveness together with captivated the investor attention (MIDA Newsletter, 2016). Policymakers believe that Industry 4.0 enhance the economic benefit and has higher potential rates of growth, especially in the future intermediate state of static productivity and in advance economies (Masayuki, 2017). Malaysia shows a good sign in the acceptance of Industry 4.0 as it considers the rise of digitization world in the manufacturing industry as the best thing since sliced bread (Ahmad et al., 2016). Malaysia recorded as the leading scorer in technologies creation and ranked 35th in the top 50 for Global Innovation Index in 2016 proved that Malaysia stands in an excellent spot to conform with Industry 4.0 (MIDA Newsletter, 2016). Malaysia manufacturing industry requires being in a well-prepared state in term of firm technological capabilities, resources and operation to face with the consequences of transformation made by Industry 4.0 in the manufacturing sector as without it Malaysia are risked being left behind in Industry 4.0 intense competition (Hamid, Hamzah, Noor, & Azali, 2018).

TECHNOLOGICAL CAPABILITIES IN MANUFACTURING INDUSTRY

The occurrence of Industry 4.0 in the manufacturing industry is rapidly growing in a very short space of time, triggered the uncertainty on manufacturing firm technological capabilities hence demanded the firm technological capabilities in manufacturing firm to soared dramatically (Seet, Jones, Hordacre, Jones, & Jones, 2018).

Table 1. The frequency of technological capabilities studies in sector

Sector	Frequency	Sources
Manufacturing	9 Empirical works	(Filho & Moori, 2017; Gewe, Abebe, Azene, & Bayu, 2016; Gupta & Barua, 2016; M. Li, Wang, & Zhao, 2017; Lin & Lai, 2020; Molina-Domene & Pietrobelli, 2012; Salisu & Bakar, 2019; Sasitharan & Lazim, 2018; Szalavetz, 2019)
	8 Conceptual papers	(Azizi, 2015; Marvel & Wyk, 2016; Marques, Agostinho, Zacharewicz, & Goncalves, 2017; Mkalama, Ndemo, & Maalu, 2018; Roblek, Mesko, & Krapez, 2016; Salisu & Bakar, 2018; Salisu & Julienti, 2019; Samonova & Semernik, 2019)
	6 Case Studies	(Biswas & Anirban, 2018; Gaithersburg, 2011; Jabar & Santa, 2011; Mohammadi, Elyasi, & Kiasari, 2014; Schuh, Vogt, & Drescher, 2016; Y. Wang, Su, Wang, & Zou, 2019)
Others	4 Empirical works	(Castillon-Barraza, Gonzalez-Angeles, Lara-Chavez, & Mendoza-Munoz, 2018; Liao, Liu, & Fu, 2019; Rahim & Zainuddin, 2016; Tumelero, Sbragia, Borini, & Franco, 2018)
	5 Conceptual papers	(Asim, 2019; Guerra & Camargo, 2016; Lestari & Ardianti, 2019; Radzi, Shamsuddin, & Wahab, 2017; Sachitra, 2016)

	4 Case Studies	(Al-Mamary, Shamsuddin, & Hamid, 2015; Iqbal, Hadi, & Zafar, 2016; Mulugeta, Muchie, & Kitaw, 2016; Sobanke, Adegbite, Ilori, & Egbetokun, 2014)
Total	13 Empirical works	
	13 Conceptual papers	
	10 Case Studies	

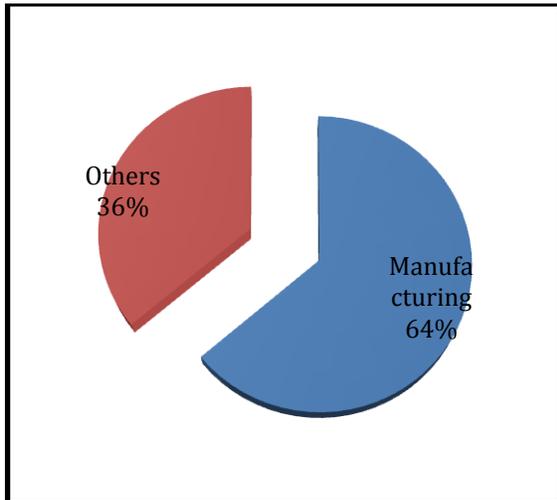


Figure 2. Sector percentage in technological capabilities studies

Majority studies of technological capabilities have been conducted in manufacturing sector compare than the others hence provide a glimpse that the utilization of machinery equipment in manufacturing industry involved heavily with the technological capabilities. Industry 4.0 introduced a new technique of operations in manufacturing firm by advancing the operation accuracy to higher standards demonstrate the evolution of Industry 4.0 in manufacturing market (Saucedo, Marmolejo, Lara, Salais, & Vasant, 2017). The manufacturing firm that armed themselves with greater technological capabilities stated that it has better resources, skills and participate in more strategic activities hence indirectly improve firm performance through its profitability and competitive advantages gained by the manufacturing firm (Lin & Lai, 2020). Rapid technological change that happened in the manufacturing environment required the firm to own a higher level of technological capabilities inside the firm (Tzokas et al., 2015) & (Hussain et al., 2018). On the flip side, there exist a huge gap between technological capabilities in developed and developing countries due to the emergence of Industry 4.0 in manufacturing industry hence crucial for both countries to conform with the changes created by Industry 4.0 which requires the ability to exploit and seize the technological opportunities offered by the world (Technology and Innovation report, 2018). It has become a critical component for manufacturing firm especially, in the newly industrialized countries explained the SME development are defined through firms capability to present new goods over a certain period (Guerra & Camargo, 2016). Firm manufacturing performance enhanced through well-developed technological capabilities in the manufacturing firm, especially in an intense transformation of manufacturing environment (Tzokas et al., 2015). Not only just that there's also another name for technological capability known as new product development (NPD) that allow firms to enhance firm performance, product development and firm profitability in manufacturing intense environment through involving with new product development

program based on the state of the art technologies (Tzokas et al., 2015). However, the depth of technological capabilities is varied based on the technological capabilities level of the manufacturing firm (Interakumnerd & Techakanont, 2015).

Technological capabilities defined as the ways firm managed and operated their capability in skills, human resources expertise and knowledge (Mulugeta et al., 2016). It recognized as the firm ability to produce new technologies, processes and goods (Gewe et al., 2016). On top of that, it identified as the firm ability to obtain, initiate and utilize new knowledge which indirectly allow firm to achieve the targeted manufacturing performance (Liao et al., 2019) likewise specified to firm's capability in cultivate new products, process, skills and knowledge on firm physical environment in productive way and employ it in design creation hence allow firm efficiently obtain firm targeted performance (Salisu & Bakar, 2018). Above and beyond, technological capabilities are known as firms capability to compete in an intense competition by obtaining and grasp new knowledge for commercial purposes (Lestari & Ardianti, 2019).

The definitions of technological capabilities derived from the number of scholars mostly emphasized on manufacturing firm ability and, it defined in various terms and perspectives in the vast area of knowledge derived from many researchers over many years. Substantially, technological capabilities is an entire set of knowledge that integrate theoretical and practical methods, and know-how portrays the superior manufacturing firm technical assets that have a close connection with several types of technologies in firm listed as product technologies, process technologies, design technologies and information technologies. Hence ultimately, technological capabilities are best to describe as firms ability to secured a complete technical knowledge for performance enhancement.

DIMENSIONS OF TECHNOLOGICAL CAPABILITIES

Most of the previous studies uncover a limited area of technological capabilities as they placed the technological capabilities to work as a moderator for research variables. Manufacturing firm technological capabilities are determined through two bases to categorize as a tangible asset and intangible asset where it works as tools to guide the firm (Gewe et al., 2016). There are several important determinants of technological capabilities classified as core technology capability, the autonomy of R&D and technological opportunities exploration (Lestari & Ardianti, 2019) and three critical components of technological capabilities listed as factory maintenance, innovation and technology adoption (Ibambi, Oloko, & Rambo, 2017). Technological capabilities varied depending on the time-proven to be dynamic instead of static (Y. Wang et al., 2019). The dynamic approach is known as an approach to acknowledge the level of technological capabilities in manufacturing firm by utilizing firm innovative capability, competences and resources (Gewe et al., 2016). Manufacturing firm that competes in the intense competition of Industry 4.0 through the help of dynamic technological capabilities has a higher possibility to survive based on the arguments from the number of scholars (Filho & Moori, 2017; Samonova & Semernik,

2018; Y. Wang et al., 2019). On top of that, technological capabilities in manufacturing firms are divided into the number of types and levels in hierarchy shape categorized as R&D, design and engineering capabilities and operating, craft along with technician capabilities accordingly (Mulugeta et al., 2016).

Technological capabilities in management point of view separated into four items classified as recruiting technical staff, research and development (R&D), inventions patenting and new products launching in the market (Tumelero et al., 2018). However, for dynamic technological capabilities the components are listed as customer demands, competitor pressures, product updates and preserve the firm internal environment that works as tools to the prepared firm in the encounter with external pressure (Y. Wang et al., 2019). Firm technological capabilities specified by few indicators listed as patents, R&D expenditures, and publications (Lestari & Ardianti, 2019). However, firm dynamic technological capabilities indicated by only a few classified as R&D personal, R&D input, intangible assets, number of inventive patent applications and number of the total patent application (Y. Wang et al., 2019). Manufacturing firm technological capabilities are determined through several components listed as innovation capability, linkage capability, information capability, and relational capability (Wang, Dou, Zhu, & Zhou, 2015). Firm's design technologies, product technologies, information and process technologies, sourcing, and integration of external knowledge are listed as the constituents lays in technological capabilities as well (Salisu & Bakar, 2019). It is also

believed that technological capabilities in manufacturing firms consist of firms generate resources, their organization suchlike the production and equipment, skills explain on employees' efficiency and effectiveness, firm technological development, their new technology creation, and adoption (Arballo, Nunez, & Tapia, 2019). Manufacturing firm can measure and identify the level of technological capabilities through innovation capability (Schubert, Baier, & Rammer, 2017) and linkage capability (Salisu & Bakar, 2018; Salisu & Julienti, 2019) together with investment capability (Liao et al., 2019). It's also added that the firm's production capability required more attention from the firm due to a direct relationship with the firm's process control and the efficiency of its equipment (Azizi, 2015). Production capability that comes together with the effectiveness of use, evaluation or quality, maintenance, production planning, the understanding of value chain and companies' knowledge of the sector of interest are also listed as the elements of technological capabilities (Castillon-Barraza et al., 2018). Not only just that, the firm's economic goals, especially in the matters of new technology, can be measure best through investment capability (Iqbal et al., 2016). Hence, many believed that four main dimensions of firm's technological capabilities are classified as innovation capability, investment capability, production capability and linkage capability (Gupta & Barua, 2016; Lin & Lai, 2020; Mkalama et al., 2018; Rahim & Zainuddin, 2016; Sachitra, 2016; Szalavetz, 2019).

Table 2. Dimensions of technological capabilities

Sources	Dimensions
(G. Wang, Dou, Zhu, & Zhou, 2015)	Innovation capability, Linkage capability, information capability and relational capability
(Azizi, 2015)	Production capability
(Gupta & Barua, 2016)	Innovation capability, investment capability, production capability and linkage capability
(Sachitra, 2016)	Innovation capability, investment capability, production capability and linkage capability
(Iqbal, Hadi, & Zafar, 2016)	Investment capability
(Rahim & Zainuddin, 2016)	Innovation capability, investment capability, production capability and linkage capability
(Mulugeta, Muchie, & Kitaw, 2016)	Investment capability, R&D, Design and engineering and operating, craft and technician
(Gewe, Abebe, Azene, & Bayu, 2016)	Innovation capability, tangible asset, intangible asset, resource, innovative capability, competence, internal capability and external capability
(Schubert, Baier, & Rammer, 2017)	Innovation capability
(Ibambi, Oloko, & Rambo, 2017)	Innovation capability, technology adoption and factory maintenance
(Mkalama, Ndemo, & Maalu, 2018)	Innovation capability, investment capability, production capability and linkage capability
(Castillon-Barraza, Gonzalez-Angeles, Lara-Chavez, & Mendoza-Munoz, 2018)	Production capability, effectiveness of use, evaluation or quality, maintenance, production planning, the understanding of value chain and the knowledge of the companies of the sector of interest
(Sasitharan & Lazim, 2018)	Innovation capability, investment capability, production capability and linkage capability
(Tumelero, Sbragia, Borini, & Franco, 2018)	Innovation capability, investment capability, R&D, Invention patenting, Technical staff hiring and introduction of new products in market
(Salisu & Bakar, 2018)	Innovation capability and linkage capability
(Salisu & Julienti, 2019)	Innovation capability and linkage capability
(Szalavetz, 2019)	Innovation capability, investment capability, production capability, linkage capability and R&D
(Arballo, Nunez, & Tapia, 2019)	Innovation capability, production capability, linkage capability, generate resources, organisation (production and equipment), skills (efficient use), appropriating, transferring and developing (technology) and use, adopt, change and create new technology
(Lestari & Ardianti, 2019)	Innovation capability, investment capability, R&D, exploring or exploiting technological capabilities, core technology capability, autonomy of R&D and training personnel
(Liao, Liu, & Fu, 2019)	Innovation capability and investment capability,
(Y. Wang, Su, Wang, & Zou, 2019)	Innovation capability, investment capability, intangible asset, R&D, technologic output, number of total patent application and number of inventive patent application
(Salisu & Bakar, 2019)	Production capability, linkage capability, firm's design technologies, product technologies, information and process technologies, sourcing and integration of external knowledge

(Lin & Lai, 2020)

Innovation capability, investment capability, production capability and linkage capability

Table 3. Repetition of technological capabilities dimensions

Dimensions	Repetition
Innovation capability	18
Investment capability	13
Linkage capability	12
Production capability	11
R&D	5
Intangible asset	2
Information capability	1
Relational capability	1
Tangible asset	1
Resource	1
Innovative capability	1
Competence	1
Internal capability of the firms.	1
External capability of the firms.	1
Technology adoption	1
Factory maintenance	1
Technology innovation	1
Effectiveness of use	1
Evaluation or quality	1
Maintenance	1
Production planning	1
The understanding of the value chain.	1
The knowledge of the companies of the sector of interest	1
Generate resources (Manage resources)	1
Organization (Production and equipment)	1
Skills (Efficient use)	1
Use, adopt, change and create new technology	1
Appropriating, transferring and developing (Technology)	1
Design and engineering	1
Operating, craft and technician	1
Exploring or exploiting technological opportunities	1
Core technology capability	1
Autonomy of R&D	1
Training personnel	1
Technologic output	1
Number of total patent application	1
Number of inventive patent applications	1
Firm's design technologies	1
Product technologies	1
Information and process technologies	1
Sourcing and integration of external knowledge	1
Invention patenting	1
Technical staff hiring	1
Introduction of new products in the market	1

TECHNOLOGICAL CAPABILITIES AND INDUSTRY 4.0

Industry 4.0 created an image of “intelligent” automated factories in the manufacturing industry where production system, employees, goods and customer are link with one another (Karre, Hammer, Kleindienst, & Ramsauer, 2017). The emergence of Industry 4.0 drive the creation of intense competition in manufacturing industry through the alterations of social, technological, economic, the continuous globalization, transmission expansion and technologies transportation (Bakan & Sekkeli, 2017) however, the industry weathered the storm by receiving wide influences from Industry 4.0 through the creation of industrial value and numbers of opportunities gained for sustainable manufacturing realization in the beginning of early of industrialized countries (Stock & Seliger, 2016). The unheralded global economic environment strongly challenged towards Malaysian manufacturing organization durability (Sasitharan & Lazim, 2018). The emergence of Industry 4.0 raises the firm technological capabilities development as the most crucial driving force to determine the successfulness of firm adaptability into the new world of digitization in the manufacturing environment (Laugsand, 2017). Industry 4.0 required SME to arm themselves with finer technological capabilities; however, SME has difficulty with constant insufficient resources alarmed the needs for the industry to develop technological capabilities (Lin & Lai, 2020). Hence explain on why manufacturing industry required guidance to leap in into the changes made by Industry 4.0 in manufacturing firm technological capabilities and practices to enhance the firm performance in achieving their objective (Gokalp, Sener, & Eren, 2017).

Industry 4.0 plays a crucial role in the manufacturing industry by introducing smart factories (Olsson & Yuanjing, 2018). The occurrence of Industry 4.0 in manufacturing industry caused the manufacturing environment to revolve intensely by times (Mulugeta et al., 2016). Industry 4.0 introduced the idea of smart manufacturing in the future manufacturing environment; it is where the machines work as one collaborative community that benefit the firm with the creation of a high level of technological capability in the aspect of predictive maintenance (Z. Li et al., 2016) & (Hussain et al., 2016). There exist the technological changes arise from Industry 4.0 that inaugurated the challenges and hurdles for manufacturing firms (Esmaeel, Zakuan, Jamal, & Taherdoost, 2018). The result obtained by manufacturing firm in the rise of Industry 4.0 depends toward the manufacturing firm employees skills and the technologies used by the firm as these two determined the ascendancy of the industry to survive in an intense competition of manufacturing industry (Misrahi, 2012). Industry 4.0 created a highly flexible, automated, connected and adjustable manufacturing enterprises and mass production that recognized as smart factories where it required a higher capability in manufacturing firm technological aspect (Olsson & Yuanjing, 2018). Firm technological capabilities enhanced manufacturing firm performance and allow the firm to survive in an intense transformation of manufacturing environment caused by Industry 4.0 through firm’s internal competence that affects firm contributive nature towards its performance efficiently and effectively (Liao et al., 2019). The drastic changes of technological development and advancement in manufacturing industry forced firms to move towards manufacturing technological systems proven to boost the manufacturing performance since it is more advanced than traditional manufacturing (Esmaeel et al., 2018). Technological capabilities benefit the manufacturing firm in several ways suchlike enhanced firm’s ability in the identification and utilization external technology resources along with strengthening external resource acquisition and exploitation process (Liao et al., 2019). Technological capabilities are known as firm value creation through core resources and distinct ability owned by the firm (Lin & Lai, 2020). Generally, technological capabilities defined as

firm ability to use the state-of-the-art technologies in working out on firm technical function and volume activity (Liao et al., 2019). However, the manufacturing firm is not aware and being ignorant with the rise of Industry 4.0 in manufacturing industry caused the occurrence of uncertainty on the preparation made in the development of firm technological capability (Mulugeta et al., 2016). The emergence of Industry 4.0 in manufacturing industry arise the complexity in all levels of the firm created the industry uncertainty in manufacturing firm technological capabilities to surge drastically (Schumacher, Erol, & Sihm, 2016).

THE CHALLENGES OF SMALL AND MEDIUM MANUFACTURERS

Industry 4.0 generated technology advancement in manufacturing industry triggered the drastic transformation in manufacturing environment make it tough to survive with the changes made by Industry 4.0 (Moniz & Krings, 2016). The challenges occurred from the emergence of Industry 4.0, addressing the concern towards the manufacturing industry to generate a proper strategy to seize the targeted manufacturing firm performance (Esmaeel et al., 2018). The emergence of Industry 4.0 in manufacturing industry promised manufacturer with greater competitiveness and profitability obtained by manufacturing firm (Guerin, Lea, Paxton, & Hager, 2015). Industry 4.0 caused current developments in environmental, economic, technological and societal aspects arise as major concerns on manufacturers across the globe hence the future prediction on manufacturing industry displays the needs of capabilities required by the manufacturing firm to supervise the entire value-chain in the most flexible ways (Schumacher et al., 2016). SME urged to develop firm technological capabilities to compete with Industry 4.0 hence required firm to accumulate their knowledge for an enhancement in continuous growth and incomparable level of competitiveness (Lin & Lai, 2020). Manufacturers believed that manufacturing firms are in dire straits by not aware of the transformation of manufacturing industry explain why there are only fewer changes made by the firm (McKinsey Digital, 2015). However, manufacturers are bold in the acceptance of digitization world in manufacturing industry even though there exist some worrisome issues due to the rise of Industry 4.0 (Thoben, Wiesner, & Wuest, 2017).

The manufacturer required SME to develop a firm capability that enables the firm to generate high-quality services and products (SME Annual Report, 2019) however; manufacturers confront with unprepared state of manufacturing firms while encountered with the new advance transformation (McKinsey Digital, 2015). Manufacturers aware that emergence of Industry 4.0 came with a concept that is highly complex, hard and challenging (Schumacher et al., 2016). The financial issue is the challenges that triggered the manufacturers in the technological transformation that occurred in the manufacturing industry. Technological advancement in Industry 4.0 arise together with high production costs for small and medium manufacturing enterprises occurred as challenges faced by manufacturers (Salisu & Julienti, 2019). Technologies used in those developed countries are up-to-date and promising however it is known to be high in production costs especially for small and medium manufacturing enterprise attributed to firm lack of abilities in it financial resources faced by manufacturers especially in indigenous manufacturing environments (Salisu & Julienti, 2019). Industry 4.0 created high commitment of technology for manufacturing firm to encounter with the dynamic technological condition demanded effective and efficient technologies in produce better outputs and services (Al-Ansari, Altalib, & Sardoh, 2013). What’s more, technological advancement in manufacturing environment created an increase in materials cost and overhead cost since it required expert skills raised as

concerns for manufacturers to deal with the difficulties occurred (Ali, 2016).

On top of that, manufacturers encountered an issue of limited resources owned by the manufacturing firm. Manufacturers confronted with issues of the incapability in utilizing the best use of manufacturing firm resources caused the firm to be satisfied with only low operational benefits when they are possible to achieve high operational benefits in the world of digitization (McKinsey Digital, 2015). Manufacturers encountered with limited technological resources as a consequence of redundancy of technological knowledge (Sears & Hoetker, 2013). Limited resources in manufacturing firm occurred from the complex success rate of new product development that worried the manufacturers (Guerra & Camargo, 2016). However, due to the rapid development and rising intensity in the complexity of technological advancement restrain the firm to make the best use of technological resources owned by the firm (Salisu & Bakar, 2018) & (Ahmed et al., 2016). Besides of that, the large investment in augmenting firm production and R&D capabilities, especially in the emergence of Industry 4.0 caused the firm not to own a sufficient resource (Shin, 2015).

Manufacturers must develop manufacturing firm technological capabilities rather than importing raw materials in the efforts for the firm to survive the intense competition of Industry 4.0 (SME Annual Report, 2019). A failure to assess manufacturing firm own capabilities in highly complex Industry 4.0 across as an obstacle for manufacturers because it stops the firm from winning any coordinate measures (Schumacher et al., 2016). SME manufacturers encounter with poor innovation and technological capabilities in the SME manufacturing firm caused the firm to acquired the technologies from external sources only in developing countries (Salisu & Julienti, 2019). Manufacturers encounter with firms' failures in the long run as firms do not rely on developing their technologies instead firm believed that product and process development is not something that they should put their focus on (Lestari & Ardianti, 2019). The issues of technological capabilities encountered by manufacturers in small and medium-sized manufacturing enterprises based on the manufacturing firm shortage of sharp boundary on technological knowledge utilizing and knowledge shifting capabilities (Szalavetz, 2019).

RECOMMENDATION

Industry 4.0 triggered an intense transformation in technological advancement and development of manufacturing industry required the firm to move towards manufacturing technological systems which result in the enhancement of manufacturing performance (Esmaeel et al., 2018). Manufacturing firms secure the higher industrial performance through product network along with vertical and horizontal production process integration created by the latest industrial revolution (Santos, Brittes, Fabián, & Germán, 2018). Manufacturing firm measured the performance achieved by the firm through the goods produced by the firm (Saunila, 2015). Manufacturing firm performance divided into several categories listed as flexibility performance, delivery performance, operational performance and quality performance (Abdallah, Phan, & Matsui, 2016). Operational performance is selected in this paper as it defined as the final result of firm operations and activities (Bagher, 2018). Operational performance evaluated by using two types of measurement known as cost-based and non-cost based measure (Saunila, 2015).

On top of that, one who identifies and evaluates the productiveness, capability and efficiency is known as an operational performance (Bagher, 2018) hence explain that operational performance works as a backbone for manufacturing

performance (Kamau, 2016). Operational performance stated as direct manufacturing performance assess four items in manufacturing firm classified as quality, flexibility, cost efficiency and delivery performance (Abazeed, 2017). Industry 4.0 marked manufacturing environment as an era of the digitization production process that produced a big impact on small and medium-sized manufacturing enterprises (Roblek et al., 2016b). Hence to identify the impact of Industry 4.0 in SME determine through manufacturing firm technological capability that works as a tool that is best to measure and evaluate firm performance (Charalambous, 2014).

CONCLUSION

This study proved that technological capability is critical for manufacturing operational performance in Malaysia. Technological capabilities are complex components that varied by times. On top of that, technological capabilities are one of the most important resources in a manufacturing firm which would determine manufacturing firm performance. The manufacturing industry in Malaysia has to keep up with the times, especially in the emergence of technological advancement from Industry 4.0. There are higher possibilities for the manufacturing industry in Malaysia to get left behind due to insufficient resources in manufacturing firms. Firms required to make the best use of its resources synergistically hence impact performance through firm value creation (Laugsand, 2017). Manufacturing firms that armed themselves with sufficient capabilities and resources benefit firm with superior manufacturing performance. Technological capabilities work as a stepping stone for one to set foot in into the world of digitization. The numbers of issues arise on technological capabilities in small and medium manufacturing enterprise led this study to review the challenges encountered by the technological capabilities of manufacturing SME. More findings underline the technological capabilities components and challenges faced by small and medium-sized manufacturing enterprise. Gap found in this conceptual paper uncover poor data found from the previous study regarding the research area. This conceptual paper will widen the field of technological capabilities that impose the needs to discover in future studies.

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