ASEAN Entrepreneurship Journal (AEJ)

Technological-Organisational-Environmental (TOE) Framework in Industry 4.0 Adoption Among SMEs in Malaysia: An Early Outlook

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Abstract
Presently, the fourth industrial revolution has already paved its way throughout many industries and left a dramatic impact on the way technology was adopted, the organisation operated and changed the business environment landscape. Since small and medium-sized enterprises (SMEs) in Malaysia have been one of the major backbones of the country's economy, accounting for up to 37% of total GDP, it is crucial for them to adopt the infusion of automation and digital practices embedded in Industry 4.0 in order to remain competitive and innovative in the market. Although Industry 4.0 has been booming worldwide, it is still a challenge for small enterprises to adopt, especially in a developing country like Malaysia. Relationships between the technological, organisational, and environmental contexts as well as the adoption implementation of Industry 4.0 by small and medium-sized enterprises in Malaysia are the main criteria to be verified in this research. The aim is to explore and discuss the use of Technological-Organisational-Environmental (TOE) framework in the analysis of factors that influence the adoption of Industry 4.0 by small and medium-sized enterprises (SMEs) in Malaysia.

ARTICLE INFORMATION
Received: 15 Oct 2020
Revised: 30 Oct 2020
Accepted: 21 Dec 2020

Keywords: *Industry 4.0, SMEs, TOE Framework, Adoption*

INTRODUCTION

Industrial Revolution 4.0, famously known as Industry 4.0 has emerged widely around the world as one of the important factors with the capability to contribute in productivity efficiency and competitiveness in various industries. Due to the new technological changes brought by the revolutionary shift, there is a permanent need in identifying, comprehending as well as indulging in the organisational adoption of technological advances, its specific features and dimensions. Not only adoption, organisations also need to adjust and transform their current business operations, develop expertise and continuously upgrade to new technology (Nguyen & Luu, 2020). Digitalisation approaches made by SMEs have sparked interests among many groups including governments, business partners, trade associations and academia.

In 2018, the Malaysian government announced Industry4WRD, which is The National Policy on Industry 4.0 – an initiative developed by the Ministry of Trade and Industry (MITI) to convert Malaysian manufacturing SMEs to become smarter, systematic and competitive. Industry4WRD will be able to cater to SMEs' needs in determining their state of readiness for Industry 4.0, recognising any existing gaps, discerning areas of improvement, forming practical strategies as well as arranging schemes to execute outcome-based intervention projects. It is also an initiative structured for SMEs that are interested to take part – it is a must for SMEs to register prior to the assessment process. A full report will be generated by the Industry4WRD committee once completed and companies are set to their readiness percentage scored towards Industry 4.0 (MITI, 2018).

The rankings in the World Economic Forum Global Competitiveness Report are reviewed as the outline in benchmarking the readiness of the country to propel in the new era of Industry 4.0. Notably, Malaysia was leading the group of upper-middle-income countries, taking the 32nd place, while China at 41st and Romania 47th. This is due to complacency enforcement and support devoted by the government to move forward ahead of others towards digital agenda and advancement and convergence of technologies, and individuals that are connected to the Internet in Malaysia has increased to nearly two-thirds of the population (The Network Readiness Index, 2019).

Readiness for the Future of Production Report 2018 reported that Malaysia is categorised in the "Leader" position and this position is ranked according to nations with "strong current production base" and "positioned well for the future" (National Policy on Industry 4.0, 2018). For the record, Malaysia and China are the only low-income nations listed in the position. Hence, this can be seen as an opportunity for local SMEs to expand and undergo progress in the current commercial operations by immediately employing the advanced technologies of Industry 4.0 to create value and extend their market growth, apart from establishing international reputation as well as developing global engagements through the initiatives prepared by the government.

This study is important since it is in line with data obtained from Malaysian Investment Development Authority (2018) which postulates that special attention should be directed towards the development of SMEs in ensuring its evolution in driving and sustaining the economy as Malaysia gravitates to becoming an industrialised country. The Government has already proposed SME Masterplan 2.0 (2021-2030) that focuses on stimulating SMEs' endeavour in an internationalised and digital marketplace. The Masterplan also plans to emphasise orientating business strategy of SMEs to adapt with the digitalisation of Industry 4.0.

SME Corporation Malaysia (2017) expects all small and medium-sized enterprises (SMEs) in the country to introduce digitalisation in their operations within five years as compared to current results. Department of Statistic Malaysia (2020) reported 98.5% (907,065) of business establishments in Malaysia are made up of SMEs cut across all sizes and sectors, and have contributed up to 38.9% of Malaysia's GDP in 2019 as compared to 38.3% in 2018, also a sterling increase in total employment which was 48.4% in 2019 compared to 48% in 2018, and a growth in gross exports which made up of 17.9% in 2019 compared to 17.3% recorded in 2018. Definitely, the local SMEs are making good progress in their contribution to the nation's GDP, which is 41% by 2020 compared to 32% in 2012. This is due to the fact that SMEs in Malaysia have currently become suppliers for multi-national companies (MNCs) in the global chain. Figure 1 illustrates the GDP performance of SMEs in Malaysia in 2019.

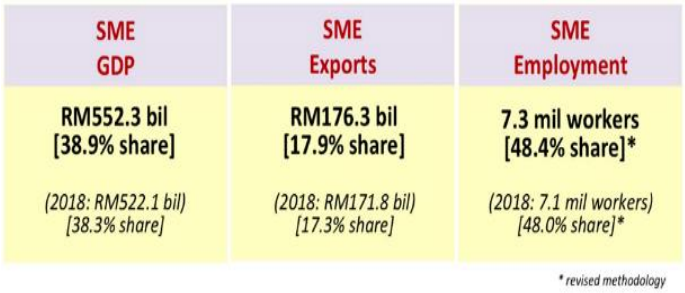

Figure 1: SME Performance in 2019

2.0 PROBLEM STATEMENT

Industry 4.0 wave has the potential to develop and enhance the capacity of organisational, management and manufacturing companies in various forms, such as improving productivity, efficiency, and cost, as well as better quality monitoring and the development of producers and innovators. However, a survey conducted by MITI (2017) has found that small and medium-sized enterprise digital adoption in Malaysia is low which is lower than 20% as manufacturing firms use little automation, meaning that most enterprises use less than 50% of automation. MITI further explained that although most large manufacturing companies anticipate the risks and returns of Industry 4.0, Malaysian SMEs seem cautious and apprehensive about taking the step, while many of them remain unaware about it.

Another concern is, several reports have claimed that Malaysian SMEs refuse to be risk-takers, lack innovativeness, and are not ready for vigorous competitions (Ismail & Zakaria, 2018). Radzi & Wahab (2017) concluded in their study that technology incompetence among Malaysian SMEs has caused them to produce low performance in business. This scenario could be avoided if organisations are willing to invest in new technology to maintain product quality through research & development in product innovation. SMEs are struggling with the process to implement Industry 4.0 due to insufficient resources (Issa, Hatiboglu, Bildstein & Bauernhansl 2018; Muller, 2019) and are hardly growing; instead they are trying to survive with financial deficit (Wei & Talib, 2019).

3.0 RESEARCH OBJECTIVE

This study will analyse factors influencing Industry 4.0 adoption in small and medium-sized enterprises (SMEs) in Malaysia using the technological-organisational-environmental (TOE) framework.

4.0 LITERATURE REVIEW

4.1 Industry 4.0

In retrospect, the German government had seemingly issued "Industrie 4.0" as early as 2011, which has expeditiously propelled others to explore and engage with the phase of digitalisation, which later becomes the most popular, timely topic across the international manufacturing industry. The concept was introduced at Hanover Messe in Germany in 2011. It has become phenomenal by taking over global economies heroically, ultimately changing the landscape of competitiveness of companies and regions. Yet, it appears that Industry 4.0 is still a new area that needs a broader and wider exposure in the field of research.

Additionally, The Boston Consulting Group discovered that the rapid acceptance and incorporation of Industry 4.0 have a facilitative impact as it could escalate labour productivity to approximately 30% by 2024. From a strategic point of view, literature concurs that Industry 4.0 has a wide-ranging, extensive influence on business models, both changing established and emerging business models (Arnold, Kiel & Voigt, 2016; Laudien, Spieth & Claub, 2017; Muller, Kiel & Voigt, 2018).

Not only that, other literature has shown that manufacturing technologies and production processes related to new business opportunities for Industry 4.0 have a positive impact on their implementation (Lee, Kao & Yang, 2014; Oettmeier & Hofmann, 2017; Muller et. al, 2018). Many studies have been done encompassing how Industry 4.0 phenomenon is able to enhance productivity when industrialists decided to engage their business practices. Altogether, it is clear that Industry 4.0 signifies a sequence of transformational changes prompted by technological innovation that has the capability to steer business operations to be more systematised and flexible with interconnected manufacturing processes (Molino, Cortese & Ghislieri, 2020).

4.2 Technological-Organisational-Environmental (TOE) Framework

It is important to examine factors that affect innovation in order to understand the factors responsible for technology adoption. Formerly, researchers have utilised TOE to inspect a vast array of innovations and technological readiness concepts at organisational level. The analysis for adoption of various information systems related to subject and technological innovations include e-commerce, online retail, e-business and enterprise resource planning (ERP), (Chong, Ooi, Lin, & Raman, 2009; Ifinedo, 2011, Lin & Lin, 2008; Oliveira & Martins, 2010; Pan & Jang, 2008; To & Ngai, 2006; Zhu, Kraemer, & Xu 2006).

TOE framework by Tornatzky and Fleischer (1990) emphasised three primary elements which are technology, organisation, as well as the environment, and according to previous studies, these contexts affect the process of organisation in adopting and accepting new technology. In particular, this new e-technology refers to the internal and external requirements of technological innovations in the field of new technology, while organisation refers to certain measures taken by the organisation, such as the organisation size, the management structure and support and, finally, the social environment in which it operates in (Roger, 2003).

In many information systems studies, the theories of TAM and TOE are specifically aimed at accepting technology, and most popularly explain end-user's adoption of it in an organisation (Awa, Ukoha & Emecheta, 2016). As a result, this theory serves as a primary theoretical framework as it can serve as a strong theory for understanding the degree to which technology is adopted. It has also been widely used to support empirical work. Since its development up until today, TOE has been among the most extensively applied theories of organisational technology adoption by researchers and practitioners.

Technological adoption readiness according to Aboelmaged (2014) in SME level can be done through digitisation readiness prediction such as Technological Readiness Index (TRI) as well as TOE framework. TOE framework is an accurate theoretical landscape to investigate digital readiness in technology maintenance and innovation implementation in technological, organisational and environmental context (Sari & Santoso, 2020).

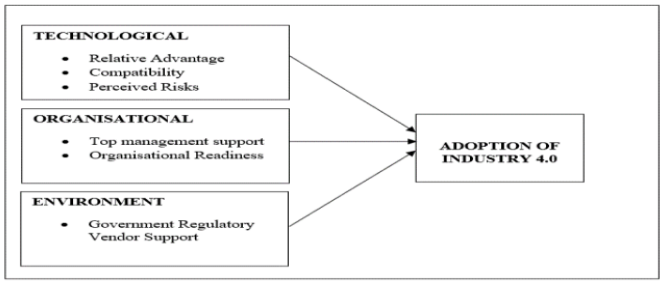

Figure 2: Technology-Organisation-Environment (TOE) Framework adopted from Tornatzky and Fleischer (1990)

4.3 Adoption of Industry 4.0

In the context of adopting Industry 4.0, it is of paramount importance that companies find ways to reconstruct, adapt and customise their machines to the new needs of modern technology. Nevertheless, it is most alarming to observe that many businesses are not well-informed of the critical factors in implementing Industry 4.0, despite admitting to understanding its prospects (Narula, Prakash, Dwivedy, Talwar & Tiwari, 2020). Therefore, the adoption factors identified are most important to be considered for the success of the implementation of this megatrend. The goal of Industry 4.0 is to improve overall efficiency and effectiveness to have transparency and more accuracy.

Fundamentally, undergoing digital transformation indicates the fact that the entire strategy of an organization has to be modified and reformed, which undoubtedly, requires a huge decision-making process. On top of that, it needs to be realised that business competitions have intensified and grown unpredictable as online platforms grant start-up businesses the opportunity to stand alongside prominent, reputable enterprises in the industry on account of the advanced techniques in the digital operations, ranging from production to sales, distribution to improve quality as well as the value brought to customers (Nguyen & Luu, 2020). Likewise, Molino et. al (2020) highlighted that concentrating on customising products, providing customer satisfaction as well as applying developed processes and innovative practices are the harbingers of quality improvement.

4.4 Technological Adoption

Technology refers to the internal and external technological requirements of an organisation before implementing new innovation (Roger, 2003). It also refers to knowledge and processes involved in developing and adopting technologies. The elements under this context include relative advantage, compatibility, and perceived risks.

Essentially, relative advantage denotes a particular degree to which innovation is considered to be improvised compared with the former, whereas compatibility is a degree to which an innovation is deemed to be reconcilable with existing values, experience of past years and adoptive needs while complexity represents a degree to which an innovation is recognised as being hard to understand intricately as well as being difficult to comprehend, exercise and use (Hoti, 2015). A recent study by Sallehudin, Razak, Ismail, Fadzil & Baker (2019) confirmed that technological adoption is positively associated with cloud computing adoption within the SMEs in Malaysia.

4.5 Organisational Adoption

The organisation context represents the features and resources owned by a firm, including the infrastructure of the organisation using the constructs, top management support, and firm size. The acceptance of technological adoption in an organisation will be much easier when it receives full support and devotion provided by top management (Alshamaila & Papagiannidis, 2013; Borgman, Bahli, Heier & Schewski., 2013; Low, Chen & Wu., 2011; Ifinedo, 2011; Tornatzky & Fleischer, 1990). Since top management acts as the decision maker, their decision affects the technology adoption process. Arnold, Veile & Voigt (2018) asserted that support and assistance from top management is a crucial aspect if an organisation aims to implement Industry 4.0 effectively, as its execution involves wide-scale investments. Along with that, Rajnai & Kocsis (2018) pointed out that although some business managers are perceptive and mindful of the presence of Industry 4.0, yet they are apprehensive as their companies are unequivocally unprepared for the full implementation of it.

Organisation readiness means the availability of financial, human, and technical resources of an organisation before implementing new technology (Yusof & Arifin, 2016). According to Geissbauer, Schrauf & Koch (2014), firms which intend to implement Industry 4.0 would have to increase their planned yearly capital investments by 50% for the next five years. However, Safar, Sopko, Bednar & Poklemba (2018) emphasised that SMEs could encounter some strains and difficulties in adopting the latest technologies as well as revising their business models, which in this case, will be especially challenging for industrial SMEs due to substantial limited sources, in contrast with large companies. Evidently, the most relevant aspect that needs to be considered and provided for the local SMEs would be a standard guide that serves as an exemplary model to direct and assist SMEs to employ strategies upon implementation of Industry 4.0.

4.6 Environmental Adoption

Environmental adoption as discussed by previous researchers, refers to the characteristics of the environment in which an organisation operates its business, including market factors, competitors, government and policies that may affect any decision-making related to the adoption of technology by an organisation (Ji & Liang, 2016; Oliveira & Martins, 2010).

Government regulatory means any assistance and aid given by the authority in order to boost more innovation use in the future (Ifinedo, 2012). According to Sallehudin, Aman, Razak, Ismail, Fadzil & Baker (2019), several studies have stressed on the significance of environmental factors in the implementation of Information Technology innovation as these studies have emphasised the importance of environmental factor (e.g. Alshamaila & Papagiannidis (2013); Lin (2013)).

Various help aids have been provided by the Malaysian government and accountable bodies in supporting SMEs to expand and improve their circumstances including financial and non-financial initiatives, for instance, consultation, technological, advertising, management, networking, distribution and R&D plans (Ambad, Andrew & Amit, 2020).

5.0 RESEARCH METHODOLOGY

The common IBM Statistical Package for the Social Sciences (SPSS) version 22 will be used in analysing the data collected. The target population for this study consists of service sector SMEs in Klang Valley registered under SME Corporation Malaysia. This area is chosen as the number of service sector SMEs located here is the highest in Malaysia according to SME Corp (2017); the number recorded is 179,271 (19.8%) in Selangor and 133,703 (14.7%) in Wilayah Persekutuan Kuala Lumpur. So, the total number of SMEs in Klang Valley is 312,974. Thus, the samples obtained are able to represent the service sector SMEs in Malaysia. The selection will be carried out according to the assortment done by stratified sampling based on geographical references to avoid cases where a sample may significantly over or under represent some members of the population.

Analysis process will be classified into several stages. Frequencies mean and standard deviation analyses will be performed in assessing the demographic profile. In order to avoid key-in errors of data and to look out for missing values in responses, data cleaning will be conducted through frequency analysis. Inferential statistics such as Pearson's coefficient and multiple linear regression analysis will be employed to investigate the existence of a variable relationship.

Descriptive analysis will be used to identify the profiles of the respondents. Next, the data will be monitored for the reliability test to indicate the correlation of each item. Factor loadings will be checked to assure that they are greater than or equal to 0.30. If the sample size used is 350 or more, it means that the value of 0.30 is considered to be significant in accordance with the rule of thumb, and this is done in response to setting a minimum level of practical significance.

6.0 CONCLUSION

Industry 4.0 concept is still at an early stage in Malaysia as it started only in 2016, according to a few studies, while Germany had introduced it back in 2011. This study is therefore important and will not become obsolete in the next 5 to 10 years, as there are many measurements and processes to be considered before SMEs in Malaysia can fully implement the Industry 4.0 technology. This paper is conceptual in nature with a view to achieve its research objective, which is to analyse the factors that would influence the implementation of Industry 4.0 by small and medium-sized enterprises in Malaysia on the basis of the TOE framework.

Substantially, the progressive technological innovation requires permanent validation of existing frameworks and constant empirical research work. As long as new technologies and new concepts for adoption are developed, the TOE framework is significant in providing researchers with a comprehensive understanding and perspective on technology adoption. In addition, given the overwhelming number of interests in Industry 4.0 studies, it is imperative that more research is conducted in the future, focusing on the adoption of Industry 4.0 technology using different adoption theories that could contribute to the development of small business technology. Since this is only a conceptual paper, researchers recommend future research on empirical studies using the framework for further validation of mentioned variables.

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