INDUSTRY 4.0: THE IMPORTANCE OF INNOVATION IN ADOPTING CLOUD COMPUTING AMONG SMEs IN MALAYSIA

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Abstract: Small and medium-sized enterprises (SMEs) are commonly perceived as an essential part in boosting and stabilising global economic growth. Accordingly, they are expected to contribute a notable 50% to Malaysia's Gross Domestic Product (GDP) by 2030, which is projected relative to their present contribution (38%). In the context of Malaysian businesses, however, SMEs especially have yet to embrace the latest technology revolution sufficiently. The country is currently in the midst of the third industrial revolution (i.e. automation), while some are still deep within the second industrial revolution. This is a particularly worrying observation as only a few industries in the country are capable of adopting the pillars of Industry 4.0, which is further characterised by a percentage of business owners that remain hesitant to embrace technologies such as cloud technology. To bridge this significant gap, the analysis carried out in this research adopted the technology acceptance model (TAM) developed by Davis (1989) and Rogers' Diffusion Innovation Theory (1995), incorporating the contexts of technology and innovation among SMEs in Malaysia. To this end, survey questionnaires were employed to collect data among domestic manufacturing and services SMEs, following which the structural equation model (SEM) was employed. By using Smart-PLS, an assessment was carried out to ascertain the important factors of innovation towards adopting cloud computing among SMEs in Malaysia.

Key words: Cloud computing, Industry 4.0, Innovation, SMEs

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Introduction

Commonly perceived as an essential component in boosting and stabilising the global economic growth, small and medium-sized enterprises (SMEs) recorded a contribution of 38.3% to the GDP of Malaysia in 2018. This amounted to USD 128.1 billion (RM521.7 billion) for the particular year as opposed to USD 120.6 billion (RM491.2 billion) documented in 2017 (Department of Statistics Malaysia, 2019). This accounts for their inclusion in the current research as they play an essential role in achieving and improving the national GDP, whereby SMEs are expected to make up 50% of the projected value by 2030. Nevertheless, various

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problems often exist and are faced by these organisations to reach this particular level, wherein digitalisation or technological revolution is one of the issues identified thus far. To increase the efficiency and productivity of SMEs, innovation has been considered as one of the main elements driving these businesses. According to the Department of Statistics Malaysia (2016), a total of 73.1% of SMEs in the country used computers in 2015 while 56.5% used the Web, whereas a mere 20.1% revealed web presence in their companies. Moreover, e-commerce as a component of digitalisation in the technological revolution then comprised only 4.8 per cent out of 907,065 SMEs.

Driven by technology evolution, it can be presumed that Malaysian-based SMEs are gradually transforming themselves towards dipping into another phase of the area. The new era requires business owners, especially the small and medium-sized businesses, to embrace the innovation dimension strategically due to it being considered as essential in promoting the growth of SMEs and national economy. As such, businesses around the world are in the midst of transforming and adopting the latest technological revolution known as Industry 4.0. In general, a few advantages are noted regarding its adoption towards SME performance, such as minimised non-value-added data manipulation, improved SME supply chain system, enhanced manufacturing technology and career opportunities, and integrated organisation in the digital world (Tahoe et al., 2017). This indicates the importance and benefits driving SMEs to engage in innovation adoption such as Industry 4.0. Thus far, nine elements of Industry 4.0 have been documented in detail. However, this study focuses on only one part of its main pillars, namely cloud computing, in line with the observation by Saucedo et al. (2018) noting that only 4% of research has discussed the topic. Therefore, the current study primarily emphasises the adoption intention of cloud computing among SMEs in Malaysia, specifically pertaining to the innovation factors.

Literature Review

Industry 4.0 and the Small and Medium-sized Enterprises (SMEs)

Based on the Ministry of International Trade and Industry (2018), the term "Industry 4.0" is basically sourced from the German government due to the initiative positioned to transform their manufacturing sector towards advance manufacturing or cyber-physical led. The vigour and influence of these technologies are further multiplied by the rapid connectivity between billions of people through enhanced mobility and the ease of access for the growing vastness of data and knowledge. Besides, the context of supply chain in a business organisation denotes cloud computing as a component used for the communication implemented between a supplier and a business operation. This element allows all participating parties to share pertinent information on the utilisation of an operational e-procurement system (Khalid, 2010; Ooi et al., 2018). In Malaysia,

SMEs are widely known as the backbone of the country due to their predominant contribution towards economic growth. Nowadays, innovation is believed as somewhat an essential tool of the work-life as it is linked with improved market performance (Husaini, Pirzada, Saiful, 2020). Accordingly, technology is usually described as allowing two or more people to work together at the same time and place or at different locations or times (Brown et al., 2010). The technological revolution worldwide plays a crucial role in the economy, rendering it compliant and necessary for SMEs to adopt innovations in enhancing their performance towards achieving higher efficiency.

Diffusion of Innovation Theory

The diffusion of innovations is a fundamental theory invented by Everett Rogers, which focuses on identifying the reason and rate of new ideas and technology evolution (Rogers, 1995). The theory has been proposed to explain the factors affecting individual intention and decision to adopt and use innovation, wherein it consists of three factors: relative advantage, compatibility, and complexity. These elements will be discussed below accordingly.

Relative Advantage

Lin and Chen (2012) have attributed relative advantage as the degree to which an individual utilises innovation to make them better. This can be described in the way organisations tend to adopt a particular technology innovation if they believe that it will be advantageous for their entities, such as increasing their efficiency. Besides, it suggests that SMEs will be aware of such action due to the opportunities and advantages that cloud computing adoption offers for their businesses. Therefore, this aligns with the main definition invented by Rogers (1995), which refers to relative advantage as the degree to which an innovation is perceived to benefit an organisation in comparison with the existing technology. As a result, this research hypothesises that:

H1: There is a relationship between relative advantage and the adoption intention of cloud computing among SMEs in Malaysia.

Compatibility

Some scholars Wu et al. (2013) have labelled the compatibility factor as the degree of integration present between infrastructure components, thus allowing the data or programs to be used by other systems regardless of the manufacturer. Here, the definition parallels with Rogers' (1955) description, whereby it is defined as the degree to which new technology is adaptable with the current technologies, values, previous experiences, and potential needs of an organisation. Moreover, the research by Amini and Bakri (2015) has stated that the compatibility of cloud computing is significantly related to the elements of the information technology (IT) department, such as the head of information system, chief of IT officer, and

chief of the executive IT department, directors, and senior IT personnel. This research, subsequently, hypothesises the following:

H2: There is a relationship between compatibility and the adoption intention of cloud computing among SMEs in Malaysia.

Complexity

Complexity, according to Rogers (1995), is relative to the degree to which cloud computing is difficult to use, recognise, and realise. Following this, Lin and Chen (2012) have reviewed this factor in technology innovation, thereby being perceived as the level of difficulty for any task. In particular, Safari et al. (2015) have elaborated that the factor of complexity further influences the adoption of SaaS, which is one of the cloud computing tools subsequent to the analysis done among professionals in IT enterprises. It is correlated to the question of whether the complex system of the cloud itself would influence the individual intention to adopt the technology. This allows this study to hypothesise the following:

H3: There is a relationship between complexity and the adoption intention of cloud computing among SMEs in Malaysia.

Technology Acceptance Model

Aharony (2015) has suggested that individual intention is the best predictor of usage behaviour in line with the technology acceptance model (TAM) by Davis (1989), which contains the two elements of perceived usefulness and perceived ease of use. This notion is further supported in the field of technology revolution following the research among the IT, manufacturing, and finance sectors in India in which perceived ease of use has been found to pose a positive effect on the perceived usefulness in adopting cloud computing (Gangwar & Date, 2016). Accordingly, perceived ease of use can be defined as 'the degree to which the prospective user expects the target system to be free of an effort'. Meanwhile, Idris et al. (2017) have described it as the extent to which an individual holds the belief to use the system. This is supported by Mahomed et al. (2017), whereby TAM is known as the model capable of providing a model of high parsimonious capacity with its high strength in predicting and explaining. Furthermore, determining the effect of perceived ease of use and perceived usefulness in a research work assessing email usage by Mahomed et al. (2017) has revealed that the former poses a significant effect on perceived usefulness towards ascertaining technology acceptance.

In line with this, Ratten (2015) has proven that perceived ease of use is one of the most critical factors in predicting one's intention of purchasing technology among the students in Turkey and the United States of America (USA), whereby the perception and individual perception are necessary to evaluate the use of said technology. Furthermore, research has found that both perceived ease of use and

perceived usefulness display a strong influence on the user intention to adopt new technology. In particular, the results of a survey by Ashraf et al. (2014) on Internet users (i.e. potential online shoppers) in Pakistan and Canada revealed that these elements positively mediated the relationship between all key customer features and customer decisions to use the technology. Thus, this research hypothesises that:

H4: There is a relationship between perceived usefulness and the intention of cloud computing adoption among SMEs in Malaysia.

H5: There is a relationship between perceived ease of use and the intention of cloud computing adoption among SMEs in Malaysia.

Research Framework

Based on the literature, the critical component prioritised in this proposed research was selected per TAM by Davis (1989) and Roger's (1995) Diffusion of Innovation Theory. In the course of developing the influencing factors, three elements were identified; they include two mediation factors thus considered as relevant concerning the adoption intention of Industry 4.0 as shown in Figure 1.

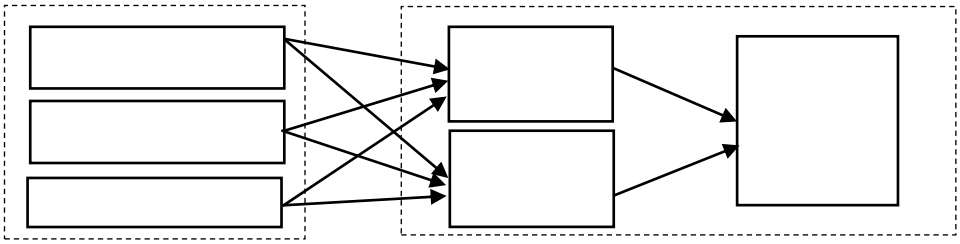

Figure 1: Research Framework (Source: Adapted from Technology Acceptance Model by Davis (1989), Diffusion of Innovation Theory by Rogers (1995))

Research Methodology

In this study, a quantitative approach was employed in which the mono-method analytical analysis was implemented as suggested by Saunders et al. (2016) and the questionnaires were disseminated using a single data collection methodology. Mono-method research generally refers to the method of which only one method of data collection is utilised, which may be either purely quantitative or qualitative in design. To this end, a total of 114 responses were collected from the manufacturing and services sectors in Malaysia. Such move is attributable to the service sector being regarded as one of the significant contributors in the country towards SMEs and production, whereas the manufacturing sector is the second-largest contributor and the field most oriented to Industry 4.0 implementation. The respondents were identified via non-probability sampling from the total number of SME establishments recorded in Malaysia, which consisted of 907,065 entities. Here,

non-probability sampling was used due to the lack of sampling frame available for research access. According to Saunders et al. (2016), this type of sampling provides an alternative technique for sample selection. Therefore, the target population for the current study was appropriately identified, namely entrepreneurs that were operating SMEs in Malaysia. Then, data analysis was carried out by subjecting the survey results to an evaluation using SPSS, wherein SEM encompassing the measurement and structural models was carried out by applying Smart-PLS. Accordingly, the measurement model denotes an evaluation of its internal consistency to validate the measurement, whereas the structural model consists of assessing the path analysis applied to test the study hypothesis (Ramayah et al., 2018).

Data Analysis and Results

This research included an analysis of the respondent demographics and the company background by using SPSS. Next, the hypotheses designed were tested via SEM by using PLS, whereby its explanation was divided into two stages, namely the measurement model and structural model. Based on Table 1, the descriptive results show the respondent frequency and percentage for the demographic profile. This study was participated by 41 male respondents (36%), while the remaining majority consisted of females (73, 64%). Out of all, 69 respondents were between 18-30 years old (60.5%) and 68 individuals (59.6%) had between 1 to 5 years of experience, while the other 19 (16.7%) responses indicated that they had 6 to 10 years of experience in SMEs. Besides, most of the respondents occupied a junior management position (69, 60.5%), followed by middle-level management (29, 25.4%), and senior-level management (16, 14%). Meanwhile, results shown in Table 2 reveal that 72 respondents (63.2%) come from the services sector, whereas the remaining 42 (36.8) are from the manufacturing sector. Collectively, these individuals consisted of those registered under sole proprietorship (36, 31.6%), partnership (5, 4.4%), Limited Liability Partnership (14, 12.3%), and Private Limited Company (59, 51.8%) accordingly. Moreover, location-wise, 16 respondents (14.0%) hailed from the northern region, whereas 48 (42.1%) were from the Southern region, 32 (28.1%) from the East coast region, and 18 (15.8%) from the Central region.

Table 1. Respondents' Demographic Profiles

Variable	Description	Frequency	Percentage (%)
Gender	Male	41	36
	Female	73	64
Age	18-30	69	60.5
	31-40	29	25.4
	41-50	13	11.4
	51-60	2	1.8

	61 and above	1	0.9
Years of working experience	No experience	5	4.4
	1-5 years	68	59.6
	6-10 years	19	16.7
	More than 10 years	22	19.3
Job position	Junior management	69	60.5
	Middle management	29	25.4
	Senior management	16	14.0

Table 2. Company profile

Variable	Description	Frequency	Percentage (%)
Legal Status	Sole Proprietorship	36	31.6
	Partnership	5	4.4
	Limited Liability Partnership	14	12.3
	Private Limited Company	59	51.8
Sector	Manufacturing	42	36.8
	Services	72	63.2
Location	Northern region	16	14.0
	Southern region	48	42.1
	East Coast region	32	28.1
	Central region	18	15.8

Measurement model

The measurement model assessment results are shown in Table 3, whereby all six variables studied in this work satisfy the scholarly requirement. In particular, the average variance obtained was greater than 0.5 as suggested by Hair et al. (2017), while the composite reliability values were more than 0.5. However, some items were removed due to the reduced number of loadings. Next, discriminant validity is assessed via Heterotrait-Monotrait Ratio (HTMT) in which Table 3 shows that all values obtained do not exceed the threshold value of 0.85 (Kline, 2015). This indicates that the discriminant validity is successfully ascertained.

Table 3. Measurement Model for Reflective Constructs

Construct	Indicator	Loading	AVE	CR
Relative Advantage	RA1	0.622	0.516	0.841
	RA 3	0.787		
	RA 4	0.709		
	RA 6	0.731		
	RA 7	0.731		
Compatibility	CB1	0.842	0.546	0.855
	CB 2	0.842		

	CB 3	0.731		
	CB 4	0.614		
	CB 5	0.634		
Complexity	CX1	0.831	0.545	0.780
	CX2	0.625		
	CX3	0.745		
Perceived usefulness	PU1	0.869	0.709	0.924
	PU2	0.846		
	PU3	0.873		
	PU4	0.811		
	PU5	0.811		
Perceived ease of use	PEOU1	0.801	0.653	0.904
	PEOU2	0.765		
	PEOU3	0.758		
	PEOU4	0.870		
	PEOU5	0.842		
Intention	AI1	0.846	0.505	0.874
	AI2	0.765		
	AI3	0.752		
	A14	0.729		
	A15	0.706		
	AI6	0.451		
	AI7	0.662		

Table 4. Discriminant Validity using Heterotrait-Monotrait Ratio

	Adoption Intention	Compatibility	Complexity	Perceived Ease of Use	Perceived Usefulness	Relative Advantage
Adoption Intention						
Compatibility	0.504					
Complexity	0.565	0.821				
Perceived Ease of Use	0.681	0.564	0.630			
Perceived Usefulness	0.709	0.747	0.497	0.571		
Relative Advantage	0.402	0.690	0.427	0.416	0.458	

Structural Model

In this study, 11 direct hypotheses were developed between the constructs, which consists of 5 main hypotheses. To identify the significance level, the t-statistics for all paths were generated using the Smart-PLS 3.0 bootstrapping function. Outcomes of the path coefficient assessment are shown in Table 5, whereby H2b, H3c, H4, and H5 yield t-values more than 1.645 at the 0.05 significance level.

Table 5. Path Coefficient Assessment

Hypothesis	Relationship	Standard Beta	Standard Deviation (STDEV)	T-value	P-Value
H1a	RA-> AI	0.043	0.071	0.607	0.272
H1b	RA -> PU	0.063	0.099	0.638	0.262
H1c	RA -> PEOU	0.138	0.093	1.483	0.069
H2a	CB -> AI	-0.111	0.126	0.882	0.189
H2b	CB -> PU	0.610	0.112	5.444	0.000
H2c	CB-> PEOU	0.175	0.135	1.299	0.097
H3a	CX -> AI	0.056	0.124	0.456	0.324
H3b	CX -> PU	-0.013	0.108	0.116	0.454
H3c	CX -> PEOU	0.369	0.103	3.585	0.000
H4	PEOU -> AI	0.387	0.097	4.003	0.000
H5	PU -> AI	0.472	0.109	4.346	0.000

Furthermore, the bootstrapping analysis revealed that all six constructs yielded indirect effects. In particular, the mediation effect was statistically significant, wherein perceived usefulness was found to wield a mediating effect between compatibility and intention at a significant value (β=0.288, p=0.000). Besides, perceived ease of use was found to pose a mediating effect between complexity and intention at (β=0.143, p=0.003). The results of mediation analysis are presented in Table 6 accordingly.

Table 6. Hypothesis Testing for Indirect Relationship

Hypothesis	Relationship	Indirect effect	Standard Deviation	T- Value	P-Value
H1d	RA-> PU-> AI	0.030	0.048	0.615	0.269
H1e	RA -> PEOU-> AI	0.053	0.040	1.323	0.093
H2d	CB -> PU-> AI	0.288	0.081	3.539	0.000
H2e	CB-> PEOU -> AI	0.068	0.057	1.183	0.119
H3d	CX -> PU-> AI	-0.006	0.055	0.108	0.457
H3e	CX-> PEOU -> AI	0.143	0.051	2.776	0.003

Discussion of the Findings

The objective of this study was to examine the relationship between innovation factors and the adoption intention within the two dominant SME sectors in

Malaysia. As underlined in the research framework, the current work positioned 17 hypotheses generated in a combination of Davis' TAM (1989) and Roger's Diffusion of Innovation Theory (1995). Based on the outcomes of analysing the three predictors of relative advantage, compatibility, and complexity, compatibility yielded a significant influence on the level of perceived usefulness. This aligns the previous work by Lee et al. (2011), which has detailed the adoption of e-learning system in Taiwan and revealed the same predictor having a significant relationship in perceived usefulness. In another study detailing part of cloud computing technology via Software as a Service (SaaS), its compatibility is one of the factors influencing the adoption and ranked sixth among others as per professionals and IT enterprises that have adopted SaaS (Safari et al., 2015). Furthermore, complexity was found to correlate with perceived ease of use in determining cloud computing adoption. This result supports those obtained by Gangwar et al. (2015), where the scholars have noted that among the companies in the IT, manufacturing, and finance sectors in India, the level of complexity in adopting cloud computing is significant. Meanwhile, in determining their mediating role in the context of the current research, perceived ease of use and perceived usefulness were employed and resulted in respective significant relationship with adoption intention. In particular, perceived usefulness was found to have a mediating effect between compatibility and adoption attention, while perceived ease of use yielded a mediating effect between complexity and perceived ease of use. In contrast, the remaining predictor of relative advantage revealed no significant relationship in determining the adoption of cloud computing. The outcome parallels those by Low et al. (2011) in which a significant advantage is absent in implementing and insinuating cloud computing among firms. This may be attributable to the fact that cloud computing itself is a new technology with complex charging mechanisms. Thus, firms are suggested to consider trading off the relative advantage and charging the costs of service.

Conclusion

The outcomes of this research are highly insightful for the applicable industries as it measures the critical nature of adoption intention indicators for cloud computing adoption among SMEs in Malaysia. This may further facilitate the development of Industry 4.0 and its pillars, which include cloud computing, by conveying practical knowledge about the intention for its adoption and the correlated relationship with the innovation factors that further contribute to SME performance. In particular, the benefits of cloud computing can vary in terms of payment, installation, and flexibility; as mentioned by Kumar et al. (2017), such perks led to its utilisation as pertinent organisations have identified the tool as easy to install and use. In sum, the technological issue plays an important role in its adoption as mentioned by Mahomed et al. (2017). The scholars have assessed information systems adoption and thus suggested that one of the critical factors contributing to its success or

failure is the technological factors of the information system itself. Moreover, the overall growth of economy has concurrently highlighted the relevance of digitalisation in increasing efficiency as it can improve the organisational process and competitiveness practised by companies within the industry (Lahkani et al., 2020). Therefore, the focus placed on cloud computing adoption in this study can answer the correlated issues due to the integration of elements based on the underpinning theories related to technological adoption. However, this study is not without its limitation: it covers two main sectors across all SMEs. Therefore, it is suggested for future research efforts to combine other SME sectors towards ensuring and providing a higher level and wider degree of technology adoption. Apart from that, this research recommends that future research positions a combination of theory and model in identifying the factors associated with Industry 4.0 adoption to widen the context of adoption.

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PRZEMYSŁ 4.0: ZNACZENIE INNOWACJI W ADOPTOWANIU CHMUR KOMPUTEROWYCH WŚRÓD MŚP NA MALEZJI

Streszczenie: Małe i średnie przedsiębiorstwa (MŚP) są powszechnie postrzegane jako istotny element stymulowania i stabilizacji globalnego wzrostu gospodarczego. W związku z tym oczekuje się, że do 2030 r. Będą one wnosić znaczące 50% do produktu krajowego brutto (PKB) Malezji, co jest prognozowane w stosunku do ich obecnego wkładu (38%). Jednak w kontekście malezyjskich przedsiębiorstw, zwłaszcza MŚP, nie przyjęły jeszcze dostatecznie najnowszej rewolucji technologicznej. Kraj jest obecnie w trakcie trzeciej rewolucji przemysłowej (czyli automatyzacji), podczas gdy niektórzy są nadal głęboko w drugiej rewolucji przemysłowej. Jest to szczególnie niepokojąca obserwacja, ponieważ tylko kilka branż w kraju jest w stanie przyjąć filary Przemysłu 4.0, który dodatkowo charakteryzuje się odsetkiem właścicieli firm, którzy niechętnie korzystają z technologii, takich jak technologia chmurowa. Aby wypełnić tę znaczącą lukę, w analizie przeprowadzonej w tym badaniu przyjęto model akceptacji technologii (TAM) opracowany przez Davisa (1989) i Rogers 'Diffusion Innovation Theory (1995), obejmujący kontekst technologii i innowacji wśród MŚP w Malezji. W tym celu wykorzystano kwestionariusze ankietowe do zebrania danych wśród krajowych MŚP z sektora przetwórstwa i usług, zgodnie z którymi zastosowano model równań strukturalnych (SEM). Korzystając ze Smart-PLS, przeprowadzono ocenę w celu ustalenia ważnych czynników innowacji w zakresie wdrażania chmury obliczeniowej wśród MŚP w Malezji.

Słowa kluczowe: przetwarzanie w chmurze, przemysł 4.0, innowacje, MŚP

工业4.0:创新对马来西亚中小企业采用云计算的重要性

摘要:中小企业通常被认为是促进和稳定全球经济增长的重要组成部分。因此，预计到2030年，它们将为马来西亚的国内生产总值(GDP)贡献显着的50%，相对于目前的贡献(38%)而言。但是，就马来西亚企业而言，中小型企业尤其尚未充分接受最新的技术革命。该国目前正处于第三次工业革命(即自动化)中，而有些国家仍处于第二次工业革命的深渊。这是一个特别令人担忧的观察，因为该国只有少数行业能够采用工业4.0的支柱，而这一特征的进一步特点是一定比例的企业所有者仍然不愿接受诸如云技术之类的技术。为了弥合这一巨大差距，本研究进行了分析，采用了戴维斯(1989)和罗杰斯的扩散创新理论(1995)开发的技术接受模型(TAM)，将马来西亚中小型企业的技术和创新背景结合在一起。为此，采用了调查问卷来收集国内制造业和服务业中小型企业的数据，然后采用结构方程模型(SEM)。通过使用Smart-PLS，进行了评估以确定在马来西亚的中小企业中采用云计算的创新的重要因素。
关键词:云计算，工业4.0，创新，中小企业