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Influence of Government Intervention towards Industry 4.0 Adoption among Service Sector SMEs: Perspective from an emerging economy

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Abstract

Small and medium-sized enterprises (SMEs) have the potential to leverage emerging technologies during the Industry 4.0 era. However, their adoption of these technologies remains challenging. The target population consists of service sector SMEs in Kuala Lumpur and Selangor, registered under SME Corporation Malaysia. In this study, we gathered data through a combination of self-distributed questionnaires and online surveys. We obtained a total of 142 responses from in-person visits and an additional 106 responses from online questionnaires. Thus, a total of 248 usable surveys were collected and analysed using SPSS version 28 and SmartPLS version 4. We employed PLS-SEM analysis to examine the impact of four factors on the adoption of Industry 4.0 in SMEs. These factors include relative advantage, compatibility, complexity and cost. Additionally, we explored the moderating effect of government intervention on the relationships between these factors and Industry 4.0 adoption. This research makes a valuable contribution to our understanding of technological implementation in small-scale enterprises by proposing a new moderating variable in framework.

Keywords: DOI theory; government intervention; Industry 4.0; SMEs, technology adoption

1.0 Introduction

Advancements in digital technology are anticipated to aid industries in creating viable business models. Furthermore, these cutting-edge technologies enhance and accelerate work processes, making them more efficient and safer although the implementation of Industry 4.0 technology can be intricate (Romero et al., 2018; Tarasov, 2018). IR4.0 represents a significant technological breakthrough that involves the automation of traditional manufacturing and industrial operations using advanced modern systems. Despite its potential benefits, technological progress poses challenges for small and medium-sized enterprises (SMEs) due to limited financial support, a smaller workforce of fewer than 250 employees, rigid organisational structures and resistance to management changes (Yuksel, 2020).

1.1 Research Objectives
This study is designed to achieve the following objectives:
(i)   To investigate the relationship between relative advantage and the adoption of IR4.0 among service sector SMEs.
(ii)   To investigate the relationship between compatibility and the adoption of IR4.0 among service sector SMEs.
(iii)   To investigate the relationship between complexity and the adoption of IR4.0 among service sector SMEs.
(iv)   To investigate the relationship between cost and the adoption of IR4.0 among service sector SMEs.
(v)   To examine the moderating effect of government intervention on relative advantage, compatibility, complexity and cost and the adoption of IR4.0 among service sector SMEs.

2.0 Literature Review

2.1 Relative Advantage

Relative advantage refers to the perception of how adopting innovation can provide greater benefits compared to not using it (Lin & Chen, 2012). It signifies the extent to which employing innovation is seen as advantageous, resulting in improved productivity, efficiency, and overall performance compared to those who do not utilise it. Firms that perceive higher relative advantage will be more likely to adopt Industry 4.0 technologies (Zhou & Zheng, 2023). Several areas have witnessed the positive influence of relative advantage in the adoption of new technological applications. Examples include interbank mobile payments (Kapoor, Dwivedi, & Williams, 2015), supply chain management (Bhattacharya, Wamba & Kamdjoug, 2019), and business intelligence systems (Puklavec, Oliveira, & Popovic, 2018). A hypothesis testing conducted by Jayashree et al. (2021) supports the significant impact of relative advantage on the successful implementation of IR4.0. The study reveals that most respondents believed in the performance of IR4.0, leading to cost savings, efficient resource utilisation, and enhanced monitoring systems, ultimately resulting in increased sales and revenues. The research also highlights that the utilisation of IR4.0 improves sustainability performance by 58%. As such, we formulate the following hypothesis:

Hypothesis 1 (H_1): There is a statistically significant influence of relative advantage on adopting IR4.0 among SMEs.

2.2 Compatibility

Compatibility refers to aligning new technology implementation with a firm's past, present, and future needs (Lian, Yen, & Wang, 2014; Rogers, 2003). It determines whether the latest innovation can seamlessly integrate with existing business practices and principles (Rogers, 2003). Organisations can accelerate their progress by ensuring compatibility between current technology and established business practices (Stieninger et al., 2014). In this study, compatibility encompasses organisational structures, business plans, and existing rules and policies. When compatibility is less favourable, there is more uncertainty and hesitation in accepting the innovation (Oliveira Thomas & Espadanal, 2014). Using compatible technologies is more cost-effective and efficient for businesses, as they only need to make minor adjustments and improvements to their existing systems rather than completely dismantling and replacing them with incompatible technologies. According to Jayashree et al. (2021), the compatibility of technologies with existing IT systems poses a significant challenge for SMEs in adopting IR4.0. Their study highlights the substantial impact of compatibility on the successful adoption of IR4.0 based on the study's findings. Thus, this study suggests the following hypothesis:

Hypothesis 2 (H_2): There is a statistically significant influence of compatibility and knowledge on adopting IR4.0 among SMEs.

2.3 Complexity

The term "complexity" refers to the challenges associated with technology implementation and the intricacy of the technology itself (Bhattacharya et al., 2019). Technology adoption rate decreases as complexity increases, indicating that the likelihood of technology adoption decreases as the complexity level rises. Small and medium-sized enterprises (SMEs) face difficulties adopting sophisticated technologies due to the requirement for more significant technical expertise in those domains. Blockchain technology, for example, can only gain public support and trust when incorporated into simpler systems, given its perceived complexity (Wong et al., 2020). Additionally, security concerns and the early stage of development of blockchain technology add further challenges to its implementation (Saberi et al., 2018). Users often feel perplexed and uncertain when dealing with highly complex technology, which can negatively impact their decision to adopt it (Slade et al., 2015). However, researchers have found a significant positive relationship between the ease of use of new technology and the decision to adopt it (Alalwan, Dwivedi, & Rana, 2017; Dwivedi et al., 2017). In the case of IR4.0, the perception of the ease of use of innovative technology has a favourable and statistically significant impact on its adoption and the performance of sustainability initiatives (Jayashree et al., 2021). Therefore, during the planning phases or technology adoption, evaluating and addressing potential challenges is crucial to minimise end-user integration difficulties for the organisation. Thus, we proposed the following:

Hypothesis 3 (H_3): There is a statistically significant influence of complexity and knowledge on adopting IR4.0 among SMEs.

2.4 Cost

The implementation of IR4.0 requires significant capital expenditures, necessitating the generation of funds (Rojko, 2017). Additionally, institutional backing, which encompasses financial and technological assistance provided by government or other institutions, plays a crucial role in facilitating technological transformation. Owners and managers should contemplate securing institutional funding to implement Industry 4.0 since the process of technological evolution can be financially demanding (Wong & Kee, 2022). Adequate investment is necessary to cover expenses related to product infrastructure, hardware and software setup, and the expansion of information technology infrastructure for IR4.0. One of the critical drivers for investing in IR4.0 is the potential for end-to-end digital integration to yield operational cost savings, increased production process speed and output, and improved process quality (Brozzi et al., 2020). Consequently, it is vital to carefully evaluate these expenditures considering the significant costs associated with implementing IR4.0. For SMEs, incorporating pervasive and large-scale systems into their businesses poses challenges due to the high costs, extensive nature, and complexity of technology upgrades. A recent survey revealed that 34% of SME owners believe cloud computing is prohibitively expensive (SME Annual Report 2017/18). Limited resources make it challenging for small businesses to make substantial investments in new technology. Moreover, more than 70% of capital requirements for local SMEs are fulfilled through internal funds or owners' savings, while only 30% come from bank loans. This is because SMEs in Malaysia face difficulties obtaining funding from banks

due to strict repayment terms, insufficient cash flow, and high requirements set by the banks. Therefore, from the preceding discussion, we formulated the following:

Hypothesis 4 (H4): There is a statistically significant cost influence on adopting IR4.0 among SMEs.

2.5 Government Intervention

Stoica, Miller, and Stotlar (2005) highlighted the challenges involved in adopting new technology and stressed the importance of a supportive government framework. However, the instability in the economic and political landscape could hinder the implementation of IR4.0. In response, SME Corp Malaysia (2017) has developed a plan to enhance the global competitiveness of SMEs by providing targeted assistance in automation, digitalisation, and robotisation, aligning with the principles of IR4.0. To encourage more SMEs to embrace technology, the government has introduced attractive funds for digital adoption in the 2020 Budget, actively promoting SMEs' engagement in the technological domain (SME Corp Malaysia, 2020). Additionally, the government can take further measures to expedite the adoption of IR4.0. One approach is to introduce new incentive packages for companies that intend to adopt the technology. For instance, Supermax Corporation Berhad, Malaysian firm recognised in the glove industry, has already incorporated IR4.0 in its manufacturing process, and the government continues to provide support by offering incentive programs to aid the growth of the firm's operation (Ing et al., 2019). Furthermore, through the utilisation of government subsidies and tax incentives, organisations have the opportunity to lower the expenses associated with the adoption of Industry 4.0 technologies (Zhou & Zheng, 2023). We decided to propose the following hypotheses:

Hypothesis 5a (H5a): Government intervention moderates the relationship between relative advantage and the adoption IR4.0 among SMEs.
Hypothesis 5b (H5b): Government intervention moderates the relationship between compatibility and adopting IR4.0 among SMEs.
Hypothesis 5c (H5c): Government intervention moderates the relationship between complexity and adopting IR4.0 among SMEs.
Hypothesis 5d (H5d): Government intervention moderates the relationship between cost and adopting IR4.0 among SMEs.

2.6 Model Conceptualisation

Drawing from the literature, this research proposed a framework to assess the influence of relative advantage, compatibility, complexity, and cost on the adoption of Industry 4.0 among service sector SMEs in Malaysia. The model incorporates government intervention as a moderator between the dependent variable and its predictors.
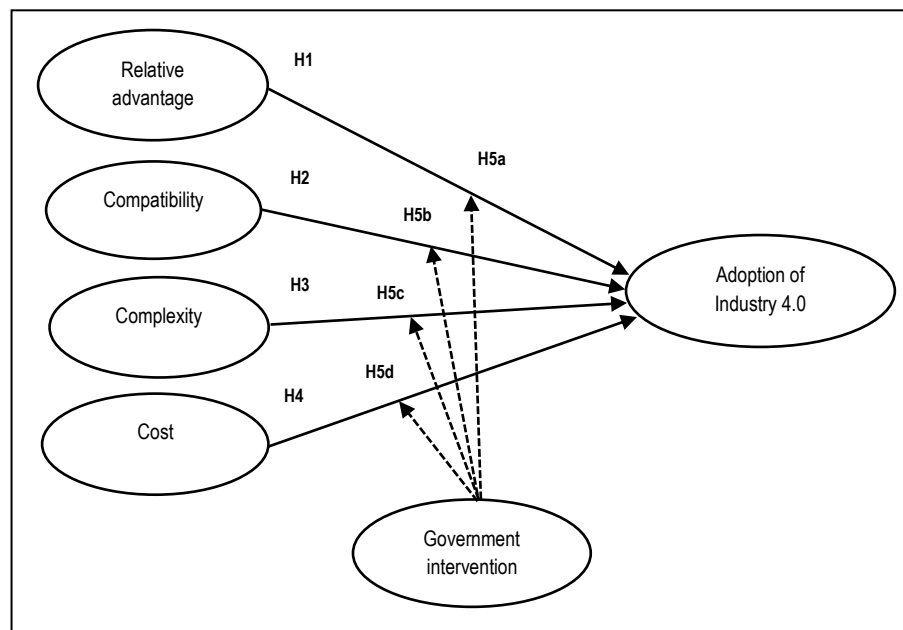

Fig. 1. The Conceptual Framework of the Study

3.0 Methodology

3.1 Study Population

SMEs were selected as the unit of analysis because it aligns with the research objectives to investigate the adoption amongst SMEs in the service industry. The target population for this study consists of service sector SMEs in Kuala Lumpur and Selangor registered under SME Corporation Malaysia. The study area was chosen due to a significant number of SMEs located there, denoting the highest SMEs in Malaysia. SME Corp Malaysia (2021) reported that SMEs made up 97.2% of businesses in Malaysia in 2019 and the state of Selangor

recorded the highest SME establishments, 19.7% followed by Wilayah Persekutuan Kuala Lumpur, 14.8%. These two areas have shown the largest representative of sample size compared to other states in Malaysia, with a total population of 312,974. In order to acquire the sample, an extensive and recently updated database of service sector SMEs was obtained from the website of the Ministry of Entrepreneur Development and Cooperatives (MEDAC). The data retrieved was up-to-date, specifically covering the year 2019.

3.2 Sampling Method

Multi-stage sampling is used as the sampling technique in reaching potential respondents. The first stage of sampling is area sampling where the locations for selecting the respondents was chosen which is Klang Valley. The second stage of sampling is convenience sampling where convenience sampling allows relevant members from the targeted respondent groups to be selected as samples (Hussin, Ali & Noor, 2014). Random visited to premises for a distribution of self-administered questionnaire include retails shops, food and beverage cafes, hotels nearby, textile/wholesale, printing and many other SMEs that offered products and services. The last stage for sampling technique is purposive sampling where the selection of participants is based on their position in the organisation. Based on the formula by Sekaran and Bougie (2016), the appropriate sample size for a population of 75,000 is 382, while a population of 100,000 and greater calls for 384. Thus, since the total population of this study is 312,974, the appropriate sample size is 384.

3.3 Data Collection

The self-administration method was employed to distribute the questionnaires. This study employed a 7-point Likert-scale, which uses interval scales for the data collection to study the states of behaviour, intentions, or other closely related variables as recommended by Hair et al. (2019). A total of 142 surveys were collected, which is very low since many SMEs were closed as a mandatory work-from-home (WFH) policy was implemented. An online questionnaire was then distributed by sending the survey link to 3000 potential SMEs and finally, a total of 106 responses managed to be recorded. Through follow-up procedures, a total of 257 responses were collected from both methods. Out of these, 248 responses were deemed suitable for further analysis. Having a substantial number of usable responses is good, as it provides a solid foundation for drawing meaningful conclusions and insights from the data.

4.0 Results and Findings

4.1 Respondents' Profiles

The sample of respondents from SMEs used for this study comprised 22.2 % Directors, 12.5 % Managing Directors, 23% IT Managers, 30.2% IT staff, while 12.1% are from other positions. 29.4% have worked for less than five years, 31.5% worked for 5 to 10 years, 23.4% worked for 11 to 15 years, and 15.7% have worked for more than 15 years. In respect of their educational background, 33.5% of respondents have a qualification of Diploma and below, 51.2% hold a Bachelor's Degree, 14.5% have a Master's Degree qualification, and only 0.4% have a PhD. The majority of SMEs, which comprised 40% have 11 to 30 employees, 27.8% of SMEs have employed 51 employees and above, 19.4% have 1 to 10 employees and 13.3% have salaried 31 to 50 employees. The respondents came from various sectors, which include wholesale & retail trade (37.5%), food and beverage (27.4%), hotel and accommodation (7.26%), textile (17.7%), and others (e.g., finance, consultation, printing) (10.1%).

4.2 Structural Model Assessment

A bootstrapping procedure using smart PLS-SEM was conducted to assess the statistical significance of the structural models. This procedure examines the significance of the model by calculating measures such as predictive accuracy (R^2), predictive relevance (Q^2), and path modelling. Specifically, we focus on the significance of the coefficient of determination (R^2) in this section. R^2 measures the predictive accuracy of a model and indicates the extent to which the exogenous constructs explain the variance in the endogenous construct (Hair et al., 2017). Ranging from 0 to 1, higher R^2 values indicate higher levels of predictive accuracy. According to Hair et al. (2019), R^2 values of 0.75, 0.50, and 0.25 correspond to strong, moderate, and weak levels, respectively. In this study, the construct of IR4.0 adoption has an R^2 value of 0.619, suggesting that the exogenous variables account for 62.9% of the variation in IR4.0 adoption. This result is considered moderate. Additionally, the adjusted R^2 score for adoption is 0.605, indicating that the regression analysis supports the research hypotheses.

Table 1. Coefficient of Determination

	R-square	R-square adjusted
Adopt	0.619	0.605

4.3 The Direct Relationship Model

To be statistically significant at the 5% level, the t-value between the constructs must be greater than the threshold of 1.65, and the p-value must be less than 0.05 (Hair et al., 2017). The three hypotheses were sustained at 90% or 95% confidence levels. The influence of relative advantage on IR4.0 adoption has been shown (β = 0.047, t = 7.885, p > 0.05). Therefore, H1 is rejected. Conversely, compatibility is significant in determining the adoption (β = 0.350, t = 5.258, p < 0.05); thus, H2 is supported. The relationship between complexity and adoption has shown otherwise (β = -0.105, t = 1.668, p > 0.05), which means H3 is rejected. Lastly, the cost is significant (β = 0.492, t = 7.484, p < 0.05). Therefore, it can be concluded that H1 and H3 are rejected, while H2 and H4 are supported in this study.

Table 2. Results of the hypothesis testing of the direct association model

Hypothesis	Relationships	Path coefficients	t-value	p-value	Decision
H1	Rel_Adv → Adopt	0.047	0.885	0.376	Rejected
H2	Compt → Adopt	0.350	5.258	0.000	Supported
H3	Compx → Adopt	-0.105	1.668	0.095	Rejected
H4	Cost → Adopt	0.492	7.484	0.000	Supported

Note (s): *p<0.05; ***p<0.001 (one-tail)
Note(s): Rel_Adv: relative advantage, Compt: Compatibility, Compx: Complexity, and Adopt: adoption of IR4.0

4.4 The Moderation Relationship Model

The latent interaction constructs were examined using the bootstrapping procedure with 5000 resamples. Based on the results, the p-value was calculated, and a decision was made regarding whether a moderating effect existed. As shown in Table 2, hypothesis H5b (β = 0.152, t = 2.113, p > 0.035) and H5d (β = 0.152, t = 2.113, p > 0.035) is supported, indicating that GOV moderates the relationships between compatibility and cost, as hypothesised in the study. However, in the other two constructs, H5a (β = -0.037, t = 0.912, p < 0.352) and H5c (β = -0.026, t = 0.564, p < 0.0572), there was no moderating effect shown because the p-value is higher than 0.05. Thus, both H5a and H5c are rejected.

Table 3. Results of the moderation relationship model

Hypothesis	Relationships	Path coefficients	t-value	p-value	Decision
H5a	Gov_Int x Rel_Adv → Adopt	-0.076	1.584	0.113	Rejected
H5b	Gov_Int x Compt → Adopt	-0.179	2.467	0.014	Supported
H5c	Gov_Int x Compx → Adopt	0.037	0.650	0.515	Rejected
H5d	Gov_Int x Cost → Adopt	0.289	3.217	0.001	Supported

Note (s): *p<0.05; ***p<0.001 (one-tail)
Note(s): Rel_Adv: relative advantage, Compt: Compatibility, Compx: Complexity, GI: government intervention, and Adopt: adoption of IR4.0
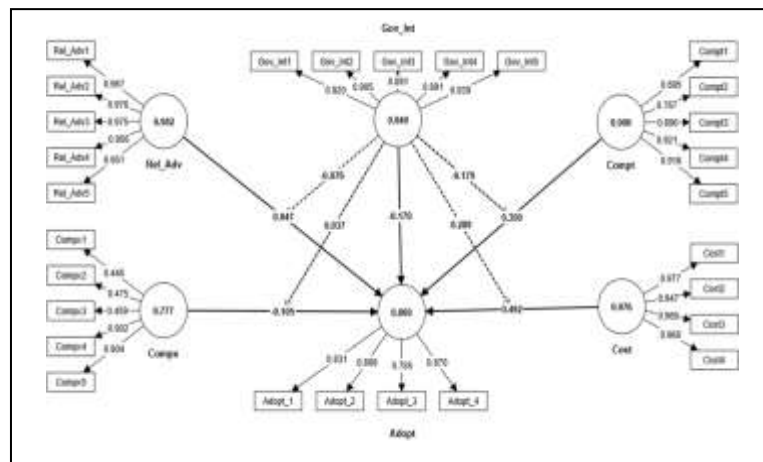

Fig. 2. PLS-SEM Model

5. Conclusion

It is important to acknowledge that not all the variables we examined had a favourable effect on the adoption of Industry 4.0. Specifically, compatibility and cost were identified as significant factors, while relative advantage and complexity did not significantly influence the adoption of Industry 4.0. While compatibility attributes can significantly influence the decision to adopt new technology since its implementation often necessitates organisations to modify their current business practices and operations to fully leverage the advantages of the technology. While for costs, according to Gkrimpizi, Peristeras & Magnisalis (2023), research shows that digital transformation requires large and upfront financial investment. The findings aligned with previous research that indicated a negative association between complexity and technology adoption due to potential limitations in successful implementation (Oliveira et al., 2014; Wang et al, 2016; Ramdani, Chevers & Williams, 2013; Gangwar, Date & Ramaswamy, 2015). Organisations may be less likely to adopt

new technology if they perceive it as too complex and incompatible with their current technologies and practices. The findings of the study however contradict with previous study by Yu and Schweisfurth (2020) that refer to when organisations perceive the advantages of new technology and possess extensive capabilities in that technology, the likelihood of adopting the technology increases.

5.1 Study Contributions
This study has significantly contributed to the body of knowledge on technological implementation by proposing a new conceptual model in examining the technology adoption factors from the viewpoint of small-scale enterprises by adapting the DOI framework with additional factors such as cost and government intervention. This research enhances the current understanding by investigating how the government intervention influences the relationship between the four key drivers and the readiness of SMEs for Industry 4.0 adoption. Even though not all moderating variables are determined to be significant, their presence is still discussed. In the context of organisational adoption, this study provides useful information for entrepreneurs and small business owners. In fact, adapting practical ideas to grow one's company is easier with forward-thinking idealism. Over time, the deployment of IR4.0 will lead to the improved performance of Malaysian SMEs.

6. Limitations of the Study and Suggestions for Future Research
The study is centred on Malaysia's SMEs in the service industry, which means the findings may not be universally applicable to all SMEs in Malaysia or other countries. Therefore, the research is limited to the scope of service-related SMEs, so future research could explore other sectors, such as agriculture and mining, which also contribute significantly to the country's GDP. Besides, the population is only contingent on the Kuala Lumpur and Selangor areas due to the highest number of SMEs situated in both areas. Besides, SMEs in these two areas have also contributed the highest amount of GDP. Thus, future studies can focus on a different setting by extending the geographic boundary to other states in Malaysia or even nationwide to represent the population of the whole Malaysia for greater generalisation of findings. Additionally, future studies may gather primary data using mixed approaches such as surveys and interviews to further explore the concept of technology diffusion in other industries and countries. In fact, interviews with prominent players in the area of new technological emergence might be beneficial for researchers to gain a better knowledge of the idea and its significance in the real world.

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