Influencing Factors of Information Technology Adoption in Taiwan's SMEs under the Trend of Digital Transformation

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ABSTRACT

Information technology has played a central role in the digital transformation of Small and Medium-Sized Enterprises (SMEs). Therefore, how to introduce appropriate information technology has become a major challenge for SMEs to maintain a sustainable competitive advantage. In order to understand the influencing factors of information technology adoption in Taiwan's SMEs under the trend of digital transformation. This study used the Technology-Organization-Environment (TOE) framework and literature review to find out relevant influencing factors and identified fourteen key factors through the expert questionnaire. This study invited nineteen SME executives with more than ten years of industry experience to participate in expert survey. The study results show that SMEs are most concerned about information security in the technical dimension. This may be related to the frequent information security incidents in recent years. In the organizational dimension, resource commitment, business goals, leadership, cost-effectiveness, and technology environment are key factors. In the environmental dimension, grabbing new business opportunities, confronting competitive pressure and partner requirements are the top three influencing factors. In addition, the results also show that government policy requirements are not the key factor. These research results can be used as a strategic reference for the government and SMEs to promote digital transformation.

Keywords: Digital transformation, Information technology adoption, TOE framework, Modified Delphi Method.

1. INTRODUCTION

In recent years, enterprises have actively adopted information technology to improve customer service and organization performance, forming a wave of customer-centric digital transformation trends, which have affected the innovation and development of enterprises. According to the IDC spending guide, worldwide spending on digital

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transformation will reach $2.3 trillion in 2023, more than half of all information and communication technologies (ICT) spending (Framingham, 2019). Kretschmer and Khashabi (2020) pointed out the positive impact of digital transformation on the sustainable competitive advantage of enterprises. Widespread adoption of information technology by organizations has caused tremendous changes in the industry and affected the organization's operations and processes. Vial (2019) indicated that information technology plays a central role in the process of digital transformation. Therefore, how to introduce appropriate information technology and combine business goals to carry out digital transformation has become a major challenge for enterprise growth and competition. However, Castelo-Branco, Cruz-Jesus and Oliveira (2019) indicate that the adoption rate of digital technologies among SMEs is still low. On the other hand, the Cisco (2020) survey indicated that only 16% of SMBs in the Asia Pacific have reached a high level of digital maturity in their digital transformation. Yang and Hsu (2017) pointed out that most of the research on the adoption of information technology in Taiwan is personally oriented and lacks relevant research on the organization level. In addition, according to the Department of Statistics, Ministry of Economic Affairs, R.O.C. (2017), Taiwan's SMEs account for 97.7% of all enterprises. Therefore, this study will explore the influencing factors of Taiwan's SMEs in information technology adoption under the trend of digital transformation through an expert survey. The research results can be used as a strategic reference for the government and SMEs to promote digital transformation.

2. LITERATURE REVIEW

2.1 Digital Transformation

Digital transformation (DT) is based on the innovative use of emerging information and communication technologies. It is a strategy-oriented and customer-centric change that improves existing processes or initiates new processes in modern organizations (Pihir, Katarina & Martina, 2019). Vial (2019) defined DT as a process that triggers major changes in organizational attributes by combining information, computer computing, communication, and connection technologies to improve organizational performance. In a nutshell, digital transformation is a dynamic adjustment process of an organization that combines information technology and business goals. It needs to change the organizational culture, daily operating processes, and value propositions. Ultimately, it will enable the enterprise to become a flexible and constantly improving organization. Therefore, digital transformation has a huge impact on the sustainable competitive advantage of enterprises. Chen (2019) pointed out digital transformation is believed to provide manufacturing SMEs with valuable advantages vital to their future competitiveness and survival, such as manufacturing productivity, reduced operating

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costs, improved product quality, and product innovation. Cisco (2020) stated that in Taiwan, 74% of SMEs seek digital transformation to introduce new products and services, allowing them to stand out from the competition and grow. 51% of SMEs are aware that competition is shifting and must keep pace with the times. 16% of SMEs seek digital transformation because of customer demand for change. The survey also pointed out that in response to digital transformation, Taiwanese SMEs will mainly invest in the procurement or upgrade of IT infrastructure hardware in 2020 (14%), followed by cloud services (13%) and information security (11%).

2.2 Information Technology Adoption

Vial (2019) pointed out that information technology causes disruptions on the social and industrial levels. These disruptions trigger the organization's strategic response. Organizations use information technology to change the value creation pathways that organizations previously relied on to remain competitive. Accordingly, organizations must implement structural reforms and overcome barriers to transformation within the organization. These changes have a positive impact on the organization. Although they can also have undesirable consequences. Digital transformation is an organization's internal and external changes caused by information technology, and it is also the source of disruption. Information technology plays a central role in the transformation process (Vial, 2019). Therefore, when discussing the process of digital transformation, researchers must understand the information technology adoption process and decision-making model.

Information technology provides many advantages and benefits to businesses especially for managing data and process (Chaveesuk & Hongsuwan, 2017). In the past ten years, information technology has evolved rapidly. The most well-known term is SMACIT (Sebastian, Ross, Beath, Mocker, Moloney & Fonstad, 2017), which includes social media, mobile communications, data analysis, cloud, and Internet of Things. Recently, enterprises have also begun to introduce artificial intelligence (AI) and robotic process automation (RPA) to improve operational efficiency and performance. In the past, research on the adoption of information technology focused on the individual's acceptance of technology. In the future, research on the adoption of information technology by organizations and groups should be increased (Rad, Nilashi & Dahlan, 2018). Yang and Hsu (2017) indicated that most of the research on the adoption of information technology in Taiwan is personally oriented, and mainly explores the various variables of personal acceptance of information technology but lacks relevant research on the organization or group level.

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2.2.1 TOE Framework

Rad et al. (2018) reviewed 330 studies and pointed out that there are about 21 research frameworks used in information technology adoption, including the Technology Acceptance Model (TAM), Diffusion of Innovation (DOI) model, Technology-Organization-Environment (TOE) framework, etc. The TOE framework is suitable for organizational research (Oliveira & Martins, 2011; Rad et al., 2018). This framework covers technology, organization (internal variables), and environment (external variables), and can conduct decision-making research on enterprise information technology adoption through a comprehensive perspective.

The TOE framework was proposed by Tornatzky and Fleischer (1990). The framework classifies the factors that influence the adoption of innovative technologies by organizations into the technology dimension, organization dimension (internal conditions), and environment dimension (external conditions). The variables of each dimension can be adjusted according to the actual situation. Information technology includes the existing technology of the organization and the technology that has not yet been adopted. The technical variables are mainly the characteristics of the technology, including compatibility, reliability, efficiency, and so on. The variables of the organizational dimension are the size of the organization, resource commitment, technical environment, human resources, etc. The environment dimension includes variables in the relationship between organization and competitor, related partner, and government. It also includes business opportunities. In the era of rapid technological change, the TOE framework takes technology as the main body, combines internal and external perspectives. It can draw possible impact variables according to the research object and can be applied to enterprise-related IT innovation research and keep pace with the times.

2.2.2 Influencing factors

This study refers to the TOE framework and explores the literature to find out the factors that influence the organization's adoption of information technology. There are five important variables at the technology dimension including (1) Performance (Chebrolu, 2011; Holotiuk & Beimborn, 2017; Raharja, Tresna & Rivani, 2019; Roecker, Mocker & Novales, 2017), the information technology used must be able to improve operational efficiency or increase the speed of service response to customers. (2) Integration (Lee & Kim, 2007; Oliveira & Martins, 2010; Smolander, Rossi & Pekkola, 2017), technology adoption needs to consider whether it can be integrated with the existing environment, infrastructure, and processes to improve the smoothness and integrity of the overall operation process. (3) Reliability (Iyer & Henderson, 2012) is a key factor in business operations. A reliable information platform is needed to support the

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operation of various businesses and customer service. (4) Ease of use (Cho & Lai, 2021; Harif & Hoe, 2018; Rad et al., 2018; Raharja, Tresna & Rivani, 2019), the information system needs to provide an easy-to-use and easy-to-manage user interface and avoid operational errors. (5) Information security (Cho & Lai, 2021; Harif & Hoe, 2018; Lee & Kim, 2007; Gonzalez, Miers, Redigolo, Simplicio, Carvalho, Näslund & Pourzandi, 2012; Smolander et al., 2017), after digitization, data is stored and transmitted digitally. Compared with traditional operation methods, it has higher requirements for information security and privacy. Kabanda, Tanner and Kent (2018) noted that cybersecurity attacks targeting SMEs are accelerating. Therefore, adding advanced digital technologies to existing operational technology requires SMEs to have some level of cyber capabilities to protect critical manufacturing systems and operations (Moeuf, Lamouri, Pellerin, Tamayo-Giraldo, Tobon-Valencia and Eburdy, 2020).

The organization dimension includes the following five variables. (1) Business goals (Lee & Kim, 2007), when companies adopt information technology, they will consider whether it meets business goals and whether the technology can support the achievement of business goals. (2) Leadership (Gonzalez et al., 2012; Lee & Kim, 2007) includes the participation of senior managers, the requirements for organizational execution, and the support of the organizational structure. (3) Resource commitment (Dhewanto, Lestari, Harif & Hoe, 2018; Heliana, Aliya & Lawiyah, 2018; Zhu & Kraemer, 2005) are commitments to the organization's investment in human and material resources, including related information technology education and training, etc. (4) Technology environment (Harif & Hoe, 2018; Lee & Kim, 2007; Oliveira & Martins, 2010) includes the background knowledge of the information technology of top managers and stakeholders, the professional skills and learning capabilities of existing manpower, and includes enterprise information infrastructure. Related research has shown that company size (Tornatzky & Fleischer, 1990) and price (Chebrolu, 2011; Harif & Hoe, 2018; Oliveira & Martins, 2010) are factors that affect the organization's adoption of information technology. However, modern enterprises evaluate investment benefits from the perspective of resource input and return, so this study uses cost-effectiveness as the fifth variable in the organization dimension.

There are five variables in the environment dimension. (1) Customer needs (Chouki, Talea, Okar & Chroqui, 2020; Dhewanto et al., 2018) include customer feedback, changes in customer consumption habits, etc. (2) Competitive pressure (Chouki et al., 2020; Dhewanto et al., 2018; Harif & Hoe, 2018; Oliveira & Martins, 2010; Wang, Wang, Y. S. & Yang, 2010) comes from intra-industry competition or cross-industry competition. For example, e-commerce brings competitive pressure on the traditional retail industry, forcing the traditional retail industry to develop on e-commerce platforms and adopt related information technologies. (3) Business partner

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requirements (Chouki et al., 2020; Dhewanto et al., 2018; Wang et al., 2010) include the integration of operating procedures, systems, or security standards between supply chains. In recent years, in response to the establishment of an industrial ecosystem, participating companies need to adopt the relevant information technology of the ecosystem. (4) Government policy requirements (Dhewanto et al., 2018; Harif & Hoe, 2018; Zhu & Kraemer, 2005) have caused pressure on companies. For example, companies must comply with information security regulations and need to introduce information security management systems and related technologies. (5) Business opportunity (Iyer & Henderson, 2012) is an external attraction. When a company discovers an emerging business opportunity, it must invest to obtain business value.

3. RESEARCH METHOD

3.1 Modified Delphi Method

The Delphi method is a research tool developed by Rand Corporation under the auspices of the United States Air Force. The Delphi method is an anonymous expert group decision-making technique. Its process is aimed at a specific issue, using the experience and expertise of experts to answer questions through multiple rounds of iterative cycles. This method can effectively minimize the differences of opinions among experts on the topic and achieve a consensus (Murry & Hammons, 1995). Lund (2020) figured out Delphi method can obtain relatively objective opinions through the independent judgment of multiple experts. However, the questionnaire survey time of the Delphi method is too long, which leads to a decrease in the response rate of the questionnaire. Duffield (1988) pointed out that if experts choose inappropriately, it is easy to have a prejudice against topics and influence the choice of factors. Therefore, Murry and Hammons (1995) proposed the Modified Delphi Method (MDM), which captures the spirit and advantages of the Delphi method, and its implementation steps and statistical methods are roughly the same as the traditional Delphi method. MDM usually uses a literature review or expert interviews to collect important dimensions and key factors. The results can replace the first round of questionnaires in the Delphi method.

3.2 Variable definition

This study finds three decision dimensions (Technology, Organization, Environment) and fifteen decision factors through literature review. Table 1 is the operational definition of the fifteen decision factors, including efficiency, integration, reliability, etc.

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Table 1. The operation definition of decision factors.

Dimensions	Decision factors	Operation definition(reference)
Technology	Efficiency	Efficient utilization of IT resources (Chebrolu, 2011; Holotiuk & Beimborn, 2017; Roecker et al., 2017).
	Integration	Interconnection and interoperability with legacy systems and business processes (Oliveira & Martins, 2010; Smolander et al., 2017).
	Reliability	Improve reliability and continuity of business services (Iyer & Henderson, 2012).
	Ease to use	Easy to use and simple management (Rad et al., 2018).
	Security	Information Security and privacy (Lee & Kim, 2007; Gonzalez et al., 2012; Smolander et al., 2017).
Organization	Business goals	Managing the result of new IT adoption as a key performance factor (Lee & Kim, 2007).
	Leadership	Top management engages and supports (Gonzalez et al., 2012; Lee & Kim, 2007).
	Resource commitment	Assigning and allocating adequate resources (Dhewanto et al., 2018; Zhu & Kraemer, 2005).
	Technical environment	The technical environment includes related knowledge, professional manpower, and infrastructure (Oliveira & Martins, 2010).
	Cost-effectiveness	Return On Investment (ROI), including investment costs, management costs, operating costs, etc. (Chebrolu, 2011; Oliveira & Martins, 2010).
Environment	Business opportunities	Newmarket opportunities, including product, service, or technology offering (Iyer & Henderson, 2012).
	Competitive pressure	Competitor pressure or alternative pressure (Chouki et al., 2020; Dhewanto et al., 2018; Oliveira & Martins, 2010; Wang et al., 2010).
	Customer needs	Customer needs, including the improvement of product, service, quality, and delivery (Chouki et al., 2020; Dhewanto et al., 2018).
	Partner requirement	Business partner requirements, including system, operation process, and data transfer interface (Chouki et al., 2020; Dhewanto et al., 2018).
	Government policy	Government policies, including industry support or regulatory requirements (Dhewanto et al., 2018; Zhu & Kraemer, 2005).

3.3 Selection and composition the panel of experts

Choosing the appropriate expert is a very important step in the Delphi method. Dalkey (1969) said that an expert group with more than 10 people have the lowest error and the highest reliability. If the expert has continuous experience of the research topic, then 10 to 15 experts are sufficient (Adler & Ziglio, 1996). Based on experts' experience and industry conditions, this study invited 19 experts (Table 2) with more than 10 years of industry experience to participate in the questionnaire survey. These 19 experts are all working in Taiwan SMEs and have rich experience in corporate decision-making. The expert group includes 12 presidents, 6 senior managers, and 1 middle manager. In addition, experts come from 7 industries including the catering industry, insurance industry, manufacturing, medical industry, service industry, traditional industry, and information industry.

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Table 2. Information of industry experts.

No.	Expert's Industry	Experience(Years)	Job Title	Age	Education	Gender
1	Catering industry	11~15	President	46-50	Master's degree	Female
2	Catering industry	16~20	President	46-50	Doctor's degree	Male
3	Catering industry	21~	President	55~	Doctor's degree	Male
4	Insurance industry	21~	Manager	55~	Master's degree	Male
5	Manufacturing	21~	President	51~54	Master's degree	Male
6	Manufacturing	21~	President	55~	Master's degree	Male
7	Medical industry	21~	President	55~	Doctor's degree	Female
8	Service industry	11~15	Senior Manager	51~54	Doctor's degree	Male
9	Service industry	16~20	Senior Manager	41-45	Master's degree	Male
10	Service industry	21~	President	51~54	Master's degree	Male
11	Service industry	21~	President	55~	Master's degree	Female
12	Service industry	21~	President	55~	Master's degree	Male
13	Service industry	21~	Senior Manager	55~	Master's degree	Male
14	Service industry	21~	Senior Manager	55~	Master's degree	Male
15	Traditional industry	21~	President	51~54	Master's degree	Male
16	Traditional industry	21~	President	51~54	Master's degree	Male
17	Traditional industry	21~	President	55~	Doctor's degree	Male
18	Information industry	21~	Senior Manager	46-50	Doctor's degree	Male
19	Information industry	21~	Senior Manager	51~54	Master's degree	Male

3.4 Establish data evaluation benchmarks

This research uses the seven-point Likert scale as the expert questionnaire scale. The scale for measuring importance will provide seven answer options (score from 1 to 7), not at all important (1), low important (2), slightly important (3), neutral (4), moderately important (5), very import important (6), extremely important (7). After the expert questionnaire survey, the Mean value of each question is calculated. If the Mean value is greater than or equal to 5, the importance of the variable is defined as high, and if it is less than 5, it is not an important variable. On the other hand, this study uses the Quartile Deviation (QD) to determine the consistency of expert opinions (Holden & Wedman, 1993). That is, half of the difference between the third quartile and the first quartile is taken. The smaller the Quartile Deviation, the smaller the degree of variation and the higher the consensus of experts. When the quartile deviation (QD)$\leqq$0.6, there is a high degree of consistency, 0.6<QD $\leqq$ 1.0 indicates a moderate degree of consistency, and QD>1 indicates a low degree of consistency. If more than 85% of the items reach a moderate consensus, the survey can be completed.

4. ANALYSIS RESULTS

This study collects expert opinions through expert questionnaire surveys. The data analysis results are shown in Table 3. The mean value of the variable "Government policy" in the first round of questionnaires is 4.737, which does not meet the importance threshold. Therefore, this study deletes this variable from the research. The remaining 14 variables are higher than 5 in terms of mean value, which means that experts believe that these 14 variables are important factors that affect the decision-making of

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information technology adoption in SMEs. In addition, this study used Quartile Deviation (QD) to analyze the consistency of variables. The analysis results showed that 8 variables were highly consistent($QD \leqq 0.6$), and 7 variables were moderately consistent($0.6 < QD \leqq 1.0$). The consistency test of all items is above moderate. The results meet the evaluation criteria of the consistency test. However, in the environment dimension, the QD value of all variables such as "Business opportunities", "Competitive pressure", "Customer needs" and "Partner requirement" are all 1.000. This shows that there is only moderate consensus among experts on these four variables. Therefore, this study conducted a second round of questionnaires. The results showed that 10 variables were highly consistent, accounting for 71.42% of all items. The remaining 4 variables were moderately consistent, accounting for 28.57% of all items. This represents a higher consensus among experts on these factors. Accordingly, this study completes the entire expert survey.

Table 3. Importance and consistency evaluation of decision factors.

Decision dimensions	Decision factors	First round results			Second round results		
		Mean(m)	QD	Result	Mean(m)	QD	Result
Technology	Efficiency	6.474	0.500	pass	6.474	0.500	pass
	Integration	6.158	0.750	pass	6.158	0.750	pass
	Reliability	6.368	0.500	pass	6.368	0.500	pass
	Ease to use	6.421	0.500	pass	6.421	0.500	pass
	Security	6.737	0.000	pass	6.789	0.000	pass
Organization	Business goals	6.263	0.500	pass	6.263	0.500	pass
	Leadership	6.158	0.500	pass	6.158	0.500	pass
	Resource commitment	6.474	0.500	pass	6.474	0.500	pass
	Technical environment	6.105	0.750	pass	6.105	0.750	pass
	Cost-effectiveness	6.158	0.500	pass	6.158	0.500	pass
Environment	Business opportunities	6.000	1.000	pass	6.158	0.500	pass
	Competitive pressure	5.895	1.000	pass	6.000	0.750	pass
	Customer needs	5.737	1.000	pass	5.789	0.500	pass
	Partner requirement	5.789	1.000	pass	5.895	0.750	pass
	Government policy	4.737	1.000	delete			

5. CONCLUSIONS

In recent years, the rapid evolution of digital technology and the maturity of information technology have driven a wave of digital transformation. The results of digital transformation also affect the sustainable competitive advantage of enterprises. In order to understand the key factors influencing the adoption of information technology by Taiwan SMEs under the trend of digital transformation. This study used the TOE framework to summarize fifteen influencing factors through literature review. During the expert survey process, this study invited 19 top managers of Taiwanese SMEs with rich decision-making experience to participate in the survey. The expert group includes

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12 presidents, 6 senior managers, and 1 mid-level manager. All members have more than 10 years of industry experience.

After two rounds of expert surveys. This study identified fourteen key influencing factors. In the technology dimension, this study found that enterprises are most concerned about whether new information technology meets information security. The second factor is the efficiency improvement that information technology brings to the enterprise. The third factor is the ease of use. It is worth noting that information security is the factor with the highest expert consensus (QD=0.000) among the fourteen key influencing factors. This may be related to the frequent information security incidents in recent years. For example, Taiwan Semiconductor Manufacturing Co., Ltd. (TSMC), the largest semiconductor company in Taiwan, was attacked by a computer virus in 2018 (TSMC, 2018). The serious security incident caused the production line to shut down. This security incident affected TSMC's revenue by 3%, equivalent to US$185M. Over the past decade, TSMC has adopted a large number of digital technologies in order to improve operational efficiency and maintain a competitive advantage. On the other hand, TSMC has also invested a lot of expenses and resources in information security protection, but it is still attacked by computer viruses and seriously affects its revenue. This information security incident has caused a shock to the confidence of Taiwan's SMEs, making management pay more attention to information security factors when evaluating new information technologies. These major information security incidents also accelerated the passage of the Cyber Security Management Act (NICST, 2018) by the Taiwanese government, requiring government agencies and critical infrastructure organizations to introduce information security management systems and strengthen information security protection measures.

The order of importance of factors in the organizational dimension is resource commitment (m=6.474), business goals (m=6.236), leadership (m=6.158), cost-effectiveness (m=6.158), and technology environment (m=6.105). This shows that managers are most concerned about the company's resource commitment in this dimension, which may be related to the limited resources of SMEs. Chaveesuk and Hongsuwan (2017) pointed out resource commitment is also an important success factor for the introduction of information technology. The second important factor is whether the information technology meets business goals. In the dimension of the external environment, the analysis results show that grabbing new business opportunities, confronting competitive pressure and partner requirements are the top three important influencing factors. The last factor is meeting the needs of existing customers. In addition, the results of this study also show that government policy requirements are not the factor influencing the adoption of new information technology by Taiwan's SMEs. This result shows that in addition to policy requirements, the

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government also needs to have further support measures or subsidy programs to improve the willingness of enterprises to cooperate with government policies. The results of this study can provide a strategic reference for Taiwan's SMEs and the government to promote digital transformation.

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