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-RESEARCH ARTICLE-

EXPLORING THE ANTECEDENTS TO INNOVATION PERFOEMANCE IN THAI INFORMATION COMMUNICATION TECHNOLOGY SEMs

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─Abstract─

Innovation performance in Information Communication Technology (ICT) firms is the key factor in developing the digital economy that plays a crucial role in enhancing overall economy of the country. Prior studies lack in explaining the intangible resources as an antecedent of IP in the context of Thai ICT Small and Medium Enterprises (SMEs). Therefore, the study set out to investigate how innovative capability (IC), quality management (QM), strategy (ST), and competitive advantage (CA) influenced a Thai ICT SME innovation performance (IP). To achieve the study objectives, the data was collected from 431 managers and entrepreneurs working in Thai ICT SMEs using multiple-stage and simple random sampling. Due to the continuing Covid-19 pandemic, data was collected online using Google Forms. The LISREL 9.1 software program was used to conduct the subsequent goodness-of-fit (GOF) assessment and the confirmatory factor analysis (CFA). A structural equation model (SEM) was used test the hypothesis of the study. The analysis showed that all the model's causal variables positively affected IP. Finally, this study presents various theoretical and practical contributions and study limitations in the concluding section of the study.

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1. INTRODUCTION

Information and communication technology (ICT) and the Internet play essential roles in a nations' drive for national development and the transition to a knowledge-based, digital economy (Sermsri et al., 2021). The importance of ICT's contribution to Thailand's national economy can be found from 2018 data, in which it was determined that 17% of Thailand's Gross Domestic Product (GDP) was derived from the digital economy (Thailand Board of Investment, 2019). Furthermore, the digital contribution to Thailand's GDP is projected to increase to 25% as early as 2027 (Review, 2017).

Department (2021) has also revealed significant numbers concerning Thailand's ICT current market value and projected growth. The group's data shows Thailand's 2020 software sector was valued at $3.96 billion, which is forecast to grow to $5.05 billion in 2022. They also revealed a digital market value of $19.24 billion in 2020. Moreover, even though Thai ICT spending was initially forecast to drop due to the business lockdowns and tourism sector destruction due to the Covid-19 pandemic, newer reports are suggesting it rose as much as 5% in 2021 due to remote work/office infrastructure spending.

Another contributing factor to the growing strength of Thailand's digital economy input to overall GDP is the significant increase in Thailand's e-Government Development Index (EGDI) which increased from 102nd in 2014 to an amazing 57th in 2020 (out of 193 countries surveyed) (Whitmore, 2012). It is also very fortunate that Thailand's digital economy has been robust within a much weaker overall economy. As with other global economies, Thailand has been hit hard by the multi-year Covid-19 pandemic and the associated destruction of tourism, trade, and supply chains. In 2020, data showed that Thailand's economy contracted 6.1%, primarily due to the destruction of a 40 million annual foreign tourism industry and its loss of exports (Yuda, 2021). However, the International Labour Organization (ILO) (2019) has indicated that the Kingdom's ICT specialists only represent a meager 1% (386,000) of the nation's entire workforce.

Furthermore, ICT companies at their core are dependent on innovation. Innovation, as described by Adler et al. (1990), consists of a firm's ability to create new products or upgrade existing products that meet market needs while also acquiring new technology that creates new opportunities. Also, Gërguri-Rashiti et al. (2017) has reported that a firm's innovation and its use with ICT are predictors of a firm's performance, with innovation that drives a company's performance (IP) a critical factor in outperforming its competitors. Contributing factors include production and exports, higher sales growth, higher market share, and the performance efficiency at which the company generates cash flow and profit (Lyver et al., 2018; Saliba de Oliveira et al., 2018). Moreover, other scholars have added that an essential aspect of attracting customers is creating new products, components, or services unique from the competition (Lyver et al., 2018; Nguyen et al., 2018; Rajapathirana et al., 2018).

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The pace and growth of Thailand's Internet and e-commerce are exploding, as is the value of IT spending to support it. However, the growth is segmented across multiple economic sectors. This creates software and hardware procurement problems for both in-house ICT staff and external system integration contractors from which efficiency, price, and technology choices will arise. Therefore, the efficiency and rapidity of an organization's *innovative capability* (IC) can be mirrored by its ability to embrace and implement these fast-paced changes. Additionally, Ferreira et al. (2019) have added that IC is a crucial resource that drives an organization's success or failure within its marketplace.

Further, *strategy* (ST) is also perceived as an essential element in the discussion on IP, with Nguyen et al. (2018) pointing out the essential nature of the establishment of long-term quality goals. Also, innovation results from a firm's internal R&D or its ability to imitate innovational ideas from other companies (F. Wang et al., 2020). Therefore, innovation ST can be an external or internal process.

Connected heavily to ST is the quality of what a company produces. In an exponentially growing competitive economic environment, *quality management* (QM) has become not only an obligation but also a managerial solution to achieve a competitive advantage (CA) (Bouzguenda et al., 2020). Taherparvar et al. (2014) has also added that the quality of innovation depends on how newly launched products or services meet customers' needs and expectations. Therefore, firms must consider quality a crucial element within their strategic visions.

Although multiple studies have stated that firms implementing QM can improve their innovation performance (Pham, 2020), other scholars have found significant problems and delay within QM's implementation due to the complexity and costs of certification standards (Bourke et al., 2017; Duhautois et al., 2022). (Saunila, 2020) has further suggested that more profound research on how innovation capability (IC) affects SMEs is due to the lack of studies on the relationship. (Martinsuo et al., 2011) have also stated the critical importance of a firm's evaluation criteria in the front end of innovation as that plays the deciding role in promoting their competitiveness and business potential. While extensive literature in the management and innovation field shows the characteristics that enhance a firm's ability to increase its innovation performance, there is still no consensus on its determinants and nature. Therefore, this study's goals are to advance the understanding of innovation performance (IP) by analyzing the four constructs to determine their interrelationships and direct effects on ICT SME IP. The antecedents under consideration include innovative capability (IC), quality management (QM), strategy (ST), and competitive advantage (CA), which are discussed further in the following section.

2. LITERATURE REVIEW

This section highlights studies related to Thai ICT SME innovation performance (IP) domains.

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2.1 Innovation Performance (IP)

Numerous studies have investigated how strategic management is developed through management's inter-organizational mobility to achieve better innovative outcomes (Crescenzi et al., 2018; Mawdsley et al., 2016). Additionally, in Malaysia, Salim and (Salim et al., 2011) studied SME ICT organization innovation and determined a substantial effect on the organization's performance. (Taiwo, 2016) also added that ICT played a very positive and significant role in an organization's performance.

These ideas are consistent with (Pintuma, 2021), who added that an organization's performance is a successful outcome measurement comprised of productivity, service quality, profits, and staff and customer satisfaction. Additional performance indicators can include fair compensation, safety, a good working environment, and work-life quality (Al Issa, 2021; Ilmudeen et al., 2019). Finally, multiple studies have shown that a variety of factors impact a firm's innovation performance (Figure 4 & Table 1). These include quality improvement methods (QIMs) (Bourke et al., 2017), total quality management (TQM) (Hung et al., 2011), ISO 9000 certification implementation (Terziovski et al., 2014), hard quality management efforts (Zeng et al., 2015), organizational learning (Hung et al., 2011), and innovation collaboration (He et al., 2012).

2.2 Innovation Capability (IC)

A commonly accepted definition of IC is an organization's ability to improve or create new products, processes, or services by identifying new ideas (Aas et al., 2017).This is consistent with older research in which (Zheng et al., 2010) stated that IC could be conceptualized as the potential to create valuable and novel knowledge or products. Also, within the literature, one can find significant similarities between the ideas of 'dynamic capability' (DC), which originated with Teece et al. (1997). Like IC, the authors stated that DC was a firm's capability to reconfigure, integrate, and construct external and internal competencies in ever-quickening environments. (C. L. Wang et al., 2015) have added that DCs are the foundation in understanding firm performance.

Furthermore, when one reviews the literature, one quickly finds that IC is a recent and emerging complex field of study. Also, there seems to be disagreement on how IC drives innovation and how IC is developed and utilized (Breznik et al., 2014; Helfat et al., 2003).

However, the thread we find through the literature concerning IC is that value does not come from resource possession alone but instead to how well those resources are used. Therefore, there is a continual need to develop expertise and innovation and the related management skills of the leaders' entrepreneurs (Aas et al., 2017). Therefore, seven observed variables were identified as potentially affecting IC. After that, the authors further postulated three hypotheses for the model's analysis:

H1: IC directly influences ST.

H2: IC directly influences IP.

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H3: IC directly influences CA.

2.3 Quality Management (QM)

Numerous studies have connected some form of *quality management* (QM) to knowledge management (KM), with QM being support for KM. This is consistent with Colurcio (2009), who reported that TQM (Total Quality Management) facilitates knowledge creation and dissemination. TQM practices also have a significant positive impact on knowledge transformation and creation (Jayawarna et al., 2009). Quality improvement and innovation are also established strategies for firms to create and defend their competitive position (Duhautois et al., 2022). Also, TQM adoption within firms can motivate the improvement in customer relationships. Therefore, six observed variables were identified as potentially affecting QM. These were x8 – x13, which are shown in Table 3. After that, the researchers further conceptualized three hypotheses for the model's analysis:

H4: QM directly influences ST.

H5: QM directly influences IP.

H6: QM directly influences CA.

2.4 Strategy (ST)

According to Knight et al. (2004), an organization's performance and strategy are dependent on its knowledge, capabilities, and innovation. Moreover, the authors state that organizational innovation creates unique knowledge and subsequent capabilities that strengthen a firm's performance. Bruhn et al. (2016) also found evidence that smaller firms have resource restrictions to export. However, firms with more than 70 employees are more likely to adopt organizational and strategic innovation.

In Norway, Nybakk et al. (2012) interviewed timber industry CEOs and found that innovation ST was essential to profitability. In Greece, Arvanitis et al. (2012) focused on five ICT-related 'soft' dimensions on a firm's IP and determined that ICT personnel, skills, strategy, and processes were essential to IP. Therefore, six observed variables were identified as potentially affecting ST. After that, the researchers further conceptualized two hypotheses for the model's analysis:

H7: ST directly influences CA.

H8: ST directly influences IP.

2.5 Competitive Advantage (CA)

According to Seeman et al. (2006). CA is dependent on the delivery of high-quality service. The authors also noted the importance of customer relationship management (CRM) as a business strategy involving customer education, loyalty, and satisfaction. Tangtatswas et al. (2021) added that if entrepreneurs do not use ICT and technology to their advantage, their competition will lead to their competitor's CA. Also, although brand loyalty is crucial,

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entrepreneurs need to keep pace with technology and innovate so that their competition does not eliminate them. Gursoy et al. (2014) and Sun et al. (2013) have additionally suggested that customer loyalty plays an essential role in CA and an organization's success in the marketplace.

Also tightly connected to good QM processes is an organization's ability to utilize effective knowledge management. This is consistent with (Kocoglu et al., 2012), which found that adapting and absorbing new technology is crucial to CA sustainability. Therefore, six observed variables were identified as potentially affecting CA. After that, the authors further conceptualized one hypothesis for the model's analysis:

H9: CA directly influences IP.

2.6 Theoretical Framework

In this study the Resource Based View (RBV) is considered as the underpinning theory of the proposed research framework. In accordance with the resource-based perspective, resources are critical for organisations in order to achieve long-term competitive advantage (Collins, 2021). A model of resource management was established by Friedman (2019), who argued that resource management contributes more to higher performance than simply possessing resources. The RBV is distinguished by the notion that resources are both tangible and intangible assets that organisations own or control, and that a firm's strategic competitiveness is dependent on the strategic resources and capabilities of the firm (Collins, 2021). Following this line of reasoning, we theorized that innovative capability (IC), quality management (QM), strategy (ST), and competitive advantage (CA) as the antecedents of innovation performance in Thai ICT SMEs. Figure 1 below shows the theoretical framework of the study.

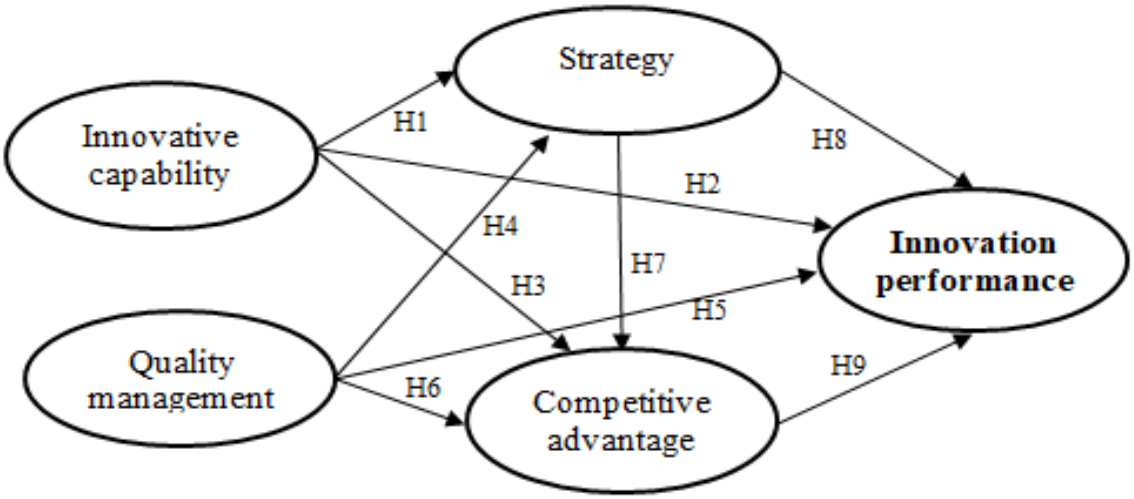

Figure 1: Theoretical Framework

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3. RESEARCH METHODOLOGY

3.1 Population and Sample Determination

The study's population consisted of companies' members of the Thai Electrical and Electronics Institute (EEI) (https://tinyurl.com/3jzhn3hf). At the time of the survey in 2021, there were 2,481 participating members. Borrowing the accepted sampling theory from (Schumacker et al., 2004) and Hair Jr et al. (2021), it is suggested that one method to determine sample size is to collect 10 – 20 questionnaires for each of a study's observed variables. From Table 3, we can identify 31 observed variables for the study's five latent variables. The researchers used a lower end of 10 x 31 (310) and a higher end of 20 x 31 (620) as a window for the sample collection. With the sample size established, the study then used systematic random sampling to contact the firms via an initial email with a follow-up phone call to confirm the study's participation invitation email.

3.2 The Questionnaire's Design

The survey instrument contained two sections in which Section 1 was concerned with seven items about each individual's personal, professional, and firm characteristics (Table 2). In Section 2, items covered the five latent variables and 31 observed variables (Table 3). The questionnaire also used a seven-level scale with '7' as an opinion indicator that the respondent 'agreed the most', '6' represented 'strongly agree', 5' represented 'somewhat agree', '4' represented 'moderate agreement', '3' represented 'somewhat disagree', '2' represented 'disagree', and finally '1' indicated that the respondent 'agree the least' (Ruenphongphun et al., 2021).

3.3 Ethics Clearance

The primary researcher attended a six-hour course titled Good Clinical Practice before the commencement of the study (Training, 2021). During this session, 12 modules were covered concerning conducting an ethical research study. We then presented our research plan methodology to our university's Human Ethics Committee using this valuable information. We obtained approval and a suggestion to receive an informed consent form from each expert, pilot-test participant, and final survey respondent, assuring each individual's anonymity.

3.4 Quality Assessment of the Research Instrument

After the questionnaire's design, a content validity (CV) assessment was done, involving five experts in their fields (Chuenban et al., 2021). It has been suggested that strength and validity from the research design and subsequent questionnaire come from how accurately the variables are selected and measured. The authors used Cronbach's α measurement scale values as an analysis tool to determine CV. From Taber's analysis of α values, experts felt that overall, the items' reliability was strong (0.91–0.93) to excellent (0.93–0.94) (Taber, 2018).

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3.5 The Questionnaire Pre-Test and Measurement of Validity

A pilot test was undertaken before the actual surveys in which 30 individuals participated who were not part of the final sample. As (Pimdee, 2020) has suggested, the reason for this is to establish each item's questionnaire relevance and the item's clarity (Pimdee, 2020).

3.6 Collection of the Data

The researchers collected the data using an online questionnaire (Google Form) with the executives and managers of ICT component manufacturers in Thailand. Prior to this, systematic random sampling was undertaken to choose each company from two rounds of solicitations, phone calls, and emails of component manufacturers. Follow-up coordination was done by phone and sending a link to the online Google Form questionnaire during June and July 2021. The response rate from the sampling process was 32%. The researchers then conducted Round 2 using simple random sampling starting in August 2021 and ending at the collection deadline of September 30, 2021. At this date, the researchers ascertained that 431 questionnaires were acceptable for the study's use. The questionnaire variables and their development from the literature and theory are presented in Table 1.

Analysis was undertaken to determine the data result's validity from the SEM model and the importance of the variables to a Thai ICT SME's IP.

4. RESEARCH RESULTS

4.1 Respondents' Characteristics

Table 2 details the responses from the431 ICT SME business owners and managers. We note that the majority of the entrepreneurial respondents were women (59.16%) and were mostly between 31-50 years of age (62.41%). Also, less than half of the entrepreneurs and managers had obtained an undergraduate degree (44.32%). Somewhat interestingly, the age of these small ICT firms seemed older than what might be expected, as 43.85% were over ten years old. Finally, 98.38% had 30 employees or less.

4.2 Goodness-Of-Fit (GOF)

The GOF for the measurement model was first established during the CFA study, as Jöreskog et al. (2016) have suggested that CFAs are a good tool for assessing a model's construct validity (CV). Westen and Rosenthol (2003) state that CV uses discriminant and convergent validity as measurement tools. Also, when the LISREL 9.1 software is used, $\chi 2$ and $\chi 2/df$ (relative Chi-square) values are created, which should have values of $p \geq 0.05$ and ≤ 2.00, respectively (Byrne et al., 1989; Rasch, 1993). LISREL also outputs values for other indices, including the goodness of fit index (GFI ≥ 0.90), comparative fit index (CFI ≥ 0.95), and the root mean square error of approximation (RMSEA ≤ 0.05). Additionally, Schumacker et al. (2004) suggest that values for the normed fit index (NFI), the adjusted goodness-of-fit index (AGFI), root mean square residual (RMR), and standardized root mean square residual (SRMR) should be ≥ 0.90, ≥ 0.90, ≤ 0.05, and ≤ 0.05, respectively.

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As such, all the GOF values for the CFA significantly exceeded the suggested minimal GOF criterion, implying that the model fit was excellent (Cangur et al., 2015) as $\chi 2 = 0.70$, $\chi 2/df = 0.95$, CFI = 1.00, GFI = 0.96, AGFI = 0.93, RMR = 0.02, SRMR = 0.02, RMSEA = 0.00, and NFI = 0.99.

4.3 The Results from the Corroborative Component Analysis

Table 3 details the results from the CFA and related validity and reliability testing. In the first column, we see the Cronbach's α analysis result and note the strong values for the questionnaire latent variables from 0.92 - 0.96 (Tavakol et al., 2011; Zheng et al., 2010). Secondly, we also find that the average variance extracted (AVE) values were from 0.67 – 0.75. Hair Jr et al. (2021) has suggested that construct validity (CV) is best achieved using the average variance extracted (AVE), correlations (main loadings), and construct/composite reliability (CR), with AVE values ≥ 0.5 and CR values ≥ 0.6 considered acceptable (Fornell et al., 1981). The analysis showed additional reliability as the CR values were 0.92 – 0.95, and the loadings/correlation values were strong as they were 0.73 - 0.91.

4.4 Mediation Effects on the Dependent and Independent Latent Variables

The analysis showed that all the model's causal variables positively affected Thai ICT SME IP, which, when combined, had an R^2 value of 96% (Table 4). Moreover, the values for the latent variables when ranked by total effect (TE) were QM (0.74), ST (0.62), CA (0.48), and IC (0.27). Moreover, there were very strong influences from CA to ST (0.95) and ST to QM (0.71).

4.5 Construct Correlation Coefficients

In Table 5, the correlation coefficient testing results are shown. A common interpretation value used for these results is that 0.50 – 1 represents a strong correlation (Chuenban et al., 2021). Also, it has been suggested that discriminant validity is further confirmed when standardized factor loading values ≥ 0.60 (Henseler et al., 2015).

4.6 Hypotheses Testing

Table 6 and Figure 5 detail the nine hypotheses testing results, from which six were found to be supported, and three were not supported. Additionally, very significant strength was found in the relationship from ST to CA ($r = 0.95$, t-value = 9.12, $p \leq 0.01$). We also note the strong relationship from QM to ST ($r = 0.71$, t-value = 10.86, $p \leq 0.01$) and the moderate strength from CA to IP ($r = 0.48$, t-value = 3.80, $p \leq 0.01$).

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Table 1. Questionnaire Constructs, Their Observed Variables, And Related Theory Support

Constructs	31 Questionnaire Items	Previous Studies
Innovation Performance (IP)	y13, y14, y15, y16, y17, y18	(Adler & Shenhar, 1990; Al Issa, 2021; Bourke & Roper, 2017; Cangur & Ercan, 2015; Crescenzi & Gagliardi, 2018; Gërguri-Rashiti et al., 2017; He & Wong, 2012; Hung et al., 2011; Ilmudeen et al., 2019; Martinsuo & Poskela, 2011; Mawdsley & Somaya, 2016; Pintuma & Aunyawong, 2021; Rajapathirana & Hui, 2018; Saeed et al., 2015; Salim & Sulaiman, 2011; Terziovski & Guerrero, 2014; Zeng et al., 2015)
Innovation Capability (IC)	x1, x2, x3, x4 x5, x6, x7	(Aas & Breunig, 2017; Akman & Yilmaz, 2008; Aljuboori et al., 2021; Colurcio, 2009; Helfat & Peteraf, 2003; Helfat et al., 2007; Jayawarna & Holt, 2009; Lidija & Robert, 2014; Mendoza-Silva, 2021; Rajapathirana & Hui, 2018; Sudolska & Łapińska, 2020; Teece et al., 1997; Wang et al., 2015; Zheng et al., 2010)
Quality Management (QM)	x8, x9, x10, x11, x12, x13	(Bourke & Roper, 2017; Colurcio, 2009; Jayawarna & Holt, 2009; Taherparvar et al., 2014)
Strategy (ST)	y1, y2, y3, y4, y5, y6	(Arvanitis et al., 2012; Beyene et al., 2016; Knight & Cavusgil, 2004; Nybakk & Jenssen, 2012; Samara et al., 2012)
Competitive Advantage (CA)	y7, y8, y9, y10, y11, y12	(Firman & Thabrani, 2018; Gursoy et al., 2014; Kocoglu et al., 2012; Ling & Mansori, 2018; Sun et al., 2013; Seeman & O'Hara, 2006; Tangtatswas et al., 2019)

Note. Please see Table 3 for each observed variable's description.

4.7 Data Analysis

Table 2: Summary of Respondents' Characteristics (*n* = 431).

Characteristic	Number	%
Gender		
Male	176	40.84
Female	255	59.16
Total	**431**	**100**
Age		
under 30 years of age	62	14.39
31 - 40 years of age	136	31.55
41 - 50 years of age	133	30.86
51 - 60 years of age	77	17.87
over 60 years of age	23	5.34
Total	**431**	**100**
Education Levels		
Vocational Certificate / High Vocational Certificate / Diploma	119	27.61
Bachelor's degree	191	44.32
Postgraduate	12	2.78
Other such as secondary school	109	25.29
Total	**431**	**100**

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Table 2: Continued

Position		
Business owner	375	87.01
Manager/Executive	56	12.99
Total	**431**	**100**
Company Status		
Company	348	80.74
Partnership	83	19.26
Total	**431**	**100**
Company Age		
less than one year	25	5.80
1-5 years old	99	22.97
6-10 years old	118	27.38
more than ten years old	189	43.85
Total	**431**	**100**
Employees		
no more than ten people	197	45.71
11-20 people	119	27.61
21-30 people	108	25.06
More than 30 people	7	1.62
Total	**431**	**100**

Table 3: Constructs and the Observed Variables Analysis Results

Constructs	**α**	**AVE**	**CR**	**Observed variables (31)**	**Loadings**	**R^2**
Innovative Capability (IC)	0.96	0.75	0.95	I believe it is essential for my firm to create a corporate culture of innovation (x1).	0.82	.68
				I believe it is essential for my firm to use knowledge from various sources, which allows it to develop the organization efficiently and quickly (x2).	0.87	.75
				I believe it is essential for my firm to quickly adapt to changes in the technological environment (x3).	0.83	.69
				I believe it is essential for my firm to listen to changes in market conditions, such as customer needs and competing products (x4).	0.91	.84
				I believe it is essential that my firm encourages employees to generate new ideas to help with product development and innovation process improvement (x5).	0.87	.76
				I believe it is essential for my firm to recruit new employees with high innovative abilities (x6).	0.85	.72
				I believe it is essential for my firm to cooperate with other innovative, capable organizations such as leading companies or schools (x7).	0.89	.79

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Table 3: Continued

Quality Management (QM)	0.94	0.71	0.92	I believe it is essential for my firm's management to be involved in quality improvement (x8).	0.82	.67
				I believe it is essential for my firm's front-line staff to be involved in quality improvement (x9).	0.76	.58
				I believe it is essential for my firm to review new product designs continuously(x10).	0.87	.75
				I believe it is essential for my firm to attach importance to quality and the satisfaction of customers' needs (x11).	0.86	.74
				I believe it is essential for my firm to manage product quality performance to meet customer expectations (x12).	0.89	.79
				I believe it is essential for my firm to have a quality management system specifically for innovation (x13).	0.87	.76
Strategy (ST)	0.94	0.70	0.93	I believe it is essential for my firm to provide strategies that create innovative products that reflect customer needs (y1).	0.80	.65
				I believe it is essential for my firm to develop a business plan based on customer needs (y2).	0.83	.68
				I believe it is essential for my firm to focus on solving problems using advanced technology development (y3).	0.86	.75
				I believe it is essential for my firm to focus on proactive innovation to become a leader in new technology in the market (y4).	0.88	.77
				I believe it is essential for my firm to have creative, strategic management unique in the marketplace (y5).	0.79	.63
				I believe it is essential for my firm to forecast future technology trends and customer needs to formulate a long-term strategy (y6).	0.85	.72
Competitive Advantage (CA)	0.92	0.72	0.94	I believe it is essential for my firm to create a product that stands out from the market (y7).	0.89	.80
				I believe it is essential for my firm to obtain manufacturing knowledge to try new things regularly (y8).	0.81	.65
				I believe it is essential for my firm to constantly seek ways to enhance its competitive advantage (y9).	0.86	.73
				I believe it is essential for my firm to have effective cost control (y10).	0.85	.72
				I believe it is essential for my firm to quickly deliver quality, innovative products and reliable technology (y11).	0.89	.79
				I believe it is essential that my firm wins product innovation awards and be recognized in the technology industry (y12).	0.77	.60
Innovation Performance (IP)	0.94	0.67	0.92	I believe it is essential for my firm to have high sales growth and market share (y13).	0.85	.73
				I believe it is essential for my firm to increase its cash flow and profit (y14).	0.81	.65
				I believe it is essential for my firm to achieve significantly higher levels of customer satisfaction than competitors (y15).	0.85	.72
				I believe it is essential for my firm to sell more innovative products/services than my competitors (y16).	0.89	.79
				I believe it is essential for my firm to have the ability to continuously develop innovative services or products that are superior to our competitors (y17).	0.73	.53
				I believe it is essential that our company's shareholders are satisfied with our performance (y18).	0.76	.58

Table 4: Mediation Effects of the Dependent and Independent Latent Variables

Dependent variables	R^2	Effect	Independent variables			
			CA	ST	QM	IC
Strategy (ST)	0.88	DE			0.71**	0.25**
		IE			-	-
		TE			0.71**	0.25**
Competitive Advantage (CA)	0.81	DE		0.95**	0.01	0.01
		IE		-	0.67**	0.23**
		TE		0.95**	0.68**	0.24**
Innovation Performance (IP)	0.96	DE	0.48**	0.16	0.30**	0.11*
		IE	-	0.46**	0.44**	0.16**
		TE	0.48**	0.62**	0.74**	0.27**

**Sig. < .05, ** $p \leq .01$.*

Table 5. Testing Results for Construct Correlation Coefficients

Constructs and Testing Items	**IC**	**QM**	**ST**	**CA**	**IP**
Innovative Capability (IC)	**1.00**				
Quality Management (QM)	.87**	**1.00**			
Strategy (ST)	.81**	.86**	**1.00**		
Competitive Advantage (CA)	.78**	.83**	.90**	**1.00**	
Innovative Performance (IP)	.82**	.86**	.87**	.90**	**1.00**
Mean	5.74	5.67	5.71	5.76	5.76
Standard Deviation	1.01	.98	.95	.93	.92
Skewness	-1.00	-.90	-1.09	-.99	-.93
Kurtosis	.57	.48	1.57	1.23	.79

** $p \leq .01$.

Additionally, although somewhat weaker, QM had a direct influence on IP (r = 0.30, t-value = 3.92, $p \leq 0.01$), followed by IC on ST (r = 0.25, t-value = 4.51, $p \leq 0.01$), and finally, IC on IP (r = 0.11, t-value = 2.31, $p \leq 0.05$). However, IC to CA, QM to CA, and ST to IP were determined to be unsupported.

Support for the study's results also come from Hair Jr et al. (2021), in which it was stated that when t-values ≥ 1.96, they are acceptable values.

Table 6 and Figure 2 detail the nine hypotheses testing results, from which six were found to be supported, and three were not supported. Additionally, very significant strength was found in the relationship from ST to CA (r = 0.95, t-value = 9.12, $p \leq 0.01$). We also note the strong relationship from QM to ST (r = 0.71, t-value = 10.86, $p \leq 0.01$) and the moderate strength from CA to IP (r = 0.48, t-value = 3.80, $p \leq 0.01$).

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Table 6. SEM Hypotheses Testing Results

Hypotheses	***r***	**t-test**	**Results**
H1: IC directly influences ST.	0.25	4.51**	Consistent
H2: IC directly influences IP.	0.11	2.31*	Consistent
H3: IC directly influences CA.	0.01	0.13	Inconsistent
H4: QM directly influences ST.	0.71	10.86**	Consistent
H5: QM directly influences IP.	0.30	3.92**	Consistent
H6: QM directly influences CA.	0.01	0.06	Inconsistent
H7: ST directly influences CA.	0.95	9.12**	Consistent
H8: ST directly influences IP.	0.16	0.97	Inconsistent
H9: CA directly influences IP.	0.48	3.80**	Consistent

* $p \leq 0.05$, ** $p \leq 0.01$

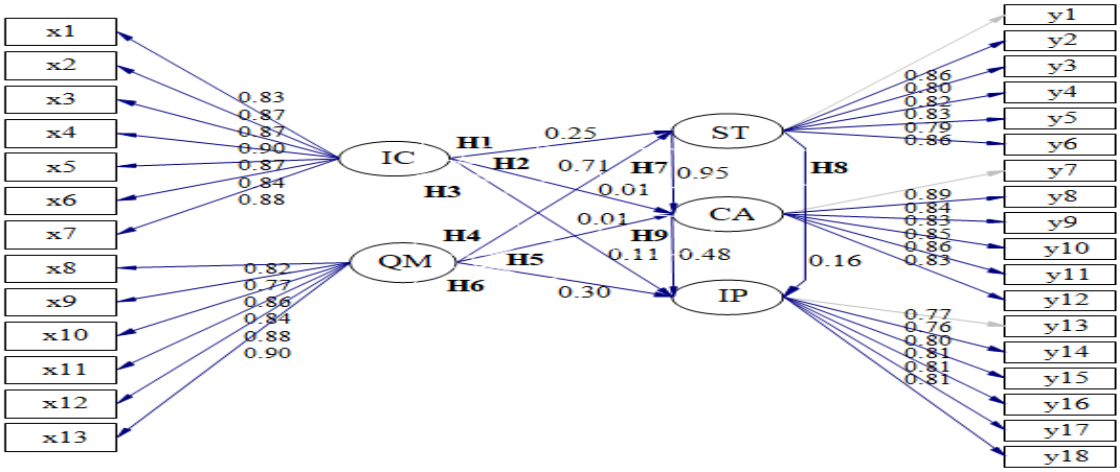

Figure 2: Final SEM Testing Results of Influencing Factors on Thai ICT SME IP
Note. Chi-Square=254.45, df=267, *p*-value=0.69942, RMSEA=0.000

5. DISCUSSION

The analysis showed that all the model's causal variables positively affected IP, which, when combined, had an R^2 value of 96%. Moreover, the values for the latent variables when ranked by total effect (TE) were QM (0.74), ST (0.62), CA (0.48), and IC (0.27). There were also very strong influences from CA to ST (0.95) and ST to QM (0.71). Further detail concerning the nine hypotheses SEM testing is as follows:

5.1 Innovative Capability (IC)

The three hypotheses testing for IC's latent variable relationships showed that H1 and H2 were weak but supported, while H3 was unsupported. This was determined as IC to ST had an $r = 0.25$, t-test = 4.51, and a $p \leq 0.01$. Likewise, H2's relationship from IC to IP was weak as it had an $r = 0.11$, t-test = 2.31, and a $p \leq 0.05$.

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However, from the study's descriptive statistics analysis (Table 7), we note that the ICT firm owners and managers believed that their firm's ability to adapt to change and customer needs with competing products was most important (mean = 5.81, SD = 1.17). There is significant support for this finding from other studies with Akman et al. (2008) in the Turkish software sector, establishing the importance of IC. In Poland, Sudolska and (Sudolska et al., 2020) described IC as a 'critical variable' in a firm's long-term competitiveness. This is consistent with IC and firm performance research in Malaysia, in which (Aljuboori et al., 2022) showed that IC's ability has a positive effect on an SME's competitive advantage. (Mendoza-Silva, 2021) also reported the critical nature of IC in firm competitiveness from a systematic literature review of 137 papers.

Secondly, we note the importance of the respondents on listening to change in their industry and from their customers (mean = 5.78, SD = 1.13). Support for this has also been established as an essential element in IC, with Helfat et al. (2003) stating that IC should be focused on offering a change to its customers. Also, Rajapathirana et al. (2018) saw a strong empirically verified connection between IC, innovation efforts, and firm performance.

Table 7: Descriptive Statistics Analysis for IC

Items	**Mean**	**SD**	**Skewness**	**Kurtosis**
Innovative capability (IC)	5.74	1.01	-1.00	.57
I believe it is essential for my firm to create a corporate culture of innovation (x1).	5.60	1.15	-.57	-.41
I believe it is essential for my firm to use knowledge from various sources, which allows it to develop the organization efficiently and quickly (x2)	5.71	1.09	-.70	-.15
I believe it is essential for my firm to quickly adapt to changes in the technological environment (x3).	5.81	1.17	-.73	-.34
I believe it is essential for my firm to listen to changes in market conditions, such as customer needs and competing products (x4).	5.78	1.13	-.92	.44
I believe it is essential that my firm encourages employees to generate new ideas to help with product development and innovation process improvement (x5).	5.75	1.16	-.78	-.05
I believe it is essential for my firm to recruit new employees with high innovative abilities (x6).	5.76	1.13	-.90	.45
I believe it is essential for my firm to cooperate with other innovative, capable organizations such as leading companies or schools (x7).	5.74	1.11	-.86	.31

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5.2 Quality Management (QM)

The first of three hypotheses tested for QM's latent variable relationship in H4 was very strong as QM to ST was $r = 0.71$, t-test = 10.86, and a $p \leq 0.01$. Also, in H5 the relationship was weak but supported from QM to IP ($r = 0.30$, t-test = 3.92, and a $p \leq 0.01$). However, the relationship from QM to CA was found to be unsupported.

Moreover, from the study's descriptive statistics analysis (Table 8), we note that the ICT firm owners and managers believed that the ability to have a process for continuous review of new product designs was most important (x10) (mean = 5.74, SD = 1.16). The ability followed this to manage product quality performance which meets customer expectations (x12) (mean = 5.71, SD = 1.12). However, as has been noted by Bourke et al. (2017), the implementation of quality improvements and innovation poses significant technical, organizational, and management challenges. Also, managers should expect long lag times between implementation and the realization of the quality improvement benefits.

Table 8. Descriptive Statistics Analysis for QM

Items	Mean	SD	Skewness	Kurtosis
Quality management (QM)	5.67	.98	-.90	.48
I believe it is essential for my firm's management to be involved in quality improvement (x8).	5.62	1.11	-.70	-.15
I believe it is essential for my firm's front-line staff to be involved in quality improvement (x9).	5.66	1.14	-.87	.45
I believe it is essential for my firm to continuously review new product designs (x10).	5.74	1.16	-.82	.22
I believe it is essential for my firm to attach importance to quality and the satisfaction of customers' needs (x11).	5.63	1.07	-.75	.35
I believe it is essential for my firm to manage product quality performance to meet customer expectations (x12).	5.71	1.12	-.84	.53
I believe it is essential for my firm to have a quality management system specifically for innovation (x13).	5.68	1.09	-.86	.59

5.3 Strategy (ST)

The first of two hypotheses tested for ST's latent variable relationship in H7 was very strong as ST to CA was $r = 0.95$, t-test = 9.12, and a $p \leq 0.01$. However, the relationship from ST to IP in H8 was unsupported.

Also, from the study's descriptive statistics analysis (Table 9), we note that the ICT firm

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owners and managers believed that the ability to have creative, strategic management that is unique in the marketplace was most important in ST (y5) (mean = 5.74, SD = 1.16). This was followed by the capability to forecast future technology trends and customer needs to formulate a long-term strategy (y6) (mean = 5.74, SD = 1.10).

Table 9. Descriptive Statistics Analysis for ST

Items	Mean	SD	Skewness	Kurtosis
Strategy (ST)	5.71	.95	-1.09	1.57
I believe it is essential for my firm to provide strategies that create innovative products that reflect customer needs (y1).	5.65	1.10	-.82	.56
I believe it is essential for my firm to develop a business plan based on information about customer needs (y2).	5.64	1.07	-.84	.76
I believe it is essential for my firm to focus on solving problems using advanced technology development (y3).	5.72	1.10	-.82	.50
I believe it is essential for my firm to focus on proactive innovation to become a leader in new technology in the market (y4).	5.71	1.08	-.86	.81
I believe it is essential for my firm to have creative, strategic management unique in the marketplace (y5).	5.78	1.09	-.99	1.36
I believe it is essential for my firm to forecast future technology trends and customer needs to formulate a long-term strategy (y6).	5.74	1.10	-.93	.95

5.4 Competitive Advantage (CA)

The single hypothesis testing for CA's latent variable relationship in H9 was moderate as CA to IP was $r = 0.48$, t-test = 3.80, and a $p \leq 0.01$. These results are consistent with Hoe et al. (2018), who in Malaysia determined that CA was critical for each firm's development and survival within their respective marketplaces within that country's engineering industry.

Also, from the study's descriptive statistics analysis (Table 10), we note that the ICT firm owners and managers believed that their firm's ability to create products that were unique within the marketplace was most important (y7) (mean = 5.80, SD = 1.10). Next was their firm's ability to obtain manufacturing knowledge that allows them to try new ways of doing things regularly (y8) (mean = 5.77, SD = 1.10). These results are similar to Hoe et al. (2018), who suggested that CA creation occurs as an organization discovers a better way to innovate when compared to its competitors. Finally, Firman et al. (2018) showed how dynamic capabilities and innovation positively and significantly impact the CA.

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Table 10. Descriptive Statistics Analysis for CA.

Items	Mean	SD	Skewness	Kurtosis
Competitive Advantage (CA)	5.76	.93	-.99	1.23
I believe it is essential for my firm to create a product that stands out from the market (y7).	5.80	1.10	-1.00	1.23
I believe it is essential for my firm to obtain manufacturing knowledge to try new things regularly (y8).	5.77	1.10	-.94	.73
I believe it is essential for my firm to constantly seek ways to enhance its competitive advantage (y9).	5.74	1.05	-.77	.44
I believe it is essential for my firm to have effective cost control (y10).	5.76	1.07	-.69	.14
I believe it is essential for my firm to quickly deliver quality, innovative products and reliable technology (y11).	5.75	1.04	-.88	.96
I believe it is essential that my firm wins product innovation awards and be recognized in the technology industry (y12).	5.74	1.01	-.65	.23

Moreover, from the study's descriptive statistics analysis (Table 7), we note that the ICT firm owners and managers believed that the ability to have a process for continuous review of new product designs was most important (x10) (mean = 5.74, SD = 1.16). The ability followed this to manage product quality performance which meets customer expectations (x12) (mean = 5.71, SD = 1.12).

5.5 Innovation Performance (IP)

Concerning IP, the descriptive statistical analysis detailed in Table 11 revealed that the respondents felt that it was essential for their firm to gain significantly greater customer satisfaction than its competitors (y15) (mean = 5.84, SD = 1.02). This was followed by the importance of increasing their firm's cash flow and profit (y14) (mean = 5.79, SD = 1.03) and their ability to sell more innovative products/services than their competitors (y16) (mean = 5.78, SD = 1.02).

Moreover, from the study's descriptive statistics analysis (Table 7), we note that the ICT firm owners and managers believed that the ability to have a process for continuous review of new product designs was most important (x10) (mean = 5.74, SD = 1.16). The ability followed this to manage product quality performance which meets customer expectations (x12) (mean = 5.71, SD = 1.12).

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Table 11. Descriptive Statistics Analysis for IP

Items	Mean	SD	Skewness	Kurtosis
Innovation Performance (IP)	5.76	.92	-.93	.79
I believe it is essential for my firm to have high sales growth and market share (y13).	5.71	1.05	-.68	.19
I believe it is essential for my firm to increase its cash flow and profit (y14).	5.79	1.03	-.79	.49
I believe it is essential for my firm to achieve significantly higher levels of customer satisfaction than competitors (y15).	5.84	1.02	-.88	.68
I believe it is essential for my firm to sell more innovative products/services than my competitors (y16).	5.78	1.02	-.69	.34
I believe it is essential for my firm to have the ability to continuously develop innovative superior products or services to our competitors (y17).	5.69	1.15	-.90	.62
I believe it is essential that our company's shareholders are satisfied with our performance (y18).	5.76	1.13	-1.01	1.10

There can also be no doubt that innovation and quality improvement are interrelated. The point of contention is whether the relationship is complementary or opposing in nature (Bourke et al., 2017). One excellent example of this dilemma comes from a study by (Duhautois et al., 2022). The authors discovered that ISO 9000 standard implementation concerned the entire organization and involved changing the fundamental behavior of routines of the entire staff.

As we have seen, great strides are underway in Thailand to create a digitally based society of knowledge workers. For over five years, efforts have been made to bring high-speed broadband to every Thai village, which in 2021 was stated to have reached 74,987 villages. Thus, as (Rajapathirana et al., 2018) have surmised, innovation's use of available technologies and resources requires knowledge management. Although innovation is primarily developed through an SME's firm efforts, innovation itself has moved to the forefront in a nation's economic growth and social welfare (Chen, 2017). Finally, as Cangur et al. (2015) pointed out, understanding the essential nature of innovation competencies for integrated services has become critical as an economic growth engine in an ever-changing world.

6. CONCLUSION

The authors investigated how a Thai ICT SME's innovation performance is affected by innovative capability, quality management, strategy, and competitive advantage. The SEM

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analysis revealed that all the model's causal variables had a positive effect on IP, which, when added together, had an R^2 value of 96%. Further strength in the modeling was determined that quality management strongly affects innovation performance. This was followed by a firm's strategy, competitive advantage, and innovative capability. Additionally, strong relationships were found between competitive advantage and strategy and strategy to quality management.

7. POTENTIAL STUDY LIMITATION AND FUTURE RESEARCH SUGGESTIONS

Although the study took place in the summer of 2021 under severe lockdown conditions precipitated by the multi-year COVID-19 pandemic, the authors managed to survey 431 Thai ICT SME entrepreneurs and managers using online questionnaire responses with Google Form. However, we believe follow-up studies under less constraining conditions can reveal greater detail from a more comprehensive sampling group. A qualitative approach can also be used to gain additional insights. These can include both one-on-one interviews and focus groups. Finally, because this study has a limitation that may impact the results, we cannot dismiss the non-significant effects of other latent factors.

8. RESEARCH CONTRIBUTIONS

The study detailed how Thailand's ICT/digital e-commerce sector is reaching ever higher highs. The study has also highlighted that ICT skills within Thailand are at an international low as a percentage of the total domestic workforce. This study makes several significant contributions. Firstly, although quality improvement and innovation have been connected, the benefits of that relationship have been debated. In this study, we determined that within a Thai ICT SME, there was a significant and positive relationship between quality management and the firm's innovation performance. Secondly, according to the study's entrepreneurs and managers, innovation performance was also surprisingly tied to higher customer satisfaction over their competitors. Thirdly, the Thai digital economy has grown significantly, projected to reach 25% of the nation's GDP in 2027, in this context the present research will help to expedite the ICT development in Thailand.

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