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Research Article

Antecedents to Thai Automotive Manufacturing Competitive Advantage: A Structural Equation Model Analysis

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Abstract: The research was undertaken to develop a structural equation model (SEM) of how technological capabilities (TC), knowledge management (KM), quality management (QM), and the supply chain (SC) affected the competitive advantage (CA) of Thailand's automotive and auto-parts manufacturing businesses. The research instrument was a questionnaire from which data were collected from 515 automotive industry entrepreneurs and managers in Thailand. Subsequently, a confirmatory factor analysis (CFA) was done using LISREL 9.1 to determine the model's fit, followed by an SEM of the variables. The results revealed that all causal variables in the model had a positive influence on CAwhich could jointly be explained by the variance of factors influencing CA (R^2) at 78%. The factors affecting CA (ranked from highest to lowest) were QM, the SC, KM, and TC, with total effect(TE) values of 0.72, 0.68, 0.45, and 0.44, respectively. Therefore, to maintain Thailand's automotive leadership within ASEAN and maintain a CA on a global scale, this study's entrepreneurs and managers felt the key factor was their firm's ability at QM. Specifically, QM should be focused on the *quality management process* and *strategic planning,* as well as *continual improvement* and the *focus on quality*. These factors were closely followed by the SC and each firm's ability to provide good *customer service,* having *a supply chain emergency plan and crisis management system,* and finally, an *ongoing supply chain development process.* The research also suggests that strategic partnerships with larger, international SC vendors enable a more secure CA. Government policymakers also need to structure their support in a way that addresses the needs of each type of firm's TC. Moreover, research & development incubators need to be established, especially in light of the Thai government's direction into EVs and the stated goal of 30% EV production by 2030. Universities and vocational education institutions must also be given the means to prepare their next generation of knowledge workers for these new technologies. Policy and direction also need to be focused, clear, and funded as well, if Thailand wants to retain its current leadership grasp within the ASEAN automotive manufacturing and auto-parts community.

Keywords: Knowledge management, quality management, supply chain, technological capabilities, Thailand

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1. Introduction

Since the 1960s Thailand has worked to develop policies to create an automotive manufacturing and auto-parts base, which today is still the largest in the Association of Southeast Asian Nations (ASEAN) despite significant and numerous challenges in recent years to this title from countries such as Malaysia and Indonesia. Furthermore, in 2021, Thailand's bumpy economic ride is now being attributed to the Covid - 19 pandemic, computer chip and container shortages, supply-chain disruptions (e.g. Suez Canal blockage), and the Sino-US trade war(Maikaew, 2019). Therefore, these combinations of factors have seen Thailand's automotive sector drop from contributing 12% of its gross domestic production (GDP) in recent years (Maikaew, 2019), to an estimated 10% GDP in 2021.

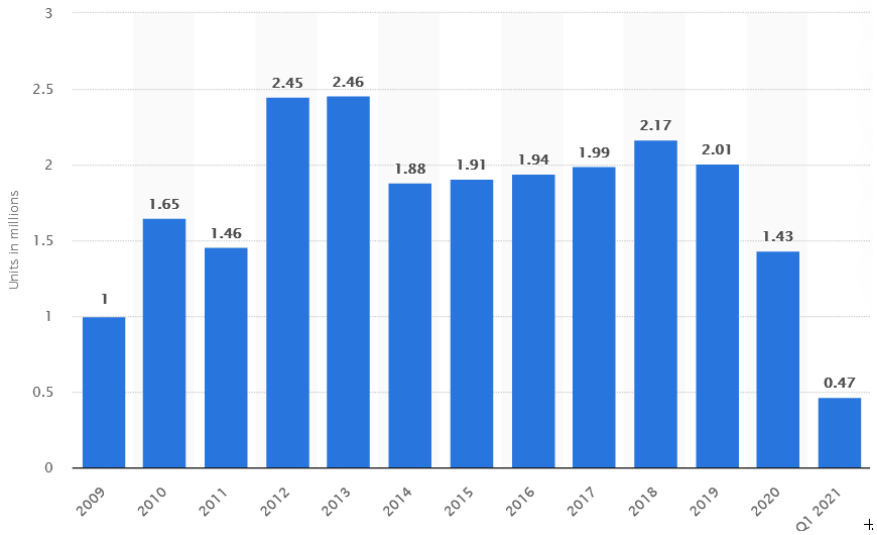
Also, in the vehicle production peak years of 2012 and 2013, over 2.4 million vehicles were produced annually (Chen, 2014). However, this has now dropped to only 1.43 million in 2020 (Figure 1) (Statista Research Department, 2021), with 2021 on track for slightly higher numbers.

As might be expected, Thailand's automotive supply-chain and its management have been a focus of numerous scholarly and organizational studies, especially its small-medium enterprises (SMEs) (Organisation for Economic Co-operation and Development, 2018). Moreover, recent industry studies have suggested that at one point, there were approximately 1,800 automotive manufacturers and parts suppliers employing 850,000 workers. Of these, 1,100 were Thai owned Tier 2 or Tier 3SME vehicle and motorcycle parts suppliers (Yongpisanphob, 2019). It is also significant to note that Thailand's automotive parts are distributed to over one hundred countries worldwide (Petcharit et al., 2020), with recent data showingThailandranked 13th overall in auto parts and 12th in vehicle production (Maikaew, 2019). Thailand's Board of Investment (BOI) (2016) has also reported that the

Kingdom is the 6th-largest commercial vehicle producer worldwide, and the 2nd - largest manufacturer of one-ton pickup trucks.

However, despite the current bumpy ride, Thailand can still claim to be one of the largest markets for vehicles in Southeast Asia, with Thailand's vehicle production reaching 470,000 units in the first quarter of 2021 (Statista Research Department, 2021). Moreover, when compared to the rest of ASEAN (Association of Southeast Asian Nations) in 2020, Thailand was still the leader in vehicle production, still surpassing Indonesia and Malaysia volumes.

Figure 1. Thai vehicle production from 2009 through 2021's quarter one



Looking forward domestically, the future is a little dim for the replacement equipment manufacturers (REM) auto parts sector even thoughdata from 2016 showed there were 16.24 million accumulative registered vehicles, up from 9.74 million in 2008 (Yongpisanphob, 2018). However, at the end of 2020the auto parts sector had contracted along with the main vehicle manufacturing sector (Figure 1). Moreover, Yongpisanphob (2020) stated that the OEM market and associated supply chains were the hardest hit by the Covid-19 pandemic, with the REM market coming out somewhat better due to an expansion of the nation's vehicle fleet and the refurbishing of older vehicles to extend their life. Looking ahead, Thailand aims to produce 1.43 million electric vehicles (EVs) per year by 2030. This total includes 725,000 automobiles and pickups, 675,000 motorcycles, and 34,000 EV buses and trucks (Praiwan, 2021). If the goals are to be met, there will need to be a massive re-tooling of the Thai automotive industry as well as the re-education of the workforce due to the disruptive change this will entail (Petcharit et al., 2020). Both are no small tasks if the Kingdom wishes to maintain its competitive advantage.

2. Literature Review

2.1. Technological Capabilities (TC)

In a report on Thailand's automotive industry innovation capability, Komolavanijet al. (2011) reported on the importance of technology transfer and innovation capabilities between the manufacturers and the Thai domestic suppliers. Moreover, Rush et al.(2007) has developed an instrument for measuring technological capability which included nine areas. From the use of this, Komolavanijet al. (2011) determined that there were four types (Type A – Type D) of Thai automotive firms and their TC. These included *Type-A* firms which were *passive* or *unaware.* Additionally, there are the firms which are *reactive*(*Type-B)* which understand their need to stay abreast of newer technologies, but lack the capabilities, skills, or responsive ability to do so. Moving up the TC scale are firms which think strategically (*Type-C),* use forward-thinking, have more capability, and clearer viewsof technology priorities. Finally, in Thailand the*Type-D* enterprises have extensive *creative* assets, which includeknowledge-intensive, fully developed capabilities, that can redefine the technology frontier and challenge existing business models and create new markets.Finally, older and well-established companieswhich are owned by foreign operators are seemingly better prepared to absorb technology and innovation.

2.2. Knowledge Management (KM)

In today's information-critical age, a smartphone-enabled, Internet-connected '*knowledge worker*' has become a critical element for both a firm and a nation's competitive advantage. Also, some believe that the economic value of knowledge is more than the value of the physical product (Alipour et al. 2010), with knowledge acting as the foundation for stable development and organizational CA (Ruggles 1998). This is consistent with a study of the

Thai automotive industry by Chomphuka et al. (2018) in which the authors wrote that a firm's capabilities in KM can stimulate and raise a firm's capacity and capability sharing, circulating, or transferring information and skills. Therefore, this enhances a firm's accessibility and exploitability. Moreover, their organizational competition creates new knowledge through a process of sharing and conversion of this knowledge into new products or services (Jyoti et al., 2015). Similarly, KM is an intervening mechanism that influences firm effectiveness (Zheng et al. 2010).

2.3. Quality Management (QM)

Various scholars have suggested that there are a multiplicity of factors involved affecting QM and the ability to provide it. According to Chahal (2015), aspects involved in QM include the firm's ability to focus on their customer, their ability to improve continuously, and their human resource management (HRM) policies and procedures. However, research at Toyota has suggested that QM process assessment is highly challenging (Kozaki et al., 2010).

2.4. Supply Chain (SC)

Barriers to effective supply chain management are many (Pearson, 2009). However, solutions can be found in technological advances and closer decision-maker collaboration (Butcher, 2007; Disney et al., 2008; Pearson, 2009). The critical nature of the supply chain within the automotive industry has also been highlighted globally in 2021 in numerous articles and media discussions due to a massive disruption in critical components and shipment disruptions (Suez Canal blockage), container shortages, and computer chip shortages (speculated to be due to an increase in smartphones and computer sales from Covid 19 lockdowns (Isidore, 2021). Barrak et al. (2017) has also noted the critical importance of supply chain management (SCM) in maintaining good financial results, reporting that as inventory increases relative to sales, manufacturing efficiency decreases. However, today the problem is not that there are too many parts, but not enough.

2.5. Competitive Advantage (CA)

In Thailand Kaewchur et al. (2021) examined factors affecting SME CA and indicated that competitiveness is crucial to SME survivability, which finds its foundation in a firm's ability to differentiate a company's products or services. This is consistent with Atchara (2017) who also reported that in Thailand, low cost, differentiating products or services, and quick response were key factors in CA. In Ethiopia, Atnafu and Balda (2018) added that CA is focused on price, product quality, and delivery speed.

2.6. Research Objectives

(1) To investigate which theory-supported variables have the highest potential of affecting a Thai automotive industry's firm competitive advantage.

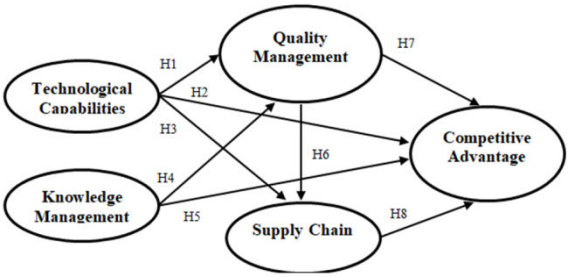
(2) To evaluate the model's fit through the use of a CFA, followed by model confirmation using a structural equation model of the conceptualized hypotheses.

2.7. Conceptualization of the Research Hypothesis

From the qualitative analysis it was established that the latent variables TC, KM, QM, and SC were theory supported candidates which could affect the Thai automotive industry CA. Therefore, the following eight hypotheses were conceptualized for the model's CFA and SEM analysis (Figure 2):

H1: Technological Capabilities (TC) have a direct and positive effect on Quality Management (QM).
H2: Technological Capabilities (TC) have a direct and positive effect on Competitive Advantage (CA).
H3: Technological Capabilities (TC) have a direct and positive effect the Supply Chain (SC).
H4: Knowledge Management (KM) has a direct and positive effect on Quality Management (QM).
H5: Knowledge Management (KM) has a direct and positive effect onCompetitive Advantage (CA).
H6: Quality Management (QM) has a direct and positive effect on the Supply Chain (SC).
H7: Quality Management (QM) has a direct and positive effect on Competitive Advantage (CA).
H8: The Supply Chain (SC) has a direct and positive effect on Competitive Advantage (CA).

Figure 2. Thai automotive industry competitive advantage conceptual model



3. Methodology

3.1. Questionnaire Development

The qualitative analysis led us to the determination for the latent variables and 25 observed variables that we used for the study. From this, a six-section questionnaire was drafted consisting of section 1's personal and firm-related information including gender, age, education level, position, the firm's age, and the number of employees. Sections 2-6 utilized a seven-level scale to determine each individual's level of agreement with the questionnaire item. Moreover, part 2 covered five items about TC, part 3 covered five items about KM, part 4 covered five items about QM, part 5 covered five items concerning the SC, and finally, part 6 covered five items about CA.

Furthermore, five experts from both our university and the private automotive sector volunteered to help with the survey's reliability and validity assessment prior to its introduction to a pilot-test group of 30 individuals. During the weekend round-table discussion, each expert was asked to read each questionnaire item and rank its seven-level response appropriateness, importance, and language use. At this point, Tuner and Carlson (2003) have suggested that it is common to use the Index of Item-Objective Congruence (IOC) establish each item's content validity. From this process, all the experts rated each item significantly above the IOC acceptable value of ≥ of 0.50. Moreover, the item measurement units used were *strongly agreed* (6.50-7.00), *very much agree* (5.50–6.49), *agree* (4.50–5.49), *disagree* (3.50–4.49), *somewhat disagree* (2.50–3.49), and finally, *strongly disagree* (1.00–1.49). Finally, from the pre-test of 30 individuals who did not participate in the final survey, Cronbach's α was used to do a content validity assessment of the survey. The values for α were 0.89 – 0.93 (Table 4), which is considered excellent.

3.2. Population, Sample, and Data Collection

The population for the study consisted of automotive industry entrepreneurs, specialist vehicle operators, and auto parts manufacturers' managers in Thailand in 2020. To determine sample size, various scholars have suggested multiple methods and techniques. One common method suggests in studies using CFA modelsthat 200 individuals are sufficient to assure reliability. Another common method suggested by Schumacker & Lomax (2010) and Hair et al. (2011) is to use 10-20 questionnaires per latent variable. Finally, systematic random sampling was used to select the initial 600 questionnaire candidates, from which 515 individuals'questionnaires were finally determined to be acceptable for analysis. All these individuals were working within the Thai automotive industry in Bangkok's metroarea or in industrial estates on Thailand's Eastern Seaboard were used (Yongpisanphob, 2018) (Table 1).

Table 1. Thai automotive industry entrepreneur sampling groups and classifications

Individual classifications	Target sample size	Actual sample size
Specialized vehicle operators Sub-Total	300	261
- large and medium-sized passenger cars	75	69
- emergency vehicles such as ambulances	75	68
- modified small trucks	75	73
- armored cars	75	51
Auto parts manufacturer executives Sub-Total	300	254
- large and medium-sized passenger cars	75	61
- emergency vehicles such as ambulances	75	69
- modified small trucks	75	71
- armored cars	75	53
Total	600	515

3.3. Data Analysis

LISREL 9.1 software was used to undertake the descriptive statistics analysis, which included the *mean*$(\overline{x})$*, standard deviation* (S.D.), *kurtosis*, and *skewness.*

3.4. Ethics clearance

Before the beginning of the meeting with the panel of experts and the resultant pilot-test questionnaire distribution, ethics clearance was obtained from the Human Ethics Committee from our university(**Pimdee, 2020).**Subsequently, all survey participants were asked to read and sign a statement that they had been made aware of the intent of the study's survey and that the researchers would make every effort to maintain the confidentiallyof all who participated.

4. Results

4.1. Characteristics of the Respondents

In Table 2the details from the questionnaire concerning each respondent's general characteristics. First, we see that there the majority of the respondents were male (61.55%) and were entrepreneurial business owners (80.39%). Ages ranged widely with the majority of 31.65% being 31 - 40 years old. Slightly less than half had an undergraduate degree (45.63%), with another 28.74% having had post-graduate studies. Interestingly, 45.05% of the firms had been in business for 10 years or more. Once again, firm employee size ranged widely with 33.40% having 51-100 employees, 27.77% having 101-150 employees, and 23.11% with less than 50 employees.

Table 2. Characteristics of Thai auto industry entrepreneurs and managers

Characteristics	Frequency	Percent
Gender		
- Male	317	61.55
- Female	198	38.45
Age		
- Under 30 years of age	50	9.71
- Between 31-40 years of age	163	31.65
- Between 41-50 years of age	148	28.74
- Between 51-60 years of age	115	22.33
- Over 60 years of age	39	7.57
Education level		
- High school or vocational school diploma	132	25.63
- Bachelor's degree	235	45.63
- Postgraduate studies	148	28.74
Job title		
- Business owner	414	80.39
- Manager / Management	101	19.61
Business classification		
- Company	419	81.36
- Partnership	96	18.64
Age of business		
- Under 1 year	31	6.02
- 1-5 years	121	23.50
- 6-10 years	131	25.44
- More than 10 years	232	45.05
Firm employees		
- 50 people or less	119	23.11
- 51-100 people	172	33.40
- 101-150 people	143	27.77
- 151-200 people	48	9.32
- Over 200 people	33	6.41

4.2. CFA for the Model's Goodness-of-Fit (GoF)

Table 3 details the results from the study's LISREL 9.1 CFA. In it we see that each of the criteria used exceeded thresholds established by the theory. Therefore, the data fit well with the model.

Table 3. The GoF analysis criteria, theories, and the study's GoF values

Criteria Index	Criteria	Supporting theory	Study's Values	Results
Chi-square: $\chi 2$	$p \geq 0.05$	Rasch, 1980	0.40	passed
Relative Chi-square: $\chi 2/df$	≤ 2.00	Byrne et al.,1989	1.02	passed
RMSEA	≤ 0.05	Hu & Bentler, 1999	0.01	passed
GFI	≥ 0.90	Jöreskog et al., 2016	0.97	passed
AGFI	≥ 0.90	Hooper et al., 2008	0.95	passed
RMR	≤ 0.05	Hu & Bentler, 1999	0.01	passed
SRMR	≤ 0.05	Hu & Bentler, 1999	0.01	passed
NFI	≥ 0.90	Schumacker & Lomax, 2010	0.99	passed
CFI	≥ 0.90	Schumacker & Lomax, 2010	1.00	passed
Cronbach's α	≥ 0.70	Tavakol & Dennick, 2011	0.89 - 0.96	passed

4.3. CFA of the Endogenousand Exogenous Latent Variables and Observed Variables

Table 4 details the LISREL 9.1 CFA results for the 25 observed variable items, the five latent variables, and the αresults from the pilot survey.

Table 4. Results of the CFA analysis

Latent variables	α	AVE	CR	Observed variables	Loading	R^2
Technological Capabilities (TC)	0.92	0.69	0.92	My organization has research and development capabilities (x1).	0.88	.78
				My organization makes quality products (x2).	0.94	.87
				My organization sets competitive prices (x3).	0.76	.58
				My organization can develop production technology and production processes (x4).	0.77	.59
				My organization has marketability (x5).	0.78	.61
Knowledge Management (KM)	0.93	0.68	0.91	My organization has excellent knowledge management processes (x6).	0.73	.53
				My organization can disseminate knowledge between employees, vendors, and customers (x7).	0.86	.75
				My organization shares and exchanges knowledge (x8).	0.87	.75
				My organization makes an effort to protect intellectual property and proprietary product knowledge (x9).	0.84	.70
				My organization can absorb knowledge (x10).	0.82	.67
Quality Management (QM)	0.96	0.73	0.93	My organization has established a quality management process (y1).	0.86	.73
				My organization is continually improving (y2).	0.84	.70
				My organization utilizes strategic planning (y3).	0.87	.75
				My organization has a quality-focused culture (y4).	0.90	.80
				My organization is focused on efficiency and quality (y5).	0.81	.66
Competitive Advantage (CA)	0.92	0.71	0.92	My organization is competitive in the bidding process (y6).	0.73	.54
				My organization uses materials whose quality offers competitive advantage (y7).	0.87	.76
				My organization emphasizes product differentiation (y8).	0.85	.73
				My organization focuses on products that are difficult to imitate, such as comfort-oriented	0.88	.78

				interior design and decoration (y9).		
				The organization can reduce costs (y10).	0.88	.77
Supply Chain (SC)	0.89	0.70	0.92	My organization selects reputable and quality business partners (y11).	0.77	.59
				My organization has developed strong supply chain processes (y12).	0.78	.60
				My organization is constantly developing new supply chain processes (y13).	0.86	.74
				My organization has established a supply chain emergency plan and crisis management system (y14).	0.94	.88
				My organization is focused on customer service (y15).	0.81	.66

4.4. SEM Reliability and Internal Consistency Testing

Table 5 details each latent variable's correlation coefficient (r) value, its mean, and S.D. From the internal consistency values we can see that construct reliability (CR) was achieved for all the latent variables as the values ranged from a low of 0.76 to a high of 0.90 (Phadungjit et al., 2020). Also, from Table 5 we can see that the strongest relationship pair was between QM and KM (r = 0.90), which was followed closely by the relationship between KM and TC (r = 0.89). Finally, the weakest relationship pair was between SC and TC (r = 0.76).

Table 5. The correlation matrix of the construct reliability analysis

Latent Variables	TC	KM	QM	SC	CA
Technological Capabilities (TC)	**1.00**				
Knowledge Management (KM)	.89**	**1.00**			
Quality Management (QM)	.85**	.90**	**1.00**		
Supply Chain (SC)	.76**	.78**	.81**	**1.00**	
Competitive Advantage (CA)	.81**	.83**	.86**	.85**	**1.00**
Mean	5.69	5.73	5.78	5.74	5.71
S.D.	1.00	.97	.98	.92	.95

***Sig. < .01*

4.5. SEM Reliability Results

From the results shown in Table 6 several determinations can be made. First, we note that when all the variables are factored in, their total combined influence reaches 78% on a Thai automotive industry's CA. Second, all the causal variables had a positive effect on CA and when ranked in order from highest to lowest, they were QM, the SC, KM, and TC, with TE values of 0.72, 0.68, 0.45, and 0.44, respectively.

Table 6. Mediation effects on Thai automotive industry CA

Dependent variables	R^2	Effect	Independent variables			
			TC	KM	QM	SC
Supply Chain (SC)	0.79	DE	0.23*	-	0.68**	
		IE	0.25**	0.41**	-	
		TE	0.48**	0.41**	0.68**	
Competitive Advantage (CA)	0.78	DE	0.03	0.01	0.27*	0.68**
		IE	0.41**	0.44**	0.45**	-
		TE	0.44**	0.45**	0.72**	0.68**
Quality Management (QM)	0.90	DE	0.37**	0.61**		
		IE	-	-		
		TE	0.37**	0.61**		

**Sig. < .05, **Sig. < .01*

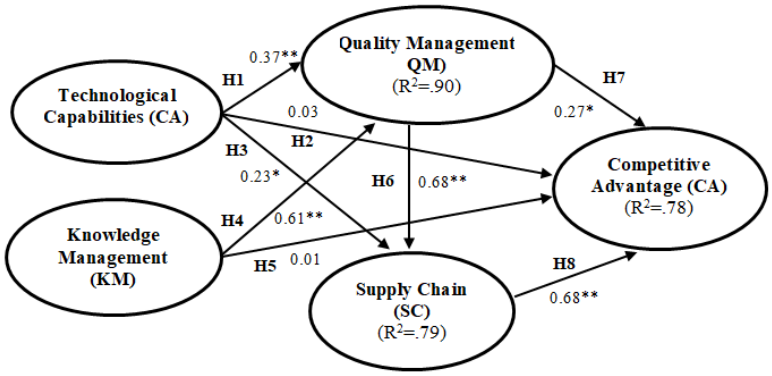
Table 7 and Figure 3 present the final SEM results of the hypotheses testing.

Table 7. Results of the hypotheses testing

Hypotheses	Coef.	t-test	Results
H1: Technological Capabilities (TC) have a direct and positive effect on Quality Management (QM).	0.37	5.50**	consistent
H2: Technological Capabilities (TC) have a direct and positive effect on Competitive Advantage (CA).	0.03	0.41	inconsistent
H3: Technological Capabilities (TC) have a direct and positive effect the Supply Chain (SC).	0.23	2.58*	consistent
H4: Knowledge Management (KM) has a direct and positive effect on Quality Management (QM).	0.61	8.83**	consistent
H5: Knowledge Management (KM) has a direct and positive effect on Competitive Advantage (CA).	0.01	0.22	inconsistent
H6: Quality Management (QM) has a direct and positive effect on the Supply Chain (SC).	0.68	7.33**	consistent
H7: Quality Management (QM) has a direct and positive effect on Competitive Advantage (CA).	0.27	2.48*	consistent
H8: The Supply Chain (SC) has a direct and positive effect on Competitive Advantage (CA).	0.68	8.32**	consistent

**Sig. < .05, **Sig. < .01*

Figure 3. Thai automotive industry competitive advantage final model



5. Discussion

From the SEM analysis, six of the study's eight hypotheses were supported. From the hypotheses testing results in Table 7 as well as Figure 2 we find the six supported hypotheses from strongest to weakest were H6 (r = 0.68) and H8 (r = 0.68) with near-identical strengths. These were followed by H4 (r = 0.61), H1 (r = 0.37), H7 (r = 0.27), and H3 (r = 0.23). It should also be noted that Pearson'sr suggests that relationships are strong when values range from 0.50 – 1, they are moderate when they range from 0.30 – 0.49 and are somewhat weak when the values are from 0.10 - 0.29 (Akoglu, 2018; Ratner, 2009). Other researchers have reported that construct validity (CV) is acceptable when the t-values are ≥ 1.96 and the standardized factor loadings ≥ 0.60 (Chuenban, 2021).Moreover, from the use of LISREL 9.1's descriptive statistics analysis of the $\bar{x}$, S.D., skewness, and kurtosis it was determined that *quality management* (QM) was the single most important variable overall on the Thai automotive industry's *competitive advantage*. Hair et al. (2016) have also suggested that data is considered '*normal*' if skewness is between -2 to +2, and kurtosis is between -7 to +7. Therefore, using the above criteria, Tables 8 - 12 are presented as well as their analysis from the results of the descriptive statistics.

5.1. Technological Capabilities (TC)

Table 8 details how the respondents' viewed each item's importance. From the item descriptions, we further note the importance placed in *production technology and processes* (x4) ($\bar{x}$ = 5.86, S.D. = 1.16). This was followed in importance by the *ability to produce quality products* (x2) ($\bar{x}$ = 5.73, S.D. = 1.19), and *competitive pricing* (x3) ($\bar{x}$ = 5.67, S.D. = 1.18). These results are consistent with Atnafu and Balda (2018) who reported that firms should focus on price, product quality, and delivery speed to assure their CA. It should also be noted that similar Thai automotive industry studies have suggested that TC is accelerated with older, established firms due to their overseas strategic mother firms (Komolavanij et al., 2011). This suggests that younger firms might have more difficulty in TC areas.

Table 8. Final descriptive analysis results for Thai automotive industry technological capabilities variables

TC questionnaire items	Mean	S.D.	Skewness	Kurtosis
My organization has research and development capabilities (x1).	5.54	1.10	-.61	-.01
My organization makes quality products (x2).	5.73	1.19	-.77	-.13
My organization sets competitive prices (x3).	5.67	1.18	-.79	.38
My organization can develop production technology and production processes (x4).	5.86	1.16	-.96	.34
My organization has marketability (x5).	5.62	1.10	-.55	-.43
Overall results	5.69	1.00	-.88	.25

5.2. Knowledge Management (KM)

Table 9 details how the respondents' viewed each item's importance. From the item descriptions, we further note the importance placed in *knowledge collection*(x10) ($\overline{x}$ = 5.83, S.D. = 1.16). This was followed in importance by the ability of *knowledge communications and dissemi*nation (x7) ($\overline{x}$ = 5.78, S.D. = 1.12), and the protection of intellectual property (x9) ($\overline{x}$ = 5.76, S.D. = 1.16).

Table 9. Final descriptive analysis results for Thai automotive industry knowledge management variables

KM questionnaire items	Mean	S.D.	Skewness	Kurtosis
My organization has excellent knowledge management processes (x6).	5.65	1.09	-.64	-.16
My organization can disseminate knowledge between employees, vendors, and customers (x7).	5.78	1.12	-.78	.00
My organization shares and exchanges knowledge (x8).	5.64	1.12	-.59	-.33
My organization makes an effort to protect intellectual property and proprietary product knowledge (x9).	5.76	1.07	-.75	.00
My organization can collect and absorb knowledge (x10).	5.83	1.16	-.75	-.32
Overall results	5.73	.97	-.88	.17

5.3. Quality Management (QM)

Table 10 details how the respondents' viewed each item's importance. From the item descriptions and values, we can easily see the greater importance that the respondents placed on QM's items. Specifically, we note that both y1 (*quality management process*) and y3 (*strategic planning*) were judged as the most important QM items. This was closely followed by y2 (*continual improvement*) and y4 (*focus on quality*).

Table 10. Final descriptive analysis results for Thai automotive industry quality management variables

QM questionnaire items	Mean	S.D.	Skewness	Kurtosis
My organization has established a quality management process (y1).	5.82	1.09	-.96	.61
My organization is continually improving (y2).	5.79	1.13	-.80	.03
My organization utilizes strategic planning (y3).	5.82	1.10	-.94	.58
My organization has a quality-focused culture (y4).	5.79	1.08	-.90	.45
My organization is focused on efficiency and quality (y5).	5.65	1.09	-.71	-.08
Overall results	5.78	.98	-1.13	1.14

5.4. Competitive Advantage (CA)

Table 11 details how the respondents' viewed each item's importance. From the item descriptions, we further note the importance placed in *competitively priced quality prod*ucts (y7) ($\overline{x}$ = 5.76, S.D. = 1.12). This was followed in importance by *product uniqueness and beauty* (y9) ($\overline{x}$ = 5.73, S.D. = 1.09). Furthermore, Hazen and Byrd (2012) have added that logistics information technology (LIT) can promote enhanced levels of effectiveness, efficiency, and resiliency for the adopting firm. Rugraff (2012) has also concluded that an automotive industry's firm survivability is dependent on the firm's ability to internationalize their production, with their CA tied to the firm's capacity to dynamically combine the oversight of their internal and external transactions.

Table 11. Final descriptive analysis results for Thai automotive industry competitive advantage variables

CA questionnaire items	Mean	S.D.	Skewness	Kurtosis
My organization is competitive in the bidding process (y6).	5.68	1.10	-.87	.59
My organization uses materials whose quality offers competitive advantage (y7).	5.76	1.12	-.81	.30

My organization emphasizes product differentiation (y8).	5.67	1.04	-.75	.46
My organization focuses on products that are difficult to imitate, such as comfort-oriented interior design and decoration (y9).	5.73	1.09	-.81	.57
The organization can reduce costs (y10).	5.71	1.05	-.89	.79
Overall results	5.71	.95	-.93	.80

5.5. Supply Chain (SC)

Table 12 details how the respondents' viewed each item's importance. From the item descriptions, we further note the importance placed on *customer service* (y15) ($\overline{x}$ = 5.83, S.D. = 1.15). This was followed in importance by *establishing a supply chain emergency plan and crisis management system* (y14) ($\overline{x}$ = 5.7, S.D. = 1.06), and an *ongoing supply chain development process* (x13) ($\overline{x}$ = 5.75, S.D. = 1.07). These factors were found to be consistent with other studies in which the management of the supply chain by SMEs was found to be problematic if the SME did not have larger customers or strategic partners (Thakkar et al., 2012). However, Arend and Wisner (2005) have also noted that supply chain management can expose an SME to greater management and control hazards while reducing the firm's private differentiation advantages. Also, in a US report on disaster supply chain management, the authors stated that the supply chain process design and management is a key element, which is a commercialsupply chain, the objectives are to minimize cost and provide good customer service (Haghani&Afshar, 2009).

Table 12. Final descriptive analysis results for Thai automotive industry supply chain variables

SC questionnaire items	Mean	S.D.	Skewness	Kurtosis
My organization selects reputable and quality business partners (y11).	5.69	1.07	-.83	.63
My organization has developed strong supply chain processes (y12).	5.67	1.04	-.84	.82
My organization is constantly developing new supply chain processes (y13).	5.75	1.07	-.81	.50
My organization has established a supply chain emergency plan and crisis management system (y14).	5.76	1.06	-.86	.84
My organization is focused on customer service (y15).	5.83	1.05	-1.00	1.47
Overall results	5.74	.92	-1.09	1.67

6. Conclusion

The study set out to examine which factors affected competitive advantage within the Thai automotive industry. The qualitative research uncovered that through a variety of factors, the automotive sector in Thailand has found itself upon a very bumpy road since its peak years of 2012 and 2013**.** Additionally, a Thai national policy has been established to transition to EVs which will require extensive re-tooling and re-education of each firm's 'knowledge worker'. Robotics is another key factor in this transition as well. Therefore, to maintain Thailand's automotive leadership within ASEAN and maintain a competitive advantage on a global scale, this study's entrepreneurs and managers felt the key factor was their firm's ability at quality management. Specifically, quality management should be focused on the *quality management process* and *strategic planning,* as well as*continual improvement* and the *focus on quality*. These factors were closely followed in importance by the supply chain and each firm's ability to provide good *customer service,* having *a supply chain emergency plan and crisis management system, and finally,* an *ongoing supply chain development processes.* Somewhat secondary in importance were knowledge management and technological capabilities.

7. Recommendations

The research suggests that strategic partnerships with larger, international supply chain vendors are one recognized method at enabling a more secure competitive advantage. Moreover, firms need to ensure that they do their utmost to enable customer service within their supply chains as this is a critical element in maintaining a competitive advantage. Furthermore, it needs to be understood by government policymakers that their support for the Thai automotive industry needs to be structured in a way that addresses the needs of each type of firm's technological capability. Moreover, research & development incubators need to be established, especially in light of the Thai government's direction into EVs and the stated goal of 30% EV production by 2030. Universities and vocational education institutions must also be given the means to prepare their next generation of knowledge workers for these new technologies, infrastructure, and environments. Policy and direction need to be focused, clear, and funded as well, if Thailand wants to retain its current leadership grasp within the ASEAN automotive manufacturing and auto-parts community.

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