Structural Equation Model of the Variables that Influence Thai Automotive Parts Industry Efficiency

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Abstract: With shipments headed for more than 100 countries, Thailand is the 13th largest automotive parts exporter and the sixth-largest commercial vehicle manufacturer globally, with over 60% of its 100 largest auto part suppliers having its production hub in Thailand.Thus, researchers set out to investigatehow *strategic planning* (STY), *technology and innovation* (TIN), *product quality* (QLY), *total quality management* (TQM), and *knowledge management* (KNG) affected a firm's *efficiency* (EFF). From the approximate 2,500 automotive-related firms based in Thailand, the authors using lists from multiple private and governmental agencies, eventually obtained 455 questionnaires from firm owners, executives, and managers from May 2017 to October 2017.The structural equation model (SEM) analysis between variables influencing EFF was conducted utilizing a latent variable LISREL 9.10path analysis and a goodness-of-fit (GOF) assessment. Results from the nine hypotheses SEM revealed support for seven of the study's conceptualized relationships. Also, all the causal variables in the SEM were determined to positively affect EFF, which was concluded due to the combined variance of the factors affecting EFF (R (^{2}by 71%.Finally, EFF was shown to be influenced by five variables, and when ranked in importance were STY, TQM, QLY, TIN, and KNG with total effect (TE) values of 0.79, 0.75, 0.39, 0.12, and 0.08, respectively.

Keywords: Automotive assembly, CLMV countries, SEM,technology, and innovation, Thailand

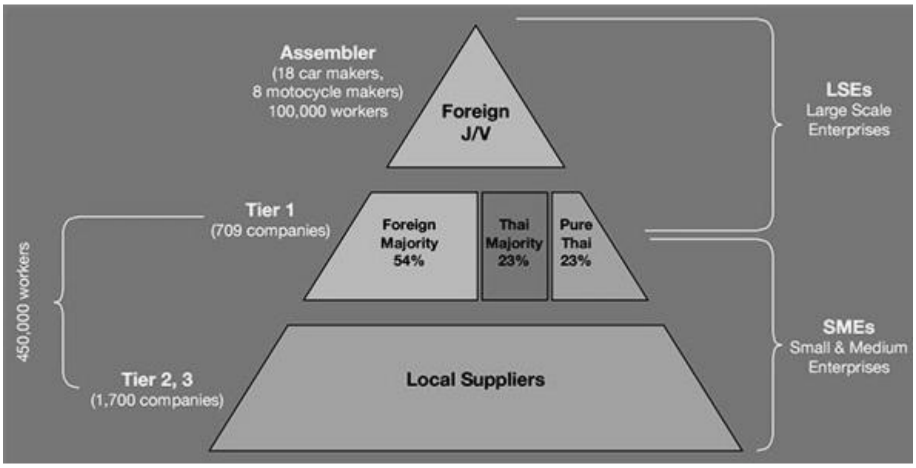
Introduction

With shipments headed for over 100 countries, Thailand is the 13th largest automotive parts exporter and the sixth-largest commercial vehicle manufacturer globally. More than 60% of the world's 100 largest auto part suppliers have their production hub in Thailand, with local parts manufacturers supplying 80-90% of the parts used in auto vehicle production within the Kingdom.

In 2017, Thailand held 12th place in global vehicle production with 1.989 million units, although this represents a significant reduction from the production peak years of 2012 and 2013 (2.454 and 2.457 million units, respectively) (Maikaew, 2019a). On a regional level, Thailand is the largest car manufacturer in Southeast Asia (Phoonphongphiphat, 2018), with 18 car assembly plants, eight motorcycle plants, 709 tier-one auto parts makers, and 1,700 tier-two and tier-three auto parts makers (Figure 1). It possesses the most vital automotive cluster in Southeast Asia, employing 850,000 people and contributing 12% of its GDP (Dansomboon et al., 2016; Maikaew, 2019b; Phoonphongphiphat, 2018). The Federation of Thai Industries (FTI) estimates exports of automotive products at $30.192 billion in 2018, up from $29.906 billion the year before.

However, other emerging economies such as Vietnam and Indonesia are developing an automotive industry, learning from Thailand's mistakes and experiences. This means Thailand needs to examine its automotive core competencies to adapt to industry upgrades necessary to meet global demands (Dansomboon et al., 2016). Also, therehasbeenatrendwithinJapanesecompanies inThailandto advanceinto neighboringcountries, called'*Thailand-Plus-One*,' withmorethan 50% targetingcountriesalong the MekongRiver, including Cambodia,Laos,Myanmar,and Vietnam(CLMVcountries) (Economic Intelligence Center, 2016).

Figure 1. Thai automotive industry structure



Source: Thai Auto Parts Manufacturers Association (TAPMA)

Therefore, the authors examined other factors leading to increasing Thai auto parts manufacturing enterprise efficiency. From an extensive literature review, one factor often presented was the need for strategic planning (STY). Another related area is how an organization uses technology and innovation (TIN) to manage its supply chain and information sharing. Also, TIN becomes critical in product development and process design. According to Bessant and Tidd(2013), product innovation is a significant component in the growth and is the lifeblood of many technology industries, with solid planning processes enabling adaptation in the face of extreme supply and demand volatility.

Another factor important to the study is product quality (QLY). As part of the *kaizen* technique of continuous improvement pioneered in Japan, the Japanese auto parts manufacturer Daisin Thailand uses visual aids and quality-control reports posted to the walls of the lounges to keep up with its Japanese competitors (Fujimura & Katsuki, 2015). Some authors have also stated that increasing global competition has forced automotive companies to improve quality and efficiency (Goicoechea & Fenollera, 2012). Others define product quality as a measure of the rate of defects and development, which then becomes a compound evaluation of quality, delivery, cost, and overall capability (Borgström & Hertz, 2011).

The authors also chose total quality management (TQM) for its great importance as it is a fundamental change in how most enterprises manage their business. AccordingtoEvans**(**2017**)**, TQMinvolvessix basic management concepts: customer focus, process orientation, continuous improvement, empowerment and teamwork, management by fact, and visionary leadership. Also, according to Friedman (2008), the goals of TQM are to eliminate waste, improve quality, shorten lead times, reduce costs, improve morale, and foster an environment in support of continuous improvement.

Furthermore, tightly connected to good TQM processes is a firm’s ability to conduct effective knowledge management (KNG), with Kocoglu et al. (2012) finding that the development of absorption and adaptation of technologytogainexposuretonewthingsisessential forsustainablecompetitiveadvantage. This process must focus on knowledge management, learning, technology, andproductioncapabilities,whichalsoserveas the basis for innovation and organizational performance.

Research Objective

Therefore, the preliminary research was used to find ideas that led to better efficiency within the Thai automotive parts manufacturing industry. From this process, a questionnaire was developed that used a confirmatory factor analysis (CFA), followed by SEM path analysis to investigate the variables that affect the efficiency of the automotive parts manufacturing industry in Thailand. Therefore, we hope that the research results will provide valuable information for companies' strategic planning and management that can better meet customer needs.

Conceptual Model

The researchers, therefore, synthesized the extensive body of literature and concluded determined that an auto parts firm's efficiency (EFF) was affected by a variety of variables, including strategic planning (STY), technology and innovation (TIN), product quality (QLY), total quality management (TQM), and knowledge management (KNG). From this, the following nine hypotheses and conceptual framework were developed (Figure 2):

H1: STY directly and positively influences TQM.

H2: STY directly and positively influences QLY.

H3: TIN directly and positively influences n QLY.

H4: TIN directly and positively influences KNG.

H5: TIN directly and positively influences EFF.

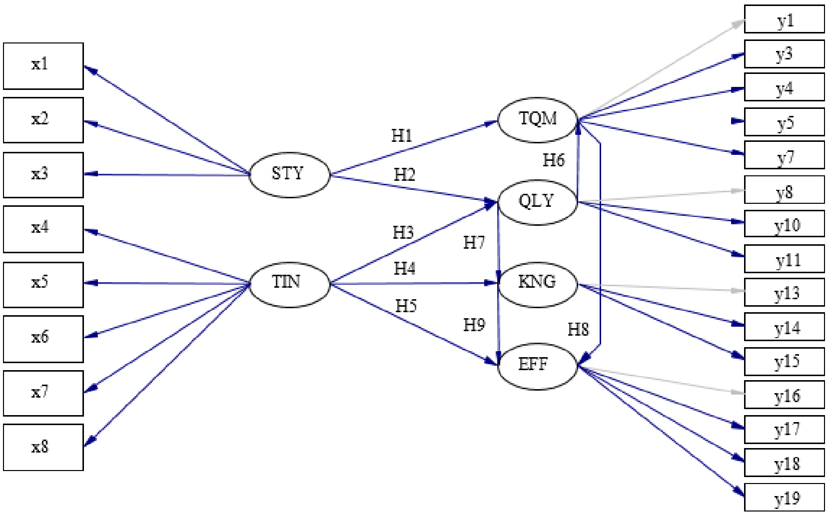
H6: QLYdirectly and positively influences TQM.

H7: QLY directly and positively influences KNG.

H8: TQM directly and positively influences EFF.

H9: KNG directly and positively influences EFF.

Figure 2. The conceptual framework



Methods

Population and sample

The population for the analysis included the managers, executives, and owners of the roughly 2,500 firms (Maikaew, 2019a) operating in Thailand as Tier 1, Tier 2, and Tier 3 auto parts producers and suppliers. The initial sample of 660 individuals was derived from a simple random sampling process from multiple lists detailing company and contact information. These lists were obtained from the Thai Auto-Parts Manufacturers Association (TAPMA), the Thailand Board of Investment (BOI), the Thai Automotive Industry Association, the Thai Commerce Ministry, and the Thailand Automotive Institute (TAI).

Starting in May 2017, initial contact was made via email to solicit each individual to participate in the survey. Follow-up phone calls were made to each party approximately two weeks after the initial contact. From this process, over six months, 159 questionnaires were eventually returned from Tier 1 company representatives and another 501 from Tier 2 and Tier 3 companies. From the initial 660 questionnaires collected, and after an audit process to determine usability and completeness of the survey, 455were found acceptable.

The research tools

The research instrument was a two-section, 30 item questionnaire. Section 1 contained seven items concerning the respondent's personal information, such as their gender, age, education level, business experience, and their firm's number of employees (Table 1). Section 2 of the questionnaire used a five-level Likert agreement scale to access the respondent's level of importance they placed on each item, with '5' indicating 'strongly agree = -4.50 5.00,' '3' indicating 'moderate agreement 3.49-2.50,' and '1' indicating 'strongly disagree = 1.49-1.00.' Initial reliability testing for the survey items was calculated using Cronbach's α and ranged from 0.73 – 0.86, ranked as 'good' (Cho & Kim, 2015). This included STY with 3 items (reliability of 0.79), TIN with 5 items (α = 0.86), TQM with 5 items (α = 0.73), QLY with 3 items (α = 0.73), KNG with 3 items (α = 0.73), and EFF with 4 items (α = 0.85). The observed variables and their confirmatory factor analysis (CFA) results and Cronbach's α reliability from the analysis (Table 2 and 3).

Ethics clearance

Ethics approval for the study was obtained from the King Mongkut's Institute of Technology Ladkrabang (KMITL),Human Ethics Committee before consultation with the five experts involved in questionnaire review, the pre-test sample group of 30 management individuals, and the final sample group of 660 managers and executives(Pimdee, 2020). Upon initial contact with each individual, the study's objectives were outlined, and each participant was assured the information obtained was confidential, and no identities would be disclosed.

Data Collection and Analysis

The researchers used the 30 item questionnaire research tool to collect data from the owners and managers of automotive parts manufacturing companies in Thailand from May to October 2017. A survey method was adopted for data collection, whose hypotheses were examined using LISREL (linear structural relations) 9.10 to the collected data (Jöreskoget al., 2016). Also, convergent validity and discriminant validity are used to assess the validity of the testing.

Results

Table 1 details the results from the study's questionnaire. As anticipated, the majority of the 455 respondents were men (59.12%), of which 87.03% identified themselves as either a manager or executive, while the remaining 12.97% indicated that they were the firm's owner. Education levels for the respondents were a bit surprising as only 2.86% had a graduate degree, with most having an undergraduate (44.84%) degree or vocational education accreditation 27.69%. Those with ten or more years experience (43.96%) were significantly higher than the next group of managers with 6 – 10 years of work (27.03%).

Table 1. Thai auto parts EFF survey descriptive analysis (*n* =455)

Gender		Frequency	Percent
Female		186	40.88
Male		269	59.12
	Total	455	100
Age			
Less than 30 years old.		69	15.16
31-40 years old.		140	30.77
41-50 years old.		140	30.77
51-60 years old.		81	17.80
Over60 years old.		25	5.49
	Total	455	100
Education			
Vocational Certificate / Diploma		126	27.69
Bachelor		204	44.84
Master's degree		13	2.86
Other (primary education, secondary education, etc.)		112	24.62
	Total	455	100
Position			
Owner		59	12.97
Manager / Executive		396	87.03
	Total	455	100
Firm Type			
Company		364	80.00
Partnership		91	20.00
	Total	455	100
Business experience			
Less than one year of experience.		25	5.49
1-5 years of experience.		107	23.52
6-10 years of experience.		123	27.03
More than ten years of experience.		200	43.96
	Total	455	100
Number of employees			

Less than 50 employees.	108	23.74
51-100employees.	127	27.91
101-150employees.	122	26.81
151-200employees.	74	16.26
More than 200employees.	24	5.27
Total	455	100

CFA Results

LISREL 9.10 software was used to conduct the study's CFA and SEM (Jöreskog et al., 2016). Anderson and Gerbing (1998) have suggested a two-step analysis be conducted in which analysis of the measurement model and both sets of external and internal variables are conducted separately (Table 2 and Table 3). In the second step, an analysis of the SEM of the two competing models of EFF is measured.

Table 2.CFA of the external latent variables

Latent variables	α	AVE	CR	Observed variables	loading	R^2
Strategic planning (STY)	0.79	0.42	0.68	Cost leadership (x1)	0.59	.34
				Service difference (x2)	0.55	.30
				Target group focus(x3)	0.77	.59
Technology and innovation (TIN)	0.86	0.58	0.87	Supply chain process (x4)	0.75	.57
				Product development (x5)	0.85	.72
				Product and process design (x6)	0.79	.62
				Information sharing (x7)	0.81	.65
				Production line process (x8)	0.57	.32

*Note.*Chi-Square = 3.93, df = 10, *p*-value = 0.95045, RMSEA = 0.000, AVE = average variance extracted, CR (t-value) = critical ratio

Table 3.CFA of the internallatent variables

Latent variables	**α**	**AVE**	**CR**	**Observed variables**	**loading**	**R^2**
Total quality management (TQM)	0.73	0.39	0.76	Leadership (y1)	0.65	.42
				Source quality management (y3)	0.57	.33
				Consumer emphasis (y4)	0.63	.39
				People management (y5)	0.58	.34
				Compensation management (y7)	0.69	.47
Product quality (QLY)	0.82	0.59	0.81	Consistent product specifications (y8)	0.76	.58
				Reliability (y10)	0.69	.48
				Product Features (y11)	0.84	.71
Knowledge management (KNG)	0.79	0.46	0.72	Knowledge acquisition (y13)	0.66	.44
				Knowledge distribution (y14)	0.78	.61
				Knowledge application (y15)	0.58	.34
Efficiency (EFF)	0.85	0.66	0.88	Profitability (y16)	0.87	.76
				Market share (y17)	0.75	.57
				Return on sales (y18)	0.80	.64
				Return on assets (y19)	0.82	.68

Note. Chi-Square = 39.60, df = 53, *p*-value = 0.91375, RMSEA = 0.000, AVE = average variance extracted, CR (t-value) = critical ratio

Convergent and Discriminant Validity (Construct Validity)

Jöreskog et al. (2016) have suggested that constructs validity (GFI, CFI, RMSEA, Chi-square/df) is usually first accessed using a CFA in SEM modeling. Table 4 shows the goodness-of-fit appraisal, along with the supporting theory for the criteria used. Furthermore, concerning the support for the Thai auto parts manufacturing EFF, all factors had an AVE ≥ 0.5, and they all show excellent levels of internal consistency, as their composite reliability (CR) is between 0.71 and 0.87 (Table 5). Based on the GOF appraisal, it was concluded that the measurement model satisfied established convergent validity criteria. Secondly, discriminant validity assessment determined whether the six factors were different from one another by testing whether the $\sqrt{AVE}$for any given two factors was more significant than the correlation between these two factors (Fornell et al., 1996).

Table 4. Criteria and theory of the values of GOF assessment

Criteria Index	Criteria	Supporting theory	Values	Results
Chi-square: $\chi2$	$p \geq 0.05$	Rasch (1980).	0.81	passed
Relative Chi-square: $\chi2/df$	≤ 2.00	Byrne et al. (1989).	0.85	passed
RMSEA	≤ 0.05	Hu and Bentler (1999).	0.00	passed
GFI	≥ 0.90	Jöreskog et al. (2016).	0.99	passed
AGFI	≥ 0.90	Hooper et al. (2008).	0.97	passed
RMR	≤ 0.05	Hu and Bentler (1999).	0.03	passed
SRMR	≤ 0.05	Hu and Bentler (1999).	0.03	passed
NFI	≥ 0.90	Schumacker and Lomax (2010).	0.99	passed
CFI	≥ 0.90	Schumacker and Lomax (2010).	1.00	passed
Cronbach's Alpha	≥ 0.70	Tavakol and Dennick (2011).	0.73-0.86	passed

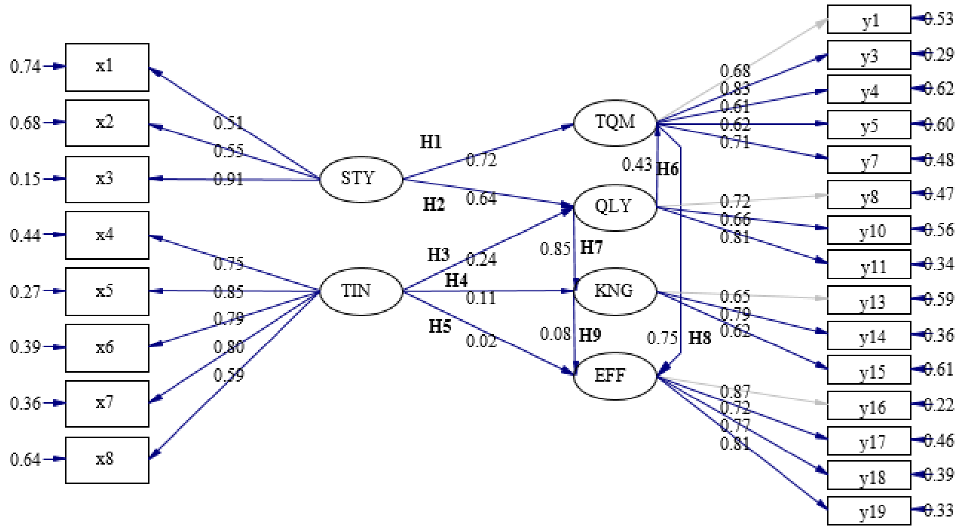
Table 5. Correlation Coefficients between the Latent Variables (under the bold diagonal) Composite Reliability (ρC) and the Average Variance Extracted (AVE)

Latent variables	STY	TIN	TQM	QLY	KNG	EFF
Strategic planning (STY)	1.00					
Technology and innovation (TIN)	.40**	1.00				
Total quality management (TQM)	.74**	.40**	1.00			
Product quality (QLY)	.66**	.45**	.74**	1.00		
Knowledge management (KNG)	.60**	.46**	.68**	.67**	1.00	
Efficiency (EFF)	.67**	.44**	.65**	.60**	.55**	1.00
ρ_V (AVE)	0.46	0.58	0.48	0.54	0.48	0.63
ρ_C (Composite Reliability)	0.71	0.87	0.82	0.77	0.73	0.87
$\sqrt{AVE}$	0.68	0.76	0.69	0.73	0.69	0.79

*Note. **Sig. < .01*

Figure 3 shows the final model with quantities close to the variables indicating their squared multiple correlations. Quantities near paths are standardized factor loadings or correlations (Kenny, 2016). A box designates measured variables, and latent variables, including disturbances, are represented by ovals. Straight lines represent paths with an arrowhead pointing from the causal variable toward the effect variable. Figure 3 and Tables 6 and 7 confirm the accuracy of the SEM and its variables affecting the efficiency (EFF) of the Thai automotive parts manufacturing industry.

Figure 3.SEM of the variables that influence the EFF of the Thai auto parts manufacturing industry.



Note. Chi-Square = 100.38, df = 102, *p*-value = 0.52690, RMSEA = 0.000.

Standard coefficients of influences

The SEM analysis determined that all the causal variables in the SEM were found to positively affect EFF, which was concluded due to the combined variance of the factors affecting EFF (R^2) by 71%. Table 6 shows the DE, IE, and TE of each construct (Bollen, 1987), with EFF shown to be influenced by five variables, when ranked in importance are STY, TQM, QLY, TIN, and KNG with total effect (TE) values of 0.79, 0.75, 0.39, 0.12, and 0.08, respectively.

Table 6. Standard coefficients of influences in causal relationships of factors influencing EFF

Dependent Variables	R^2	Effect	Independent Variables				
			STY	TIN	TQM	QLY	KNG
Total quality management (TQM)	1.00	DE	0.72**	-		0.43**	
		IE	0.27**	0.10**		-	
		TE	0.99**	0.10**		0.43**	
Product quality (QLY)	.58	DE	0.64**	0.24**			
		IE	-	-			
		TE	0.64**	0.24**			
Knowledge management (KNG)	.52	DE	-	0.11*		0.85**	
		IE	0.54**	0.20**		-	
		TE	0.54**	0.31**		0.85**	
Efficiency (EFF)	.71	DE	-	0.02	0.75**	-	0.08
		IE	0.79**	0.10**	-	0.39**	-
		TE	0.79**	0.12**	0.75**	0.39**	0.08

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

Table 7. Hypotheses testing results

Hypotheses testing statements	Coefficients	*t*-value	Results
H1: STYdirectly and positively influencesTQM	0.72	7.58**	Consistent
H2: STYdirectly and positively influencesQLY	0.64	11.03**	Consistent
H3: TIN directly and positively influencesQLY	0.24	5.30**	Consistent
H4: TIN directly and positively influencesKNG	0.11	2.07*	Consistent
H5: TIN directly and positively influencesEFF	0.02	0.58	Inconsistent
H6: QLYdirectly and positively influencesTQM	0.43	5.05**	Consistent
H7: QLY directly and positively influencesKNG	0.85	2.10*	Consistent
H8: TQM directly and positively influencesEFF	0.75	6.64**	Consistent

H9: KNG directly and positively influencesEFF	0.08	0.77	Inconsistent

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

Discussion

Regression weights were used for the hypotheses testing when examining the extent of the effects of the exogenous latent variables on the endogenous latent variables. An absolute fit measure was used to determine how the structural and measurement models fit the sample data. Out of the nine hypotheses in the study, seven were accepted, and two were rejected.

In Figure 3 and Table 6, the standardized regression weights are shown. From this, the customer loyalty score frequencies and values one standard deviation above and below the mean are indicated with a significant statistical relationship between the variables indicated at $p \leq 0.01$. Critical ratios (t-value) more than 1.96 are significant at the 0.05 level, with greater evidence against the null hypothesis increasing as the t-value increases positively or negatively. The closer the t-value is to 0, the more likely no significant difference is (H5 and N9). Therefore the results indicated that:

H1: There was a significant causal relationship between STY and TQM. The results indicated that STY directly affects TQM on the standardized regression weight scale as indicated by the coefficient estimate = 0.72, t-value = 5.828, and $p \leq 0.01$. Support for the critical importance of the STY/TQM relationship is stated in a study from Indian. In it, Khanna et al. (2007) indicate that although TQM plays a vital role in the survival and growth of many industries, in the Indian automobile sector, one of the primary reasons for its dismal performance is the fact that the sector has been unable to prioritize and focus on crucial TQM variables.

H2: There was a significant causal relationship between STY and QLY. The results indicated that STY directly affects QLY on the standardized regression weight scale as indicated by coefficient estimate = 0.64, t-value = 11.03, and $p \leq 0.01$.

H3: There was also a significant causal relationship between TIN and QLY. The results indicated that TIN directly affects QLY on the standardized regression weight scale as indicated by coefficient estimate = 0.64, t-value = 5.30, and $p \leq 0.01$.

Further support for the study's findings can be found in a global study by PWC (2018), in which it was stated that the most successful innovators are targeting more breakthrough and radical innovation, not just on products, but innovating to improve business models and supply chains can help automotive companies compete in a marketplace that's radically changing.

H4: There was a significant causal relationship between TIN and KNG, with results indicating that TIN has a direct and positive effect on KNG on the standardized regression weight scale as indicated by coefficient estimate = 0.24, t-value = 11.03, and $p \leq 0.01$.

H5: However, the causal relationship between TIN and EFF was shown to be insignificant, and the hypothesis was unsupported as TIN had minimal effect on EFF on the standardized regression weight scale as indicated by coefficient estimate = 0.02, with a t-value = 0.58.

H6: There was a significant causal relationship between QLY and TQM, with results indicating that QLY has a direct and positive effect on TQM on the standardized regression weight scale as indicated by coefficient estimate = 0.43, t-value = 5.05, and $p \leq 0.01$.

H7: There was also a moderate causal relationship between QLY and KNG, with results indicating that QLY directly and positively influencesKNG as the standardized regression weight scale indicated by coefficient estimate = 0.85, t-value = 2.10, and $p \leq 0.05$.

H8: There was a significant causal relationship between TQM and EFF, with results indicating that TQM has a direct and positive effect on EFF on the standardized regression weight scale as indicated by coefficient estimate = 0.75, t-value = 6.64, and $p \leq 0.01$.

Support for H8 is found throughout the literature, as TQM practices within the Thai and Malaysian automotive industries come from a highly competitive automotive market and customer pressure. In this highly competitive environment, the demand for quality is emerging as the single most critical component for firms to survive in the ever-expanding global marketplace, with quality critical in determining the economic success of manufacturing enterprises (Curkovic et al., 2000; Garvin, 1988; Zakuan et al., 2009).

Furthermore, in Macduffie's (1995) investigation of 62 automotive assembly plants on how innovative HR practices affects performance, the author reported that flexible production plants with team-based work systems, HR practices that use contingent compensation, extensive training, and low inventory and repair buffers, consistently outperformed mass production plants.

H9: However, the causal relationship between KNG and EFF was insignificant, and the hypothesis was unsupported as TIN had minimal effect on EFF on the standardized regression weight scale as indicated by coefficient estimate = 0.08, with coefficient estimate a t-value = 0.77.

Conclusion

The study's objective was to use an SEM to investigate the relationships between the factors influencing automotive parts manufacturing efficiency in Thailand. With shipments outbound to over 100 countries, Thailand has become the 13th largest automotive parts exporter globally, with nearly 2,500 tier-one, tier-two, and tier-three auto parts makers. It possesses the most vital automotive cluster in Southeast Asia, employing 850,000 people and contributing over 10% of the Kingdom's GDP. From the nine hypotheses developed for the study, strategic planning (STY), total quality management (TQM), product quality (QLY), technology and innovation (TIN), and knowledge management (KNG) were determined to have the most significant importance (listed in order of importance). All the causal factors in the model had a positive influence on EFF, with the variance of the factors influencing EFF (R^2) being 71 %.

Future Implications

Globally, the automotive sector is entering a limited growth and stagnation period. In China, one in six of the country's 800 million-strong workforce is employed indirectly or directly in the automotive industry, but China's car sales have declined for the first time since 1992. In the United States, 2019 first-quarter auto sales dropped 2.5% from a year earlier. In addition, Europe is halting car imports from Thailand under the region's Generalised System of Preferences, thus creating a fragile situation as 2019 evolves. Is the technology transition the reason for the slowdown, or is it economic trade wars?

Significant changes are upsetting the finely tuned supply chain process with the rising fear and ever-increasing rhetoric of trade wars, with the US and China differences continuing to have a widespread negative impact and has been stated by some Thai officials as an essential factor hurting the global economy and Thai exports. Also, starting in 2021, the Thai automotive industry is expected to transition to electric vehicles (EVs). The EV trend has been stated by many to be a game-changer for the industry and will encourage many tier-one companies to research and develop high-tech auto parts, making many non-EV parts obsolete.

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References

Anderson, J. C., & Gerbing, D. W. (1998). Structural equation modeling in practice: A review and recommended two-step approach. *Psychological Bulletin, 103*(5), 204–215. https://doi.org/10.1037//0033-2909.103.3.411

Bessant, J., & Tidd, J. (2013). *Managing Innovation*. https://tinyurl.com/75nkw2dp

Bollen, K. A. (1987). Total, direct and indirect effects in structural equation models. *Sociological Methodology, 17*, 37–69. Retrieved from https://tinyurl.com/ybmyqaol

Borgström, B., & Hertz, S. (2011). Supply chain strategies: Changes in customer order-based production. *Journal of Business Logistics, 32*(4), 361–373. https://doi.org/10.1111/j.0000-0000.2011.01031.x

Byrne, B. M., Shavelson, R. J., & Muthén, B. (1989). Testing for the equivalence of factor covariance and mean structures: The issue of partial measurement invariance. *Psychological Bulletin, 105*(3), 456–466. https://doi.org/10.1037//0033-2909.105.3.456

Cho, E., & Kim, S. (2015). Cronbach's coefficient alpha: Well-known but poorly understood. *Organizational Research Methods, 18*(2), 207 – 230. https://doi.org/10.1177/1094428114555994

Curkovic, S., Melnyk, S., Calantone. R., & Handfield, R. (2000). Validating the Malcolm Baldrige national quality award framework through structural equation modeling. *International Journal of Production Research,* 38(4), 765-791. https://doi.org/10.1080/002075400189149

Dansomboon, S., Phimonsathienand, T., & Fongsuwan, W. (2016). Cross-Cultural Logistics and Supply Chain Management Towards Organizational Effectiveness within the Asean/Thai Automotive Industries: A Sem Analysis. *Management and Production Engineering Review, 7*(3), 23 – 38. https://doi.org/10.1515/mper-2016-0023

Economic Intelligence Center. (2016, April 4). Japan's "Thailand-Plus-One" revisited: A business opportunity in the Mekong sub-region. *Bangkok Post*. https://tinyurl.com/y57fuoxo

Evans, J. R. (2017). *Quality &performance excellence: Management,organization,andstrategy*. Cengage Learning.

Friedman, S. (2008). Roles, responsibilities, and resources: best practices in managing people. Paper presented at PMI® Global Congress 2008 — North America, Denver, CO. Newtown Square, PA: Project Management Institute. https://tinyurl.com/yxczquor

Fornell, C., Johnson, M. D., Anderson, E. W., Cha, J., & Bryant, B. E. (1996). The Americancustomersatisfactionindex: Nature, purpose, and findings. *Journal of Marketing*, *60*(4), 7–14. https://doi.org/10.2307/1251898

Fujimura, K., & Katsuki, N. (2015, October 31). Thai car parts makers muscle into supply chains, venture abroad. *Nikkei Asian Review*. https://tinyurl.com/y4zetdcf

Garvin, D. A. (1988). *Managingquality: The strategic and competitive edge*. The Free Press.

Goicoechea, I., & Fenollera, M. (2012). Quality Management in the Automotive Industry, Chapter 51. In B. Katalinic (Ed.), *DAAAM International Scientific Book* (pp. 619-632). Vienna, Austria: DAAAM International. https://doi.org/10.2507/daaam.scibook.2012.51

Hooper, D., Coughlan, J., & Mullen, M. (2008). Structural equation modelling: Guidelines for determining model fit. *Electronic Journal of Business Research Methods, 6*(1), 53 - 60. http://tinyurl.com/zyd6od2

Hu, L. T., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling, 6*(1), 1 – 55. https://doi.org/http://dx.doi.org/10.1080/10705519909540118

Jöreskog, K. G., Olsson, U. H., & Fan, Y. W. (2016). *Multivariate analysis with LISREL.* Springer.

Kenny, D. A. (2016). Multiple latent variable models: Confirmatory factor analysis. http://davidakenny.net/cm/mfactor.htm

Khanna, V.K., Sahay, B.S., Vrat, P., & Shankar, R. (2007). TQM implementation in the Indian automobile sector: insights using system dynamics approach. *Journal of Advances in Management Research, 4*(1), 49 – 62. https://doi.org/10.1108/97279810780001251

Kocoglu,I.,Imamoglu,S.Z.,Ince,H.,&Keskin, H. (2012). Learning, R&D and manufacturingcapabilities as determinants of technological learning: enhancing innovationandfirmperformance.*Procedia- Social andBehavioral Sciences*,*58*, 842–852.https://doi.org/10.1016/j.sbspro.2012.09.1062

Macduffie, J. P. (1995). Human resource bundles and manufacturing performance: Organizational logic and flexible production systems in the world auto industry. *Industrial and Labor Relations Review, 48*(2), 197 - 221. https://doi.org/10.2307/2524483

Maikaew, P. (2019a, January 7). Automotive industry at a turning point. *Bangkok Post*.https://tinyurl.com/ya3njco6

Maikaew, P. (2019b, April 27). The man behind Thai auto policy. *Bangkok Post*. https://tinyurl.com/y27ndrxy

Phoonphongphiphat, A. (2018, February 20).Thai automakers desperate to keep high tariff on imported cars. *Nikkei Asian Review*. https://tinyurl.com/yxp6napg

Pımdee, P. (2020). Antecedents of Thai student teacher sustainable consumption behavior.*Heliyon, 6*(8), e04676.https://doi.org/10.1016/j.heliyon.2020.e04676

PWC. (2018). *The highway to growth: Strategies for automotive innovation*. https://tinyurl.com/y2s6q5v7

Rasch, G. (1980). *Probabilistic models for some intelligence and attainment tests.* University of Chicago Press.

Schumacker, R. E., & Lomax, R. G. (2010). *A Beginner's Guide to Structural Equation Modeling*. Routledge.

Tavakol, M., & Dennick, R. (2011). Making sense of Cronbach's alpha. *International Journal of Medical Education, 2*, 53–55. https://doi.org/10.5116/ijme.4dfb.8dfd

Zakuan, N., Yusof, S. M., Saman, M. Z. M., &Shaharoun, A. M.(2009). Confirmatory factor analysis of TQM practices in Malaysia and Thailand automotive industries. *International Journal of Business and Management, 5*(1), 160 - 175. https://doi.org/10.5539/ijbm.v5n1p160