

# CRITICAL PERFORMANCE ATTRIBUTES OF THAI AUTOMOTIVE SUPPLY CHAINS

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**ABSTRACT**

The Thai automotive industry has been ranked one of the top ten of the Thai export products for several years. Effective supply chain management has become a key strategy for the industry to stay competitive. Performance measurement has thus become a crucial issue in automotive supply chains. The purpose of the research is to gain insight into the relevant performance attributes that affect the automotive supply chains. The critical factor indexes (CFIs) are calculated in order to determine which of the performance attributes are considered to be the strength and which ones need to be specially focused, so that precautions could be made in developing the performance measurement system. Based on the CFIs, companies in Thai automotive supply chains can support their decision making under scarce resources with valid data. A set of questionnaires with different performance attributes is used comprising of two separate parts, one intended for the first tier supplier companies and the other for the automakers. Each performance attribute in the questionnaires is assessed on how important the company sees them from their perspective, how well the tasks measured by each performance attribute have been carried out in their companies, how they see themselves compared to their competitors, and how they see each performance attribute developing compared to the situation 1 to 2 years before. The results provide a guideline to the companies in Thai automotive supply chains to measure the right performance attributes for making the right decision in a competitive environment.

**KEYWORDS**

supply chain performance, performance measurement, critical factor index, Thai automotive industry.

## Introduction

The Thai automotive industry is important to the Thai economy. It has been ranked one of the top ten of the Thai export products. Besides Thailand is a regional hub of automotives and auto-parts manufacturing of leading automakers in the world. To have low prices as a competitive advantage factor is no longer sufficient for surviving under this high competitive economy. For instance, during the 1980s there was the cheapest car, branded “Yugo”, sold in the United States but it went out of business because of its poor quality and the customers did not

want to buy this car at any price. Thus, the company using the cost strategy required to deliver the consistent quality to customers while still retaining an attractive margin between prices received from its customers and the amount it pays its suppliers. Similarly, this principle also applies to the company’s suppliers. Effective supply chain management has become a key strategy for the industry to stay competitive. Performance measurement has thus become a crucial issue in automotive supply chain. With the scarce resources in highly competitive environment, the first step to improve supply chain performance is to know which supply chain’s performance attributes are critical and should be improved.

## Literature review

### The automotive supply chain in Thailand

Nowadays Thailand is a trusted regional automotive manufacturing hub of automotive leaders around the world. There are many automakers establish in Thailand [1] such as Toyota Motor Thailand Co., Ltd., Isuzu Motors Company (Thailand) Co., Ltd., Honda Automobile (Thailand) Co., Ltd., Thai-Swedish Assembly Co., Ltd., General Motors (Thailand) Co., Ltd., Thonburi Automotive Assembly Plant Co., Ltd., Tata Motors (Thailand) Co., Ltd. (with manufacturing facility established at Thonburi Automotive Assembly Plant Co. Ltd.), Nissan Motor (Thailand) Co., Ltd., Nissan Diesel (Thailand) Co., Ltd., BMW Manufacturing (Thailand) Co., Ltd., Mitsubishi Fuso Truck (Thailand) Co., Ltd., Mitsubishi Motors (Thailand) Co., Ltd., Siam Motors And Nissan Co., Ltd., Auto Alliance (Thailand) Co., Ltd., Hino Motors Manufacturing (Thailand) Co., Ltd. etc. The Thai automotive supply chain involves many different industry sectors. The supply chain of Thai automotive industry is depicted in Fig. 1.

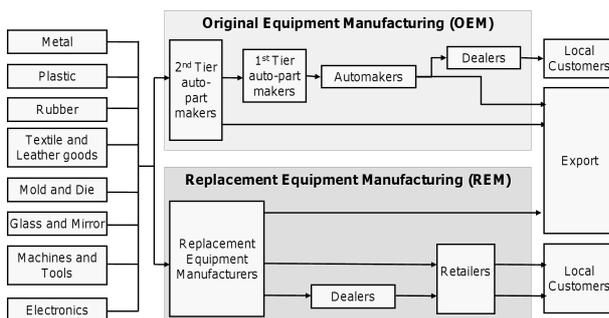


Fig. 1. Thai automotive supply chain (adapted from [2]).

As per reference [2], the generic Thai automotive supply chain comprises various industries from downstream to upstream (see Fig. 1). This ranges from the basic products such as metal, plastic, rubber, textile and leather goods, mold and die, electronics, etc. to the more complex products such as engine parts, body parts, lighting and electrical parts, transmission and steering parts, etc.

The Thai automotive supply chain is separated into two groups, namely the Original Equipment Manufacturing (OEM) and Replacement Equipment Manufacturing (REM). This research is focused on the OEM side between first tier auto-part makers (or “first tier supplier” in this paper) and automakers.

### Performance of the individual firm: Balanced Scorecard

The balanced scorecard allows managers to look at the business from four important perspectives and could minimize information overload by limiting the number of measures used. Reference [3] indicated that companies rarely suffer from having too few measures; on the contrary, they keep adding new measures whenever an employee or a consultant suggested. The balanced scorecard helped managers to focus on the handful of measures that are most critical, by forcing managers to consider all the important operational measures together; the balanced scorecard lets them see whether improvement in one area may have been achieved at the expense of another. The balanced scorecard translates a mission and strategy into a set of measures and metrics that comprises of four perspectives which link to performance measures [3]. Reference [4] has studied the effect of intangible assets on the business performance of individual firm by adapting from the strategy map of balanced scorecard. They have explored the inter-relationships of three elements of intangible assets: learning and growth, internal process, and external structure on the business performance of the firm.

### Linkage for the firms in a supply chain: Trust

Nowadays several companies increase their competitive advantage by making the collaborative relationships with their alliance partners in the supply chain. Trust makes the supply chain relationships strong [5–7]. Benefits of trust to supply chains are as follows [5]:

- Lower transaction costs to develop and maintain supply chain relationships by using fewer resources to develop detailed contracts; lower contract monitoring and enforcement costs; and reducing contract renewal, switching, and set up costs.
- Increased value-creation opportunities by identifying and sharing resources and knowledge to solve problems; jointly developing the product; and making process improvement.
- Enhanced collaborative learning by having close collaboration allow information to flow freely among parties results in transfer of existing knowledge and generation of new knowledge.

Trust is a multidimensional concept [5, 7] and the definitions of trust from several scholars are summarized as per Table 1.

Table 1  
 Definitions of trust [5]

Author(s)	Definition
Anderson and Narus (1990)	A firm's belief that another company will perform actions that will result in positive outcomes for the firm, as well as not take unexpected actions that would result in negative outcomes for the firm
Ring and Van de Ven (1992)	Confidence in the other's goodwill
Sabel (1993)	The mutual confidence that no party to an exchange will exploit the others' vulnerability
Mayer et al. (1995)	Willingness of a party to be vulnerable to the actions of another party based on the expectation that the other will perform a particular action important to the trustor, irrespective of the ability to monitor or control that other party
Zaheer et al. (1998)	Expectation that an actor can be relied on to fulfill obligations, will behave in a predictable manner, and will act and negotiate fairly when the possibility of opportunism is present
Sako (1998)	Expectation held by an agent that its trading partner will behave in a mutually acceptable manner (including an expectation that neither party will exploit the other's vulnerabilities)
Dyer and Chu (2003)	One party's confidence that the other party in the exchange relationship will not exploit its vulnerabilities
Lui and Ngo (2004)	Expectation of a partner fulfilling a collaborative role in a risky situation, and (the reliability) of both the partner's intention to perform and its ability to do so
Kwon and Suh (2005)	A willingness to take risk and a willingness to rely on an exchange partner in whom one has confidence
Ireland and Webb (2007)	The decision to rely on a partner with the expectation that the partner will act according to a common agreement

Companies with supernormal returns (relational rent) are generated when partners make investment in relation-specific assets; exchange knowledge that results in joint learning; having joint resources that create unique new products and services; and lower transaction costs because of effective governance mechanisms.

Reference [8] as cited in [5] developed a robust construct of trust that can be measured by categorizing trust to be five indicators as follows:

#### 1. Performance-to-promise

Trust are increase when the partners perform according to the promises they have made such as the buyers will gain more confidence in a supplier if the supplier repeatedly delivers product on time with consistent quality.

#### 2. Professional-relationship

The relationships occur from the buyer's agent and supplier's agent. The company's trustworthiness can be built if the company's agent demonstrates a consistent, credible, and positive interface with its partner's agent.

#### 3. Openness

Openness can be shown by the amount, frequency, and type of information sharing among supply chain partners. The openness can signal commitment to a relationship and increase trust because it makes visibility to the partners, then the uncertainty can be reduced.

#### 4. Benevolent-collaboration

Benevolent-collaboration can be in the form of resources planning. If supply chain partners share

the saving they get, make some investments (such as in equipment, people etc.) to increase efficiency that benefit to their partner; then the supply chain partners will perceive one another as fair and can increase trust in each others.

#### 5. Empathy

Supply chain partners that act with empathy will treat their partners fairly and consider their needs when making decisions. If the external environment changes such that their partner is in trouble, they may choose to alter its contract to safeguard the relationship.

### Research framework

The purpose of the research is to gain insight into the relevant performance attributes that affect the automotive supply chains. The performance attributes were established according to each indicator for individual company. The companies in a supply chain can create more competitive advantage than individual company by making collaborative relationships with each other. Therefore, the benefits gained by two companies are more than sum of them. As mentioned in [5], "trust" is the most essential elements to develop the strong collaborative relationships and the alliance parties in the supply chain could gain mutual benefit to achieve the competitive advantage. Hence, trust is an element that links the individual company in the supply chain and the level of trust can affect the performance of a supply chain.

According to the above reason, the individual company's elements [4], and the collaborative relationships element or "trust" [5] with their indicators were used as a basis to established the elements of supply chain performance and their indicators. The elements of supply chain performance and their indicators are depicted in Table 2. The Thai automotive supply chain was used as a case study for finding the critical performance attributes of the first tier suppliers and automakers.

Table 2  
The elements of supply chain performance and their indicators

Elements of Supply Chain Performance	Supply Chain Performance Indicators
Business performance	Financial Sales Customer
External structure	Customer satisfaction Customer loyalty Brand
Internal process	Process improvement Innovation Information technology
Learning and growth	Know-how Knowledge Competency Engagement
Trust	Performance-to-promise Professional-relationship Openness Benevolent-collaboration Empathy

## Research methodology

### Planning the questionnaire

The primary data for analyzing and investigating the critical performance attributes were gathered by opinion survey questionnaire. The population was limited to the companies within the automotive industry in Thailand. Two questionnaires were developed. The performance attributes in the questionnaires are based on the researches performed by [4] and [5] that were categorized under five main elements: business performance, internal structure, external structure, learning and growth, and trust. A set of questionnaires comprising of two separate parts; one intended for the first tier supplier companies, i.e. companies that produce materials and components for car manufacturers; and the other for the automaker companies, i.e. automotive assemblers. The list of the target group is gathered from the database of Automotive Intelligent Unit, Thailand Automotive Institute (TAI) [1]. The questionnaires were mailed to the top management, factory

managers, sales managers, and purchasing managers of first tier suppliers and automakers in the Thai automotive supply chains.

Each performance attribute in the questionnaires is assessed on how important the company sees them from their perspective, how well the tasks measured by each performance attribute have been carried out in their companies, how they see themselves compared to their competitors and how they see each performance attribute developing compared to the situation 1 to 2 years before. The format of the questionnaire had been adapted from [9] and shown in Fig. 2. The questionnaire format can be used to collect answers that reliable and valid ones, the structure is attractive to answer and the wide numerical estimation- scale from 1 to 10 made the questionnaire to be easy to find differences between attributes [9].

Performance Attribute	Scale: 1 = Low, 10 = High		Compared with competitors			Direction of development		
	Expectation (1-10)	Experiences (1-10)	Worse	Same	Better	Worse	Same	Better
Performance Attribute#1			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Performance Attribute#2			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Fig. 2. Format of the questionnaire (adapted from [9]).

## Results

### Data analysis

A total of 14 questionnaires from first tier suppliers were completed. In order to compare the views and opinions of the different interest groups, the respondents were divided into 4 groups: Top management, Factory manager, Purchasing manager, and Sales/Marketing manager. The purchasing manager group was excluded from the analysis since only one respondent answered which could not be analyzed by using one respondent. Then, the averages and standard deviations of the expectations and experiences for each performance attributes are calculated. Standard deviations help to evaluate the validity and reliability of the results. Gap index is calculated from the absolute value of the expectations and experiences. The direction of development and importance indexes are calculated by using the formulas shown in Fig. 3.

The value of each index can be interpreted as shown in Table 3.

The results of standard deviations and indexes are used to calculate Critical Factor Index (CFI) in order to determine whether which performance attributes are considered to be strength and which ones need to be specially focused. The equation of CFI is depicted in Fig. 4. The smaller value of the CFI is more critical performance attribute.

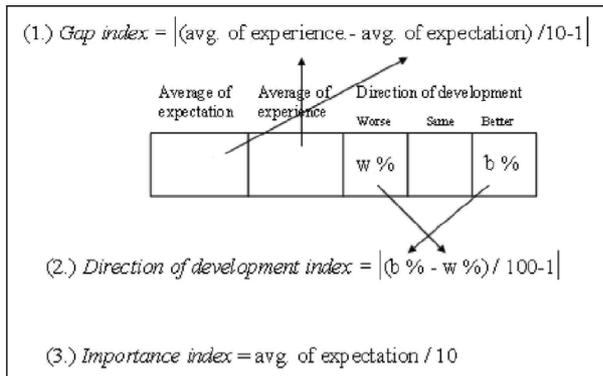


Fig. 3. Calculating formulas [9].

 Table 3  
 Meaning of each index [9].

Index	Value	Meaning
Direction of development	= 1	The performance has remained on the same level.
	< 1	The performance has been developed.
	> 1	The performance has been decreased.
Gap index	= 1	There is no gap between expectations and experiences.
	< 1	The expectations are lower than experiences.
	> 1	The experiences are lower than expectations
Importance index	Large	More important expectation of the attribute.
	Small	Less important expectation of the attribute.

$$CFI = \frac{SD\ of\ expectation * SD\ of\ experience}{Importance\ index * Gap\ index * Direction\ of\ development\ index}$$

Fig. 4. Critical Factor Index (CFI) [9].

## Research results

The analysis was done by including all the answers and separating each group of respondents i.e. Top management, Factory manager, and Sales/Marketing manager. The reason to separate these groups is to see the critical performance attributes from different perspectives. The top management group looks at the performance attributes in the strategic view. The factory manager group looks at the performance attributes in the operation or practical point of view. The sales/marketing manager group considers the performance attribute as a joint that is closest to the automotive customer.

## Preliminary analysis – all

The preliminary result for answers collected from all 13 respondents of first tier suppliers are depicted in Table 4.

Preliminary result indicates the high expectation on TPR3, BC1, and BC8 which are honest and truthful with customers; customer satisfaction; and overall response to customer. The performance attribute of TPR3 (honest and truthful with customers) also has high value in how the companies see that the performance attribute is being carried out in their companies (experience). The lowest importance for companies are IIT4, TBC4, and TBC5 which are completing the registration of new ideas and products at the Department of Intellectual Property; offering technical training/education to customers to help them improve performance; and sharing profits gained through collaborative efforts with their customers. The IIT4 (completing the registration of new ideas and products at Department of Intellectual Property) also has lowest value in how performance attributes are being fulfilled in the companies (experience).

All the performance attributes have the score higher in importance than the experience in their companies. This features show that all the performance attributes should be developed. However, there are a total of 88 performance attributes and the companies have the scarce resources. Therefore, they have to find and focus on the critical performance attributes determined in this paper by using CFI. The respondents see that nearly all performance attributes in their companies are better than competitors, except 7 out of 88 performance attributes that are worse than their competitors. These seven performance attributes are LKL1 (comprehensive in recruitment program by dedicating to hiring the best candidates available), LKL5 (provision of self-learning facilities for employees), LE2 (the employees generally give their all which makes the firm different from the others in the industry), LE3 (employee involvement in business policy and strategy setting), II5 (development of new ideas and products), IIT4 (registration of new ideas and products at the Department of Intellectual Property), and BS3 (market share). There is one performance attribute that is the same as their competitors, which is TBC4 (technical training/education that offered to customers to help them improve performance). This may be because they see the TBC4 as low in important as the average of expectation is only 6.77. Normally in the Thai automotive supply chain, most of the automakers are huge multinational companies that transfer knowledge to them.

Table 4  
Preliminary result for answer collected from all first tier suppliers

Performance Attribute		Expectations		Experiences		Compared with competitors			Direction of development		
		Average	SD	Average	SD	Worse %	Same %	Better %	Worse %	Same %	Better %
1	2	3	4	5	6	7	8	9	10	11	12
1	LKH1	8.46	1.27	6.23	1.96	30.77	30.77	38.46	7.69	46.15	46.15
2	LKH2	8.38	1.94	6.23	1.69	15.38	53.85	30.77	7.69	53.85	38.46
3	LKH3	8.31	1.80	7.00	1.58	7.69	53.85	38.46	0.00	53.85	46.15
4	LKH4	8.77	2.28	7.00	2.48	15.38	38.46	46.15	15.38	38.46	46.15
5	LKH5	7.92	1.89	6.15	2.61	15.38	69.23	15.38	<b>23.08</b>	53.85	<b>23.08</b>
6	LKL1	8.38	1.76	5.77	1.83	<b>23.08</b>	69.23	7.69	0.00	76.92	23.08
7	LKL2	8.31	1.70	6.08	1.61	15.38	38.46	46.15	0.00	53.85	46.15
8	LKL3	8.38	1.50	6.46	2.07	7.69	61.54	30.77	0.00	46.15	53.85
9	LKL4	9.23	1.30	7.46	1.98	0.00	46.15	53.85	7.69	46.15	46.15
10	LKL5	8.23	1.42	5.15	1.77	<b>38.46</b>	53.85	7.69	<b>15.38</b>	69.23	<b>15.38</b>
11	LC1	8.85	1.21	6.46	1.51	23.08	23.08	53.85	0.00	53.85	46.15
12	LC2	7.77	2.09	5.69	2.06	0.00	84.62	15.38	0.00	76.92	23.08
13	LC3	8.31	1.70	5.46	2.30	15.38	69.23	15.38	0.00	69.23	30.77
14	LC4	9.08	1.32	6.38	1.33	0.00	53.85	46.15	0.00	69.23	30.77
15	LC5	8.31	1.44	6.08	1.98	15.38	61.54	23.08	7.69	61.54	30.77
16	LE1	7.62	1.80	5.62	1.98	15.38	53.85	30.77	0.00	61.54	38.46
17	LE2	8.08	1.75	5.92	2.47	<b>30.77</b>	46.15	23.08	0.00	84.62	15.38
18	LE3	7.69	2.36	<b>5.00</b>	2.31	<b>15.38</b>	84.62	0.00	<b>15.38</b>	76.92	7.69
19	LE4	9.23	1.01	7.23	<b>0.73</b>	0.00	53.85	46.15	0.00	53.85	46.15
20	LE5	8.62	1.19	6.77	2.05	7.69	30.77	61.54	7.69	46.15	46.15
21	TPP1	8.54	1.94	7.46	2.15	15.38	30.77	53.85	7.69	30.77	61.54
22	TPP2	9.46	0.78	8.77	1.30	7.69	38.46	53.85	0.00	38.46	61.54
23	TPP3	9.31	1.49	<b>8.85</b>	1.57	0.00	46.15	53.85	0.00	38.46	61.54
24	TPR1	9.08	1.44	8.54	1.76	0.00	38.46	61.54	0.00	46.15	53.85
25	TPR2	9.15	1.28	8.62	1.33	0.00	30.77	69.23	0.00	53.85	46.15
26	TPR3	<b>9.85</b>	<b>0.38</b>	<b>9.15</b>	<b>0.90</b>	0.00	46.15	53.85	0.00	38.46	61.54
27	TO1	9.38	1.19	<b>9.08</b>	1.32	0.00	46.15	53.85	0.00	38.46	61.54
28	TO2	9.54	0.78	8.62	1.71	0.00	53.85	46.15	0.00	46.15	53.85
29	TO3	9.00	1.53	8.38	2.06	0.00	46.15	53.85	0.00	46.15	53.85
30	TO4	9.23	1.30	7.54	1.76	0.00	46.15	53.85	0.00	30.77	69.23
31	TO5	7.54	2.33	6.08	2.43	7.69	69.23	23.08	0.00	76.92	23.08
32	TBC1	8.62	1.56	7.54	1.85	0.00	69.23	30.77	0.00	53.85	46.15
33	TBC2	7.77	2.13	6.85	2.44	0.00	76.92	23.08	0.00	61.54	38.46
34	TBC3	8.15	1.82	7.46	2.22	0.00	61.54	38.46	0.00	53.85	46.15
35	TBC4	<b>6.77</b>	2.45	5.46	2.57	<b>15.38</b>	69.23	<b>15.38</b>	0.00	61.54	38.46
36	TBC5	<b>6.92</b>	<b>2.81</b>	5.54	3.07	7.69	69.23	23.08	0.00	69.23	30.77
37	TE1	7.62	2.18	6.69	2.10	0.00	76.92	23.08	0.00	76.92	23.08
38	TE2	8.31	2.43	7.92	2.18	0.00	53.85	46.15	0.00	61.54	38.46
39	TE3	7.38	2.50	6.54	2.37	0.00	61.54	38.46	0.00	61.54	38.46
40	TE4	8.38	2.22	7.62	2.43	0.00	46.15	53.85	0.00	61.54	38.46
41	IPI1	9.08	1.12	7.46	2.07	0.00	23.08	76.92	0.00	23.08	76.92
42	IPI2	9.00	1.29	7.31	1.75	7.69	30.77	61.54	0.00	38.46	61.54
43	IPI3	9.31	1.11	7.69	1.89	15.38	46.15	38.46	7.69	46.15	46.15
44	IPI4	8.92	1.32	6.92	1.80	0.00	76.92	23.08	0.00	61.54	38.46
45	IPI5	8.46	1.81	6.62	1.89	23.08	46.15	30.77	15.38	30.77	53.85
46	IPI6	8.85	1.57	7.62	1.76	7.69	53.85	38.46	0.00	46.15	53.85
47	II1	8.46	1.56	7.62	1.94	0.00	46.15	53.85	0.00	53.85	46.15
48	II2	8.46	1.66	6.85	1.63	15.38	38.46	46.15	7.69	46.15	46.15
49	II3	8.46	1.90	6.54	2.11	15.38	38.46	46.15	0.00	46.15	53.85
50	II4	8.23	1.92	6.15	2.12	23.08	46.15	30.77	7.69	46.15	46.15

1	2	3	4	5	6	7	8	9	10	11	12
51	Ii5	7.77	1.92	<b>5.00</b>	1.68	<b>23.08</b>	69.23	7.69	7.69	53.85	38.46
52	IIT1	8.46	1.27	6.85	1.95	7.69	46.15	46.15	0.00	38.46	61.54
53	IIT2	8.77	1.54	6.69	1.60	15.38	53.85	30.77	0.00	46.15	53.85
54	IIT3	8.54	1.71	7.23	1.96	0.00	69.23	30.77	0.00	46.15	53.85
55	IIT4	<b>6.31</b>	2.56	<b>2.69</b>	2.02	<b>46.15</b>	53.85	0.00	7.69	69.23	23.08
56	IIT5	9.00	1.29	7.15	1.46	7.69	53.85	38.46	0.00	53.85	46.15
57	ECS1	9.00	1.08	7.38	1.71	0.00	84.62	15.38	0.00	61.54	38.46
58	ECS2	8.77	1.79	7.23	2.01	7.69	61.54	30.77	0.00	53.85	46.15
59	ECS3	8.69	1.25	7.54	1.71	0.00	53.85	46.15	0.00	46.15	53.85
60	ECS4	9.00	1.08	7.62	1.04	0.00	61.54	38.46	0.00	46.15	53.85
61	ECS5	9.08	1.55	7.54	2.03	7.69	53.85	38.46	7.69	38.46	53.85
62	ECS6	8.85	1.46	7.46	1.66	0.00	61.54	38.46	0.00	61.54	38.46
63	ECS7	9.15	1.14	7.69	1.38	0.00	46.15	53.85	7.69	38.46	53.85
64	ECL1	8.54	1.13	7.31	1.70	0.00	69.23	30.77	0.00	46.15	53.85
65	ECL2	7.85	1.57	6.77	1.74	0.00	84.62	15.38	0.00	61.54	38.46
66	ECL3	8.62	1.80	7.77	1.92	7.69	61.54	30.77	0.00	46.15	53.85
67	ECL4	8.15	1.72	7.23	2.13	0.00	61.54	38.46	0.00	61.54	38.46
68	EB1	8.38	1.76	6.62	2.02	7.69	61.54	30.77	0.00	69.23	30.77
69	EB2	7.77	1.92	6.85	1.82	7.69	61.54	30.77	0.00	53.85	46.15
70	EB3	8.85	1.21	7.77	1.59	7.69	53.85	38.46	0.00	53.85	46.15
71	EB4	7.54	2.22	5.69	2.43	23.08	53.85	23.08	0.00	69.23	30.77
72	EB5	7.54	2.15	5.23	2.31	15.38	46.15	38.46	0.00	53.85	46.15
73	EB6	7.85	2.58	6.31	2.36	7.69	53.85	38.46	0.00	61.54	38.46
74	BF1	8.92	2.72	6.31	<b>3.22</b>	23.08	38.46	23.08	15.38	30.77	46.15
75	BF2	8.62	<b>2.84</b>	6.31	<b>3.12</b>	15.38	46.15	23.08	23.08	23.08	46.15
76	BF3	8.92	2.72	6.31	<b>3.25</b>	23.08	38.46	23.08	23.08	23.08	46.15
77	BS1	8.62	2.72	7.23	2.59	23.08	46.15	23.08	0.00	46.15	46.15
78	BS2	8.62	2.75	6.85	2.70	15.38	53.85	23.08	7.69	30.77	53.85
79	BS3	8.23	2.80	6.08	2.90	<b>30.77</b>	38.46	23.08	7.69	46.15	38.46
80	BS4	8.38	<b>2.84</b>	6.23	2.89	15.38	38.46	38.46	7.69	30.77	53.85
81	BC1	<b>9.77</b>	<b>0.60</b>	8.08	<b>0.76</b>	0.00	38.46	61.54	0.00	46.15	53.85
82	BC2	9.62	0.77	8.31	1.25	0.00	61.54	38.46	7.69	53.85	38.46
83	BC3	8.77	1.64	7.08	2.75	23.08	38.46	38.46	7.69	30.77	61.54
84	BC4	8.08	1.80	6.69	2.10	0.00	69.23	30.77	0.00	53.85	46.15
85	BC5	7.92	1.71	6.54	2.18	7.69	69.23	23.08	0.00	61.54	38.46
86	BC6	9.62	0.77	8.38	1.26	7.69	69.23	23.08	0.00	61.54	38.46
87	BC7	8.38	2.63	7.85	2.48	0.00	38.46	61.54	0.00	46.15	53.85
88	BC8	<b>9.69</b>	<b>0.63</b>	8.38	0.96	0.00	46.15	53.85	0.00	61.54	38.46

All the performance attributes at the time the respondents answer in the questionnaires are better than last two years, except LE3 (the employee involvement in business policy and strategy setting), which is worse than previous; and LKH5 (a succession training program for replacement an employee who leaved the firm) and LKL5 (provision of self-learning facilities for employees) are remaining the same as previous two years.

In the next sections, the answers were divided into three separated groups of positions, namely Top management, Factory manager, and Sales/Marketing manager.

### Preliminary analysis – top management

The top management sees TPR3 (honest and truthful with customers) as the highest importance and the experience of this performance attribute being carried out in the companies is also high. This is the same as the result from all positions. In the top management's point of view, the lowest importance for companies are the same as results from all positions which are TBC5, IIT4, and TBC4 which are sharing profits gained through collaborative efforts with their customers; completing the registration of new ideas and products at Department of Intellectual

Property; and offering technical training/education to customers to help them improve performance. The IIT4 (completing the registration of new ideas and products at Department of Intellectual Property) is also has lowest value in how performance attributes are being carried out in the companies. This is also the same as the result from all position. This may be because most of the first tier suppliers of the Thai automotive companies are the OEM (Original Equipment Manufacturing). Almost all of the auto parts are designed by the customers (automakers) or otherwise the collaborative design is made by involving part makers at the beginning stage of product development. There are only a few first tier suppliers that have their own designed products and offer for use in the automobiles. The top management sees that all performance attributes are better than last two years as depicted in the direction of development, except LKL5 (provision of self-learning facilities for employees) and LE3 (employee involvement in business policy and strategy setting) are the same as previous two years.

#### **Preliminary analysis – factory manager**

The factory managers see several performance attributes are equal important level, as the maximum value of 13 performance attributes in average expectation is 9.75. Three of them were also the highest important in the result of all positions which are TPR3, BC1, and BC8. Lowest important in the factory managers' point of view are LE1 (employees' understanding about companies' target market segments and customer profiles), LE3 (employee involvement in business policy and strategy setting), and TBC4 (offering technical training/ education to customers to help them improve performance). LE1 and LE3 are different from the result from the other positions. For the direction of development, the factory managers see all performance attributes are improved or at least the same as last two years.

#### **Preliminary analysis – sales/marketing manager**

There are six performance attributes that all sales/marketing managers see them as highest important with the average expectation is 10.00 combined with the zero standard deviation. This is important to indicate that these performance attributes are the keys that should be focused. These six performance attributes are TPP3 (always deliver on promises made to customers), TPR1 (companies' culture encourages sellers to treat customers with fairness and respect), TPR3 (honest and truth-

ful with customers), TO1 (do not use any proprietary information to our customers' disadvantage), BC1 (customer satisfaction), and BC2 (customer retention/loyalty). This is not that surprising in that all are related to the customers since the sales/marketing is the function in the firm that has the closest linkage to the customers. TPP3 is the only performance attribute that all sales/marketing managers see it completely carried out in the company as can be seen that the experience was scored 10.00 combined with zero standard deviation. Sales/marketing managers saw 26 performance attributes are worse than their competitors; 22 performance attributes are the same as their competitors; the direction of development of 13 performance attributes are worse than previous two years; and 27 performance attributes are the same as previous two years.

In summary, all groups indicated that TPR3 (honest and truthful with customers), BC1 (customer satisfaction), and BC8 (overall response to customer) are important to them. Their answers also indicated that IIT4 (completes the registration of new ideas and products at the Department of Intellectual Property) has been less carried out in the companies and their expectations are also low compared to other performance attributes.

#### **Critical Factor Index (CFI)**

The CFIs were calculated by using the formulas as mentioned previously. The goal of this CFI analysis is to provide support decision making whether which performance attributes are critical and should be focused. The CFIs were calculated from all respondents as well as separately for top management, factory manager, and sales/marketing manager. The compared CFIs results from all respondents and in separated groups are depicted in Table 5 and shown in Fig. 5 to Fig. 8. The numbers in red indicate performance attributes that are to be seen as critical and figures in green are attributes that are considered to be strengths.

Figure 5 indicates that the highest CFIs for all positions of first tier suppliers are TBC5 (share profits gained through collaborative efforts with customers), BF2 (profit growth), and TBC4 (offer technical training/education to customers to help them improve performance). The performance attributes that are proposed to be critical (in red) are TPR3 (honest and truthful with customers), BC1 (customer satisfaction), BC8 (overall response to customer), and LE4 (encouraged communication with all levels in organization).

Table 5  
Results of Critical Factor Index (CFI).

Performance Attribute	CFI All positions	CFI General Manager/ Top Management	CFI Factory Manager	CFI Sales/Marketing Manager	
1	2	3	4	5	6
1	LKH1	2.4122	2.9291	3.5229	<b>0.4536</b>
2	LKH2	3.2258	3.4830	3.7407	3.0450
3	LKH3	3.0393	3.8478	1.8022	3.7245
4	LKH4	5.4996	13.5755	1.1410	2.3316
5	LKH5	5.2919	6.8399	<b>7.1517</b>	3.1016
6	LKL1	3.0527	2.5859	5.3317	1.6973
7	LKL2	2.7017	0.9906	3.9664	1.6316
8	LKL3	3.1215	3.6833	4.1628	2.5689
9	LKL4	2.3848	4.5739	1.4786	1.8260
10	LKL5	2.3435	2.2928	3.4819	0.9077
11	LC1	1.6773	1.7432	1.4560	1.2981
12	LC2	4.5874	3.0341	<b>5.7692</b>	6.7891
13	LC3	3.6725	1.0238	4.8368	3.0011
14	LC4	1.5237	2.2174	1.2033	1.1909
15	LC5	2.8024	3.7304	2.8422	1.1921
16	LE1	3.9263	4.9800	2.5976	0.5371
17	LE2	4.4117	3.8413	4.0721	3.9406
18	LE3	5.5753	7.3857	4.8794	1.8766
19	LE4	<b>0.6659</b>	<b>0.8996</b>	0.4340	0.8248
20	LE5	2.4025	3.4776	0.9789	3.5596
21	TPP1	4.4276	9.3495	1.4614	2.2109
22	TPP2	1.0044	1.5993	0.5944	0.5016
23	TPP3	2.4277	5.0504	1.2479	<b>0.0000</b>
24	TPR1	2.6681	5.1974	0.7205	<b>0.0000</b>
25	TPR2	1.7681	3.1852	0.4497	<b>0.2889</b>
26	TPR3	<b>0.3226</b>	<b>0.4251</b>	0.4723	<b>0.0000</b>
27	TO1	1.6385	3.1151	1.4425	<b>0.0000</b>
28	TO2	1.2807	1.7186	0.6751	1.5443
29	TO3	3.3165	7.4357	0.6734	1.1690
30	TO4	2.1379	3.7739	0.5002	2.1981
31	TO5	6.5753	11.9111	4.0287	2.2146
32	TBC1	3.0375	5.1239	0.7205	2.7902
33	TBC2	6.1509	9.1172	1.8038	5.8768
34	TBC3	4.6561	9.8712	1.6620	2.4360
35	TBC4	<b>8.2721</b>	13.5477	<b>9.6709</b>	2.3733
36	TBC5	<b>10.9953</b>	<b>21.4635</b>	5.5128	<b>9.5526</b>
37	TE1	5.5107	7.2313	0.3943	8.0668
38	TE2	6.1544	9.4856	0.9985	6.4722
39	TE3	7.4204	10.9576	1.1960	6.4717
40	TE4	6.0034	15.0024	0.6832	2.2043
41	IPI1	2.2024	1.5032	1.5527	4.4789
42	IPI2	2.1608	3.0185	1.5487	2.5909
43	IPI3	1.9447	3.6897	0.4989	1.0763
44	IPI4	2.2295	3.2212	0.6740	1.3994
45	IPI5	3.4308	3.5262	2.3399	4.6612
46	IPI6	2.7982	4.7498	1.7867	2.0253
47	II1	3.3113	3.2781	2.1456	5.6315
48	II2	2.7622	3.0983	1.0472	5.6716
49	II3	3.9839	5.5573	0.6928	6.8756
50	II4	4.1048	7.1730	1.2033	5.4982

1	2	3	4	5	6
51	II5	3.2703	3.8465	2.2691	3.8364
52	IIT1	2.5289	3.0955	3.2041	1.7025
53	IIT2	2.3348	3.9057	1.4167	1.7304
54	IIT3	3.5051	7.0952	1.1458	2.6682
55	IIT4	6.0234	5.9489	4.4158	<b>9.5896</b>
56	IIT5	1.7800	1.5781	<b>0.2429</b>	1.8003
57	ECS1	1.7733	2.7012	0.4302	1.6889
58	ECS2	3.5593	8.5131	0.7968	2.3282
59	ECS3	2.2222	4.2720	0.4513	1.1387
60	ECS4	1.1064	1.7315	<b>0.2147</b>	0.5626
61	ECS5	3.0164	2.3564	0.3590	7.0443
62	ECS6	2.4271	3.8157	1.2416	1.5276
63	ECS7	1.5083	<b>0.8989</b>	1.5235	2.6682
64	ECL1	2.0106	2.6482	2.5749	1.8571
65	ECL2	3.1604	3.6348	2.6153	3.5477
66	ECL3	3.7309	5.4374	1.2447	5.3669
67	ECL4	4.1353	4.7407	1.0633	4.3753
68	EB1	3.6134	5.7837	2.4520	2.7606
69	EB2	4.1371	5.5250	4.5044	3.2551
70	EB3	1.9784	2.8800	1.4106	1.0714
71	EB4	6.0603	6.8059	3.3956	8.9155
72	EB5	5.3776	5.2135	5.6120	6.6290
73	EB6	6.7404	3.5613	0.6915	<b>13.0573</b>
74	BF1	7.8217	21.0377	0.6861	1.5077
75	BF2	<b>8.3867</b>	<b>21.4356</b>	0.6200	2.8870
76	BF3	7.8781	19.7921	<b>0.2946</b>	1.6371
77	BS1	7.2193	<b>21.3436</b>	0.6849	0.8752
78	BS2	7.3789	19.5895	1.0743	2.1962
79	BS3	8.1521	19.5895	0.6928	5.0754
80	BS4	8.1069	18.5814	<b>0.2946</b>	5.0881
81	BC1	<b>0.4006</b>	<b>0.6879</b>	<b>0.2153</b>	<b>0.0000</b>
82	BC2	0.8861	1.0699	1.2493	<b>0.0000</b>
83	BC3	4.4289	5.6443	2.2390	4.0655
84	BC4	4.1263	6.9209	1.4996	3.7541
85	BC5	4.1462	5.0689	3.8589	3.5684
86	BC6	0.9001	1.1409	0.4486	1.3472
87	BC7	7.4192	13.1428	0.4774	8.4555
88	BC8	<b>0.5548</b>	<b>0.7470</b>	0.5404	<b>0.0000</b>

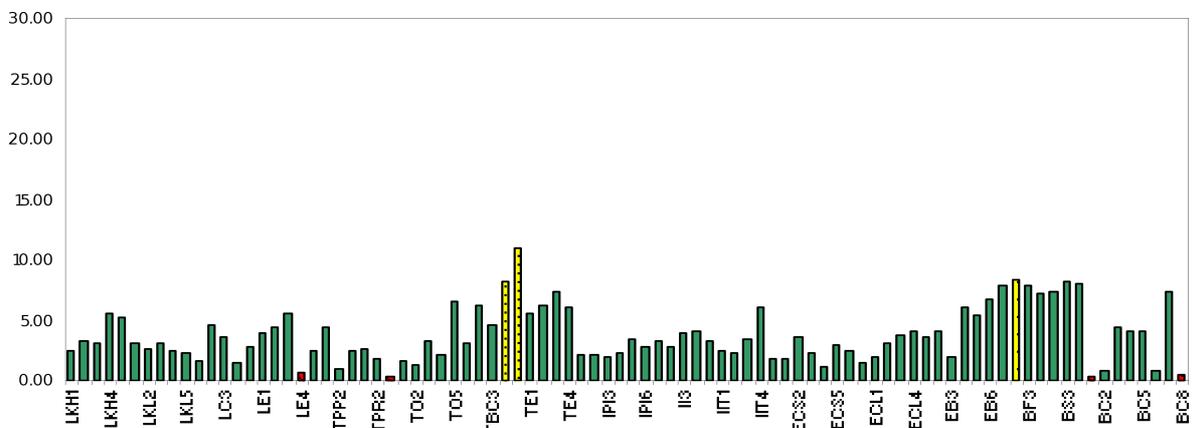


Fig. 5. Critical Factor Index (CFI) for answers collected from all first tier suppliers.

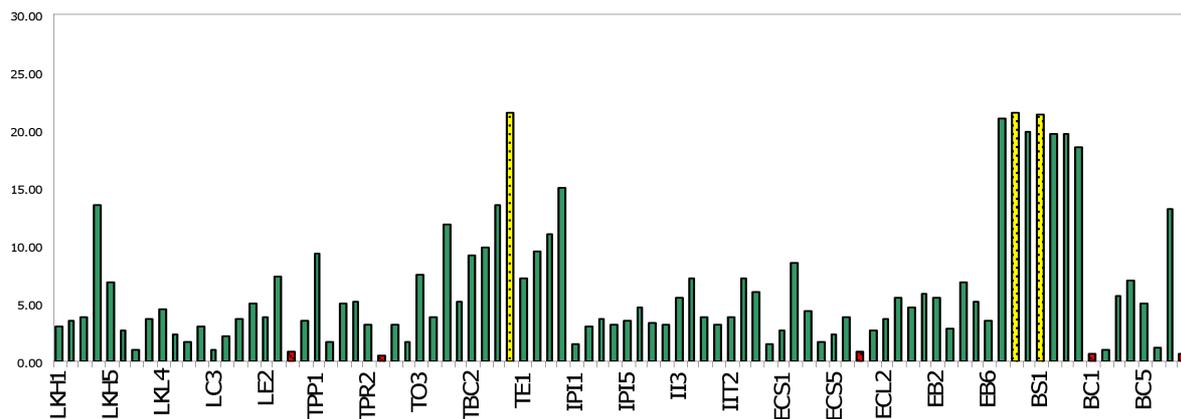


Fig. 6. Critical Factor Index (CFI) for answers collected from Top management of first tier suppliers.

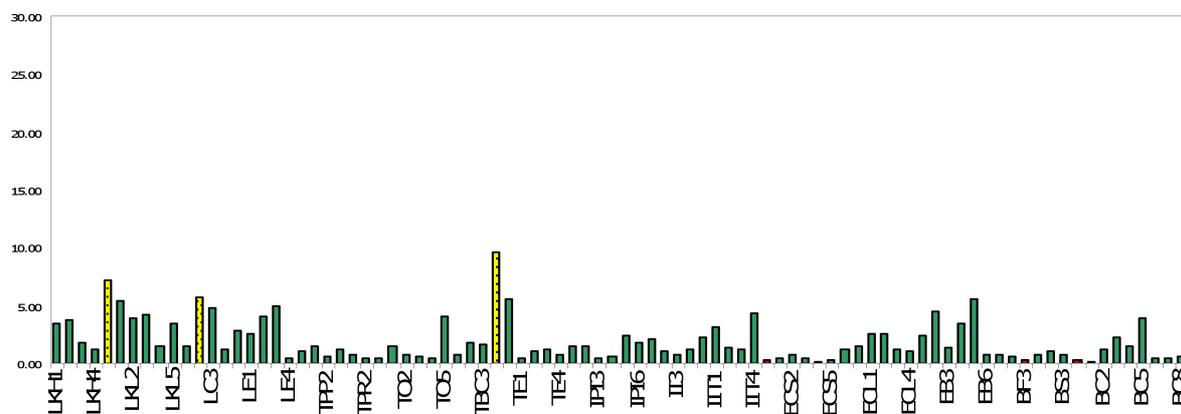


Fig. 7. Critical Factor Index (CFI) for answers collected from factory managers of first tier suppliers.

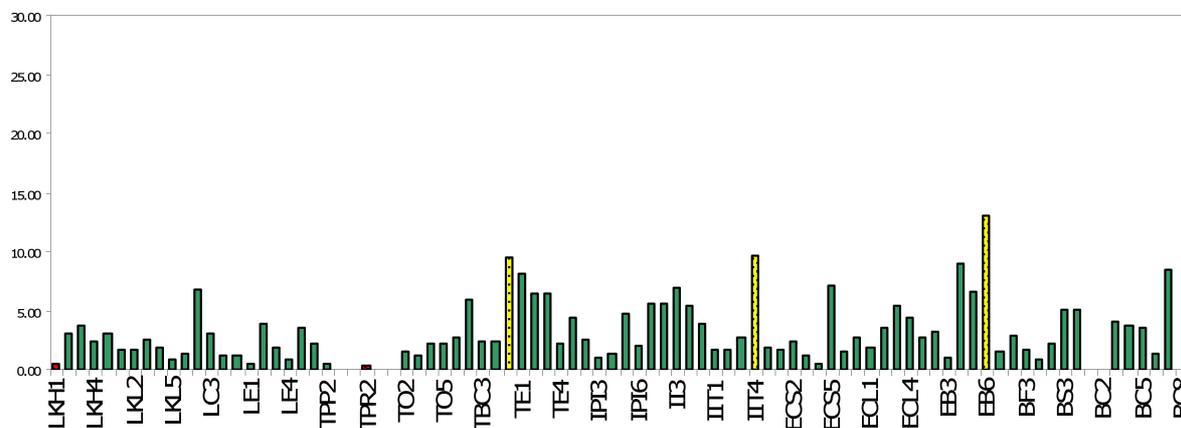


Fig. 8. Critical Factor Index (CFI) for answers collected from sales/marketing managers of first tier suppliers.

**CFI – top management**

The CFIs calculated from top management’s answers are depicted in Fig. 6. The top management CFIs are quite similar to the overall CFIs. From this figure, it can be seen that the CFIs in red are TPR3 (honest and truthful with customers), BC8 (overall response to customer), BC1 (customer satisfaction), ECS7 (a pool of their customers would indicate that

the customers are generally satisfied with their organization), and LE4 (encouraged communication with all levels in organization) and four of five performance attributes are also in red while calculating by using the answers from all position, only ECS7 (a pool of their customers would indicate that the customers are generally satisfied with their organization) is different.

### CFI – factory manager

The CFIs calculated from factory managers' answers are depicted in Fig. 7. The factory managers CFIs are quite different from the others. From the figures, the performance attributes in red are ECS4 (care about what the customer thinks or wants); BC1 (customer satisfaction); IIT5 (communicate with other departments to solve the problems in the organization and keep records); BF3 (profit margin); and BS4 (market share growth). Only BC1 is also appeared to be high score in expectation by the other positions.

### CFI – sales/marketing manager

The CFIs calculated from sales/marketing managers' answers are depicted in Fig. 8. Some of the performance attributes that were answers from the sales/marketing could not be calculated for CFIs since the standard deviation of expectation or experience is zero value. However, the remaining performance attributes were calculated and plotted in the graph. The figures in red are TPR2 and LKH1 which are fairness and integrity accurately characterize all dealing with customers; and training for the new staff before starting job.

### Discussion and further studies

The results from the analysis can be summarized in Table 6.

According to the results from all respondents, the first tier suppliers in the Thai automotive supply chain should focus on the engagement in learning and growth element, professional relationship in trust, and customer in business performance element. However, there are some results analyzed from different positions that appear to have some different critical performance attributes. This is understandable as different groups have different points of view. For instance, sales/marketing managers focused on the know-how in learning and growth element (LKH1: training is required for the new staff before starting job.) because they are the contact point to the customer. Therefore they require having know-how in order to explain or answer the customers' questions about products and company. Factory managers required the information technology in the internal process element (IIT5: communication with other departments to solve the problem in the organization and keep record) because they manage the factory that produce the products where the problems that occur in the manufacturing process need to be solved quickly and always need other departments to be involved.

Table 6  
Summarized results of Critical Factor Index (CFI).

Supply chain performance		Critical performance attribute			
Elements	Indicators	All	Top Management	Factory Manager	Sales/ Marketing Manager
Learning and growth	Know-how (LKH)				LKH1
	Knowledge (LKL)				
	Competency (LC)				
	Engagement (LE)	LE4	LE4		
Trust	Performance-to-promise (TPP)				
	Professional-relationship (TPR)	TPR3	TPR3		TPR2
	Openness (TO)				
	Benevolent- collaboration (TB)				
	Empathy (TE)				
Internal process	Process improvement (IPI)				
	Innovation (II)				
	Information technology (IIT)			IIT5	
External structure	Customer satisfaction (ECS)		ECS7	ECS4	
	Customer loyalty (ECL)				
	Brand (EB)				
Business performance	Financial (BF)			BF3	
	Sales (BS)			BS4	
	Customer (BC)	BC1 BC8	BC1 BC8	BC1	

The results from this questionnaire process are still preliminary. The answers from the automaker companies are few and cannot be analyzed. In future researches, the answers from the automakers will be collected and analysis will be made. In the long term, the causal relationship between the supply chain performance elements focusing on the critical performance attributes will be studied.

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