Relationship Analysis between Purchasing Strategy and Supplier's Learning Ability in the Automotive Industry

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Abstract

The purposes of this research are to identify criteria for supplier selection and the proper strategy to order parts for the automotive industry, and also bring the suppliers' learning ability to be analyzed. The data is surveyed from the aspects of the experts in purchasing departments of car assembly companies which are the first tier in the automotive industry by in-depth interviews based on the outline of a questionnaire with three main points to concern: (1) to identify criteria to select the proper suppliers and the weight of each criteria, (2) to investigate the factors which are considered to specify ordering and purchasing strategy and the strategy which affects the purchasing efficiency, and (3) to compare the influence of the factors which affect the suppliers' learning rate. The surveyed data is analyzed by statistical techniques to construct a structural equation model. The result of research could be the guideline for the development of supplier selection method, and specify proper ordering strategy which also considers suppliers' learning ability.

Keywords: Supplier Selection, Purchasing Strategy, Learning Ability, Automotive Industry

1. Introduction

As we know, competition capability in the automotive industry depends on purchasing efficiency. The data from a survey indicates that 50-90% of total cost comes from raw materials and parts purchasing cost (Telgen 1994). It shows clearly that the purchasing process is extremely important for the survival of organizations. Moreover, after Thailand has bilaterally negotiated with many countries to establish a Free Trade Area agreement, those organizations will have many choices to buy cheap and tax-free raw materials and component parts from suppliers freely. However, the possibility is of more or less advantages (the company gets cheaper raw materials). There are still questions because obstruction of efficient purchasing can occur from many factors, such as, long purchasing lead time, fluctuation of exchange rate, product quality, including the lack of necessary qualifications of suppliers in developing countries which the buyer needs. In addition, the result of the research shows that many suppliers can improve themselves; it depends on suppliers' readiness of resources, like infrastructure, human resources, investment funds, or production experience (Yelle 1976). Therefore, these factors can be brought to support the analysis that can help the buyer to select the proper supplier by considering from the long-term benefits.

This research aims to investigate necessary information from automotive industry companies including, (1) proper criteria and weight for supplier selection, (2) factors to specify the ordering and purchasing strategy, (3) suitable ordering and purchasing strategy, and (4) factors affecting the supplier learning rate. All survey results are used to develop methods for supplier selection and specifying proper ordering strategy which also consider suppliers' learning ability to find the answers of: (1) which supplier should be ordered from?, (2) how to order? and (3) when is a suitable time to order?

2. Literature Review

The previous study of supplier selection and purchasing shows that the critical criteria

are varied along with the market environment, the purchasing strategy and material requirement planning system. Earlier, the purchasing experts concentrated on the total cost (Dickson 1966), then, considered the qualitative criteria which affect the development of various evaluation methods (Weber *et al.* 1991). The research changed from mathematical models with single objective (Pan 1989; Hong, and Hayya 1992) to multi-objective, in which qualitative criteria are considered with weighting system for each criterion (Weber and Current 1993; Ghodsypour and O'Brien 2001). This system has various methods such as adopting the Analytical Hierarchy Process (AHP) (Ghodsypour and O'Brien 1998). Because the essential weights influence the answer, it should come from reliable sources and suit the needs of each firm to select suppliers. Moreover, the proper criteria must fit the current situation, firm characteristics and also the policy.

For better purchasing efficiency, the strategy which should be applied to the supplier, is very important. Especially in the past 20 years, raw material purchasing from global sourcing has played a much more important role for the survival of firms (Kotabe and Murray 2004). Hence, the adapted strategy has to be considered carefully. This strategy has to be efficient and has to help the development occur. The researchers tried to identify the proper strategy for supplier efficiency development by surveying purchasing specialists' opinions, and then building a mathematical relationship model based on the principle of statistics (Watts and Haln 1993; Amelia and Larry 1999; Krause 1999). Most strategies can increase the development of purchasing efficiency, e.g. supplier development plans, contract types and communications between buyers and suppliers, etc (Li *et al.* 2003; Humphreys *et al.* 2004). Furthermore, positive thinking and fair benefits between each other can make suppliers willingly cooperate more in other activities (Masato 2004).

The learning curve phenomenon was discovered in 1920 in the aircraft industry. It revealed that after producing goods for a while, capability was developed which was the result of experience, skill, and production process improvement. Then, production time and cost were reduced. A mathematical equation was first developed by Yelle (1976) to simulate the learning curve phenomenon which resulted from experience and skill. There are a lot of researchers trying to apply this equation in many fields of study. Bowan (2003) applied

mathematical model concerned with the learning effect, in order to find out suitable amounts of purchasing parts from 2 suppliers, and assumed that the learning effect depends on the duration of time and the amount of parts which have already been produced, by fixing the learning rate all of cost reduction capability. Almost all of the previous studies referred to, and assumed the learning effect and learning rate in different patterns, (Bowan 2003; Gavious and Rabinowitz 2003; Valluri and Croson 2003) that question, which factor and circumstances influence the supplier learning rate, and how strong is the influence.

3. Theoretical Framework
3.1 Supplier Selection Criteria
This research collects criteria from the supplier selection and purchasing literature (Weber and Current 1993; Ghodsypour and O'Brien 2001) and from interviews of purchasing experts. The criteria consist of the followings:

(1) *Cost*, e.g. price, ordering cost, tax and tariff, and transportation cost, etc.

(2) *Quality*, e.g. defect rate, the system to examine and control the quality, etc.

(3) *Delivery*, e.g. on-time delivery, delivery type, etc.

(4) *Flexibility*, e.g. the ability to change the order, the minimum amount of order that the supplier sets, etc.

(5) *Production and Technology*, e.g. the readiness of production equipment, supplier's experience, etc.

(6) *Management*, e.g. the supplier's organizational structure, executive leadership, etc.

(7) *Service*, e.g. product warranty, reserved spare parts service, etc.

(8) *Other common qualifications*, e.g. supplier's reputation, supplier's geographic location, etc.

3.2 Factors to Specify the Ordering and Purchasing Strategy
This research collects factors not only from various studies of purchasing theory (Chopra and Meindl 2003; Jaturongkakul 2004; Yuupo 2001) but also from the interviews of purchasing experts. The factors consist of the following:

(1) *Supplier factor* (FAC01): To specify suitable strategy involving supplier development plans, a buyer has to know the characteristics of a supplier, such as, total cost, quality, lead time, etc. (Jaturongkakul 2004).

(2) *Competitor factor* (FAC02): Because of the highly competitive market, a firm should be adjustable and find suitable strategy which helps to sustain advantages over rivals. Hence, a firm should know about knowledge and the ability of competitors (Kotabe and Murray 2004).

(3) *Customer factor* (FAC03): To survive in business, each firm must well satisfy customers. Hence, strategic planning should be also considered for customer needs (Chopra and Meindl 2003).

(4) *Part specification factor* (FAC04): In the automotive industry, some parts have different properties, life times, and up-to-date factors. These factors influence purchasing efficiency, therefore, a buyer should consider these factors for specifying proper strategy (Smith 1999).

(5) *Management factor* (FAC05): Because of the difference of each firm's characteristics, such as purchasing procedure, organization's culture, raw material planning system, etc., suitable ordering and purchasing strategy should be specified depending on firm characteristics (Chopra and Meindl 2003).

(6) *Production factor* (FAC06): If parts purchasing depends on the overall picture of production, including other parts, purchasing will be more efficient (Chopra and Meindl 2003). Hence, to specify purchasing strategy, readiness of tools and machines, readiness of other component etc. should be considered.

(7) *Storage of parts factor* (FAC07): Beside the storage ability, storage area limitations are also different between each firm. Therefore, purchasing strategy should be adjustable to suit these factors as well (Chopra and Meindl 2003):

(8) *Personnel factor* (FAC08): Due to variety and complexity of purchasing strategies, success depends on knowledge, ability and experience of purchasing staff (Masato 2004). So a buyer should specify strategy to suit a firm's personnel and relationships between a buyer and a supplier's personnel.

(9) *Economic factor* (FAC09): Demand and sales amounts of a firm depends on the economic environment, which affects part prices and part shortages. The risk to the firm is reduced by using suitable - strategy for any situation that can give more advantages than competitors (Yuupo 2001). Factors which should be considered are market demand and supply, the establishment of the free trade area, etc.

(10) *Social and cultural factor* (FAC10): Other than product quality and on-time delivery, some customers expect environmental and social

responsibility which buyers also gain benefits, such as, government policy to support local suppliers, etc.

(11) *Rule and regulation factor* (FAC11): Present purchasing procedure has many rules and regulations involved which make more or less benefits to purchasing efficiency (Jaturongkakul 2004). Therefore, for proper purchasing process, a buyer should consider these factors as well, for example, rules of purchasing parts from other countries, etc.

(12) *International situation factor* (FAC12): Due to the increase of global sourcing, buyers should consider trade barriers, riots, etc., to get more advantages and sustain suitable strategy to suit global situations (Chopra and Meindl 2003).

3.3 Ordering and Purchasing Strategy

In this research, ordering strategy means which supplier that the buyer should order parts from, how to order, and when to order to achieve high purchasing efficiency. Purchasing strategy means the strategy concerning purchasing procedure, e.g. contract type strategy, supplier development strategy, etc. These strategies aim to improve purchasing efficiency and supplier development. Information from purchasing literature and interviews of purchasing experts provide the baseline strategy in this research. The strategy consists of the following:

(1) *Supplier evaluation* (ST01) is the supplier efficiency rating system. An Effective evaluation system must identify and track supplier efficiency from key multi-dimensions (Li *et al.* 2003). In order to keep supplier efficiency and reliability, supplier evaluations must always be carried out (Humphreys *et al.* 2004). In addition, evaluations let the buyers know suppliers' important weak points which help the buyers make correct and suitable plans to develop key supplier.

(2) *Supplier policy* (ST02): To apply the supplier strategy successfully, it depends on the objectives and situations being used (Paul and Jack 1998). A single sourcing strategy is suitable for long term efficiency development, while a multiple sourcing strategy makes the competitors develop efficiency to be a supplier in emergency cases also (Ramsay and Wilson 1990).

(3) *Supplier contract type* (ST03): The contract is the key to develop a supplier's efficiency because without any contract or agreement, the supplier may not willingly adjust

the procedure to meet the buyer's requirements. Hence, a contract must have suitable details and objectives, e.g. the duration and contract details should offer incentives and punishment to the supplier and improve efficiency along with key dimensional measures (Ramsay and Wilson 1990). And a good contract should be fair for both buyer and supplier.

(4) *Supplier development plan* (ST04): A long term plan is the main factor to develop suppliers (Amelia and Larry 1999; Li *et al.* 2003). Watts and Haln (1993) suggested that the supplier development plan should emphasize development of the supplier's future capability in production technology; management and budget try to reduce production cost and develop parts quality. Hence, a good development plan should specify objective clearly and develop suppliers in many aspects.

(5) *Cooperation* (ST05): In order to get correct and good quality parts, both the buyer and supplier have to cooperate in every step from designing and producing. Those steps begin from analyzing and designing the parts, specifying part details, specifying the raw materials for production, designing the production process, and testing the parts (Chopra and Meindl 2003). Every step of the cooperation mentioned above, between the buyer and the supplier, will raise the purchasing efficiency (Masato 2004).

(6) *Trade alliance* (ST06): Generally, suppliers may not be willing to change themselves in order to meet the buyer's requirements. However, the buyer who accepts the supplier as a partner provides some help when the supplier faces some problems and is ready to develop a relationship with the supplier for a long time period. This can reduce the resistance of the supplier to change, so supplier development will have good cooperation (Krause 1999; Masato 2004).

(7) *Effective communication* (ST07): The buyer and the supplier need to communicate with each other to exchange important information for running their business, e.g. the data forecast the parts requirements, efficiency data, etc. Therefore, to make the communication more efficient, the buyer and the supplier should exchange important data more often and open the communication channels in every level of administration (Amelia and Larry 1999). The communication not only increases the understanding and decreases the conflict between the buyer and the supplier, but it helps both firms to develop effective plans (Li *et al.*

2003).

(8) *Sourcing development* (ST08): In the automotive industry, the local suppliers are important to manage the business. However, when the global economic situation changes very quickly, the parts purchased from global sourcing are very important to maintain the competitive capability of the firm in the automotive industry (Kotabe and Murray 2004). Therefore, searching and listing new suppliers, including the development of the new suppliers for better delivery, will give more alternatives for the buyer and push the suppliers to try harder to exist and be selected by the buyer.

3.4 Purchasing Efficiency

(1) *Buyer efficiency* (EFF01): The normal efficiency indicator of the firm (cost of goods in stock, sales amount of the firm), advantages over competitors and reaction capability to market requirements, and also fast development of new products, are good indicators to show the survival of the firm (Kotabe and Murray 2004). This makes efficiency measurement from this concept important to develop a purchasing strategy.

(2) *Supplier efficiency* (EFF02): The measurement of the supplier efficiency depends on the criteria that the buyer uses to evaluate and select a supplier, e.g. price of the parts, supplier quality, delivery, lead time and the development of new products, etc. These indicators are easy to understand and the changes can be noticed easily.

3.5 Factors Affecting Supplier Learning Rate

The concept of these factors is developed from the literature about learning curves (Bowan 2003; Gavious and Rabinowitz 2003; Valluri and Croson 2003) and interviews from the purchasing experts as below:

(1) *Technology transfer types* consist of the buyer passing on technology to key suppliers and the key suppliers pass on technology to buyers.

(2) *Duration of contracts* consists of short term contracts and long term contracts.

(3) *Contract types* consist of incentive contracts and punishment contracts.

(4) *Supplier strategies* consist of single sourcing and multiple sourcing.

Ramsay and Wilson (1990) indicated that those factors affect the supplier learning rate, which is different for each field of learning as follows:

(1) *Production cost* is the capability level to

reduce production cost.

(2) *Quality* is the capability level to reduce defect rate.

(3) *Delivery* is the capability level to

improve on time delivery.

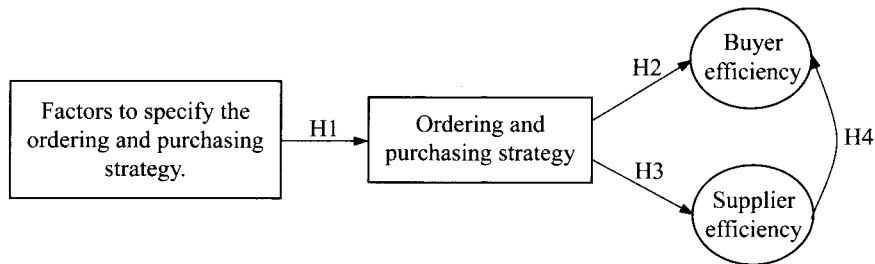(4) *Lead time* is the capability level to reduce the ordering lead time.

Figure 1: Relationship between studied factors, ordering and purchasing strategy, and buyer-supplier efficiency.

4. Hypothesis

From the research's objectives -- to identify the necessary factors for consideration to specify the ordering and purchasing strategy and to specify the proper ordering and purchasing strategy -- the researcher examined the hypothesis as follows:

(1) To guide automotive firms in finding proper and efficient specification of purchasing strategy in any circumstance: Twelve factors (FAC01-FAC12 shown in section 3.2) to specify purchasing and ordering strategy were tested to verify the main factors which should be considered in specifying appropriate strategy as shown in hypothesis 1.

H1: The factors, to specify the ordering and purchasing strategy, are positively related to the ordering and purchasing strategy which the buyer applies to use.

(2) Many purchasing strategies were presented in previous literature. In effect, few of them affect purchasing efficiency development. Hence, this research aims to explore and indicate which strategies used in the automotive industry make suppliers and buyers to be more efficient. These strategies consist of 8 strategies as described in hypotheses 2-3.

H2: The ordering and purchasing strategy, which the buyer applies to use, has impact on the supplier efficiency.

H3: The ordering and purchasing strategy, which the buyer applies to use, has impact on the buyer efficiency.

(3) From previous literature and interviews of purchasing experts, the development of a supplier is a key to accomplish the buyer's efficiency improvement, e.g. advantages over the competitors, reaction capability to the market

requirements, etc. To encourage automotive firms to realize the supplier development importance, in this paper, this hypothesis was tested through the point of view of purchasing experts in the automotive industry as shown in hypothesis 4.

H4: The supplier efficiency has impact on the buyer efficiency.

The initial conceptual model is drawn from all hypotheses as shown in Figure 1.

5 Methodology
5.1 Instrument

The survey instruments consist of the questionnaire and the exploratory interview guide. The questionnaire was developed based on literature review in the areas of supplier selection, ordering and purchasing strategy and from questioning the purchasing experts (questionnaire's structure shown in Table 1). The questionnaire was created through the procedure of creating the questionnaire for general research (Jamornman 2001). The drafted questionnaire was examined for content accuracy which can be measured from the index of Item Objective Consistency (IOC). If the IOC value, which is examined and evaluated by 3 qualified experts who have experience and knowledge in the field, is equal to 0.5 and above, it shows that the questionnaire has content accuracy. Then, the questionnaire was pre-tested by collecting the data in automotive industry companies, which are not the samples to study. The result was analysed to find the reliability of the questionnaire by Cronbach's alpha coefficiency.

In the data survey stage, because the required data has both facts and opinions, "how" and "why" questions were asked to the

interviewees who helped us question the data correctly.

Table 1: Purpose of the questionnaire.

Question	The objectives of the questions
Section 1	To identify characteristics of respondents.
Section 2	To identify the type of firm.
Section 3	To observe general company information in terms of purchasing process.
Section 4	To identify weight of supplier selection criteria.
Section 5	To investigate all factors that specify the ordering and purchasing strategy.
Seciotn 6	To investigate ordering and purchasing strategy.
Section 7	To investigate the supplier and buyer efficiency.
Section 8	To investigate respondents's view on factors that affect the supplier's learning rate

5.2 Respondents

The respondents in this research are purchasing managers in car assembly companies or the people directly concerned or whom the companies assigned to give information. The researcher agrees that they have experience, knowledge, and competence enough to give correct information on our objectives.

5.3 The Survey Result

This research surveyed and collected data by interviewing 18 case studies and found that interviewees in each case study have qualifications enough to give correct and reliable data, because they are in high level posts and their responsibility directly affects the purchasing section, which are 7 purchasing managers (38.9%), 4 purchasing assistant managers (22.2%), 6 purchasing experts (33.3%) and 1 purchasing engineer (5.6%), which have long period experiences (shortest experience is 2 years). Most of them, 9 (50.0%), have experience of more than 10 years.

The company registered capital was used as an indicator of firm's size. We found that most of them have registered capital of more than 2,000 million baht which are 38.9% of respondents. The registered capitals are varied

into many intervals and the respondents that have registered capital lower than 500 million baht are 16.7% of respondents, the registered capital between 500-1,000 million baht are 22.2% of respondents, and between 1,000-2,000 million baht is also 22.2% of respondents.

We found there are 3 reasons that pushed buyers to purchase parts from suppliers. 50.0% of the respondents want to reduce the cost. 33.3% of the respondents want to get more advanced technology from suppliers and the rest, 16.7% think that they still have a lack of skill.

Most respondents (61.1%) need 3 suppliers for comparison when the company is required to purchase a part while 27.78% of respondents need more than 3 suppliers. Only 1 or 2 suppliers are needed by the same 5.56% of respondents.

The result shows that 16.7% of respondents buy their raw material and parts from abroad with 11-20% of their purchasing budgets. 50.0% of respondents buy their raw material and parts from abroad with 21-30% of their purchasing with, 27.7% of respondents buy their raw material and parts from abroad with 31-40 of their purchasing budget, and 5.6% of respondents buy their raw material and parts from abroad with 41-50% of their purchasing budget.

There are various reasons to purchase parts from global sourcing. Most of them (44.44%) can not find the required part in the domestic area. 27.78% of respondents mentioned that a global supplier has more advanced technology than the local. 16.67% of respondents want to build new transactions and expand the business into the purchased country. 11.11% of respondents mentioned that global sourcing is cheaper than local sourcing.

6. Result Analysis
6.1 Supplier Selection Criteria

In the data collection procedure, we let the respondents arrange the standard priority from 8 criteria which the buyers use to select the suppliers (1-8, the 8 is the most important). The data was brought to make the factor analysis for grouping the criteria which should have equal importance weight in statistics, and find the weight of criteria in each aspect from averages of the survey data.

(1) Criteria in the 1st group consist of delivery, production and technology and management which have importance weight in equivalent to 12.62%.

(2) Criteria in the 2nd group consist of cost

and quality which have importance weight equivalent to 20.48%.

(3) Criteria in the 3rd group consist of flexibility and other common qualifications which have importance weight equivalent to 6.26%.

(4) Criteria in the 4th group consist of service which have importance weight equivalent to 8.66%.

6.2 Structural Equation Model

From the interviews of 18 purchasing experts in the automotive industry, the original data are shown only for FAC02 (Table 2).

Table 2: Original surveyed data of FAC02.

Case Study	Competitor factor (FAC02)		
	CPT01	CPT02	CPT03
1	5	5	5
2	5	4	5
3	4	4	4
4	5	5	5
5	5	4	4
6	5	5	5
7	5	5	4
8	5	5	5
9	4	5	5
10	4	5	4
11	5	4	4
12	4	4	3
13	3	4	4
14	5	5	5
15	3	4	3
16	5	5	5
17	4	4	5
18	4	4	4

Table 2 shows original data from the survey in which the Competitor factor (FAC02) consists of 3 internal factors, CPT01 (Competitor's production ability CPT02 (Production standard established by market competition) and CPT03 (Level of intensity in competition). The answer of the interview exposes the strength of influence to the factor specifying purchasing and ordering strategy, which is classified into 5 scales: 5=extremely, 4=severely, 3=moderately, 2=fairly, and 1=not at all. Then, the survey result was analyzed to construct the structural equation model as follow:

6.2.1 Validity And Reliability

The Structural equation model has to be evaluated for validity and reliability of all

factors by exploratory factor analysis and correlation analysis.

For example, the results of validity and reliability analyses of Competitor factor are shown in Table 3. Validity of these internal factors must be tested by the factor analysis

Table 3: Variable name, factor loading and reliability Cronbach's alpha.

Factor	Factor Name	Factor loading
FAC02	- Competitor factor *reliability Cronbach's alpha = 0.776*	
CPT01	Competitor's production ability	0.824
CPT02	Production standard established by market competition	0.818
CPT03	Level of intensity in competition	0.866

technique. If all of the internal factors are valid structures of the main factor, the factor loading value must be positive and a high value for all of the group, which should have a value of more than 0.300 in order to accept the internal factors as a valid structures (Humphreys et al. 2004). From Table 3, factor loading values of these internal factors are high so that all internal factors are valid structures of the main factor FAC02.

For all main factors (FAC01-FAC12, ST01-ST08 and EFF01-EFF02), the result found that the factor loading value is between 0.426 (STORC: Inventory storage cost is internal factor of EFF01) and 0.936 (DEV02: Listing new suppliers from abroad is internal factor of ST08), which the lowest value is more than 0.300. Hence, it is acceptable that all of the internal factors are valid structures.

Furthermore, for reliability of structure, all main factors must be tested. The reliability is the measurement of the internal consistency by measuring the reliability Cronbach's alpha. If the value is more than 0.700, it shows that the internal factors have strong relationships to each other and will affect the main factor to be reliable. However, if the value of the reliability Cronbach's alpha is between 0.400-0.700 that the internal factor can still be accepred (Amelia and Larry 1999). From Table 3, reliability Cronbach's alpha value of Competitor factor is 0.776, which is more than 0.700, hence, internal factors have relationships to each other and

make this main factor structure reliable.

The exploratory factor analysis found that the value of the reliability Cronbach's alpha of each main factor is between 0.504 (main factor FAC12) and 0.938 (main factor ST04), of which the lowest value is more than 0.400. It is acceptable that the internal factors have relationships to each other and all the main factor structures are reliable.

6.2.2 Regression Analysis

Regression analysis was used to test all hypotheses. The result is shown in Table 4.

Table 4: Summary of regression analysis for hypotheses 1-4.

Independent Variable	B	S.E.	Beta	Adj.R^2
H1: Predicting ST01				
(Constant)	-2.383	1.225	-	0.612
FAC01	0.563	0.227	0.389[b]	
FAC02	0.486	0.158	0.468[c]	
FAC05	0.405	0.155	0.408[b]	
H1: Predicting ST02				
(Constant)	-1.511	1.268	-	0.507
FAC08	0.677	0.221	0.522[c]	
FAC09	0.704	0.212	0.567[c]	
H1: Predicting ST03				
(Constant)	-0.519	2.025	-	0.540
FAC05	0.923	0.271	0.579[c]	
FAC06	0.724	0.315	0.384[b]	
FAC08	-0.745	0.320	0.395[b]	
H1: Predicting ST04				
(Constant)	-2.973	1.087	-	0.705
FAC04	0.569	0.153	0.496[c]	
FAC06	0.689	0.199	0.512[c]	
FAC09	0.412	0.191	0.320[b]	
H1: Predicting ST05				
(Constant)	3.218	1.304	-	0.536
FAC01	-0.482	0.212	0.378[b]	
FAC06	0.655	0.172	0.634[c]	
H1: Predicting ST06				
(Constant)	2.531	0.893	-	0.178

Independent Variable	B	S.E.	Beta	Adj.R^2
FAC09	0.453	0.209	0.476[b]	
H1: Predicting ST07				
(Constant)	-0.315	1.205	-	0.419
FAC07	0.459	0.202	0.420[b]	
FAC09	0.602	0.202	0.551[c]	
H1: Predicting ST08				
(Constant)	-4.690	1.863	-	0.526
FAC10	0.762	0.213	0.615[c]	
FAC11	1.114	0.310	0.616[c]	
H2: Predicting EFF01				
(Constant)	-0.956	1.192	-	0.419
ST01	-0.076	0.179	-0.150	
ST02	0.005	0.191	0.006	
ST03	0.439	0.239	0.536[c]	
ST04	0.327	0.205	0.389[b]	
ST05	0.249	0.219	0.268[b]	
ST06	0.221	0.216	0.229[a]	
ST07	0.099	0.224	0.138	
ST08	-0.087	0.228	-0.112	
H3: Predicting EFF02				
(Constant)	-0.958	0.789	-	0.746
ST01	-0.018	0.118	-0.036	
ST02	-0.046	0.126	-0.062	
ST03	0.256	0.158	0.313[b]	
ST04	-0.03	0.135	-0.036	
ST05	0.405	0.145	0.436[c]	
ST06	0.291	0.143	0.302[b]	
ST07	0.028	0.148	0.039	
ST08	0.288	0.151	0.372[b]	
H4: Predicting EFF01				
(Constant)	1.556	0.692	-	0.410
EFF02	0.667	0.186	0.667[c]	

Note: significance level a: $p < 0.1$, b: $p < 0.05$, c: $p < 0.01$

From the result of regression analysis in Table 4, Hypothesis 1, which included 8 sub-

hypotheses, is shown in H1: Predicting ST01 to ST08. The test result of Hypothesis 2 is shown in H2: Predicting EFF01. The test result of Hypothesis 3 is shown in H3: Predicting EFF02, and the test result of Hypothesis 4 is shown in H4: Predicting EFF01.

Adjusted R^2 is goodness-of-fit measure of the regression model in the population. It ranges in value from 0 to 1. A large value indicates that the model fits the data well. From Table 4, only the result of H1: Predicting ST06 has a low value of adjusted R^2 because there is only one factor that is significant.

Standard Error is a measure of how much the value of a test statistic varies from sample to sample.

Beta coefficients are the regression coefficients when all variables are expressed in standardized (z-score) form. The minus of Beta means two factors are correlated in the opposite direction. The higher value of the number means a stronger correlation between two factors. A factor with low Beta value is not significant as shown in Table 4.

We can formulate the regression equation by using the b coefficient from Table 4 to estimate the change in the dependent variable that can be attributed to a change of one unit in the independent variable, as shown below (for H1, here we will show only 1 example):

H1:

$$ST01 = -2.383 + 0.563 FAC01 + 0.486 FAC02 + 0.405 FAC05 \tag{1}$$

Supplier factor (FAC01), Competitor factor (FAC02) and Management factor (FAC05) have positive relationship with Supplier evaluation (ST01) with levels of significance 0.05, 0.01 and 0.05 respectively.

H2:

$$EFF01 = -0.956 + 0.439 ST03 + 0.327 ST04 + 0.249 ST05 + 0.221 ST06 \tag{2}$$

Supplier contract type (ST03), Supplier development plan (ST04), Cooperation (ST05) and Trade alliance (ST06) correlate to (EFF01) in the positive direction at the level of significance 0.05 (except ST06, the level of significance is 0.1).

H3:

$$EFF02 = -0.958 + 0.256 ST03 + 0.405 ST05 + 0.291 ST06 + 0.288 ST08 \tag{3}$$

Supplier contract type (ST03), Cooperation (ST05), Trade alliance (ST06) and Sourcing development (ST08) correlate to (EFF02) in the positive direction at the level of significance = 0.05 (for ST05, it is also significant at the 0.01 level).

H4:

$$EFF01 = 1.556 + 0.667 EFF02 \tag{4}$$

Supplier efficiency (EFF02) has a positive relationship with Buyer efficiency (EFF01) which has beta = 0.667 at the level of significance = 0.01.
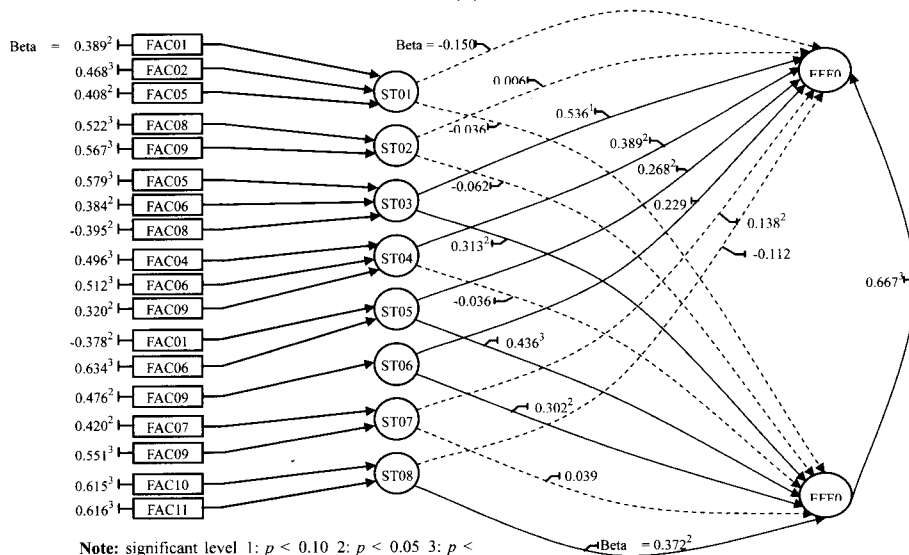

Figure 2: Structural equation model of factors to specify the ordering and purchasing strategy, ordering and purchasing strategy and purchasing efficiency.

The result from regression analysis will be used to construct the structural equation model as shown in Figure 2. Solid lines represent factors which are correlated to each other, where Beta is the correlation level from the regression analysis. The level of significance can be seen from Figure 2 and Table 4.

We can apply Figure 2 for purchasing, development planning and strategic specifications of organizations in the automotive industry. It can be used as a guideline, which factors should be considered in purchasing and ordering strategy specifications. It also helps to decide which strategy should be applied and gives both buyer and supplier more efficiency. Moreover, it confirms that development of suppliers encourages buyers to be more efficient.

6.2.3 Discussion
1. Factors to specify the ordering and purchasing strategy

There are many factors which buyers in the automotive industry consider to specify proper ordering and purchasing strategy: supplier factor, competitor factor, part specification factor, management factor, production factor, storage of part factor, personnel factor, economic factor, social and cultural factor and rules and regulations factor. For example, from our survey information, the economic factors which are significant to supplier policy, supplier development, trade alliance and effective communication, are used to specify strategy by the purchasing manager. This manager found that in the future, there will be a shortage of some parts. So he uses the single sourcing strategy with long term contract and attempts to keep good relations with the supplier, and also plans for development of the supplier. Moreover there is frequent communication and exchange of forecasting data between both parties to reduce the risk of shortage.

From this study, the personnel factor has a negative relationship with contract type. The data from the survey points out that respondents are concerned about the personnel factor as it is an important factor to specify the contract type strategy. But they are not concerned much about the implementation of that contract type strategy. However, the study of Masato (2004) indicated that a perceived moral obligation between personnel of the buyer's organization and the supplier gives both good and bad results for business process and strategy, which the buyer uses with the supplier. The supplier factor has a negative relationship with cooperation strategy.

Respondents see the importance of this factor but do not use this strategy. This may because the property of the supplier passes the qualifications, so some respondents neglect to implement this strategy seriously.

2. Ordering and purchasing strategy affecting purchasing efficiency

The analysis allows us to see that the type of contract affects the efficiency of buyer and supplier, which is consistent with the previous study. In addition, many contract type strategies are applied in organizations which also specify the development of supplier efficiency such as defect rate reduction, etc.

A supplier development plan affects the buyer efficiency but shows no affect on the supplier. Some of the respondents are small-to-medium sizes, therefore, they do not have enough potential to implement the supplier development plan strategy with the supplier.

Cooperation between buyer and supplier affects the efficiency. This is supporting the previous study. If there is good cooperation in every stage, the buyer will get part fitting design specifications and the supplier will pass on new technology from the buyer. Moreover, the supplier will have a chance to present a substitute.

Trade alliances affect either buyer or supplier efficiency, supporting the previous study. Sometimes, suppliers are not willing to change to meet buyer's requirements. But if this supplier is provided some help and a long term relationship from the buyer, the supplier will reduce resistance.

Sourcing development affects supplier efficiency but not buyer efficiency. If the buyer seeks a new supplier continuously, it will push the current supplier to improve its efficiency. This result is agreed only the interviews that local suppliers are forced to improve themselves by looking for new sources in the FTA of buyers. If the local suppliers do not improve themselves, they will not survive in the business.

Supplier efficiency has positive correlation with buyer efficiency. Hence, buyers should focus on the development of suppliers.

6.3 Factor Affecting Learning Rate
1. Technology transfer type

The example of analysis:

Data from the survey was tested by regression analysis to identify the influence of each factor on the supplier learning rate. Here, we will give an example of the regression analysis between technology transfer type (*BS*)

and price as the equation below:

$$PRICE = 4.000 - 1.167BS \qquad (5)$$

From the equation, if a buyer passes on technology to a supplier (BS=0), the learning rate on reduction of cost will equal 4.000. But if a supplier passes on technology to a buyer, (BS=1)the learning rate on reduction of cost will equal 2.833. It shows that passing on technology from buyer to supplier has more influence than supplier to buyer at the 0.05 significance level. The results show that passing on technology from buyer to supplier has more effect on supplier learning rates on production cost, reduction of defect rate, improvement of on-time delivery and reduction of lead time, more than from supplier to buyer.

2. Duration of contract
(1) Long term contracts affect the supplier learning rates on cost reduction and lead time reduction much more than short term contracts.
(2) Short term contracts affect the supplier learning rates on defects rate reduction and on time delivery improvement much more than long term contracts.

3. Contract types
(1) Incentive contracts affects supplier learning rates on cost reduction and lead time reduction much more than punishment contracts.
(2) Punishment contracts affect supplier learning rate on defect rate reduction and on time delivery improvement much more than incentive contracts.

4. Supplier strategy
(1) Purchasing from multiple sourcing affects supplier learning rates on cost reduction and on time delivery improvement much more than single sourcing.
(2) Purchasing from single sourcing affects supplier learning rates on defect rate reduction and lead time reduction much more than multiple sourcing.
The results from this analysis will be used as a guideline for supplier learning rate specifications.

7. Conclusion
For the supplier selection criteria, and its weight, most buyers focus on the cost and quality. This result is consistent with munch literature which emphasizes the importance of these 2 criteria (Weber and Current 1993;

Ghodsypour and O'Brien 1998). Hence, suppliers should be adjustable in any situation and focus on the development of the main selection criteria of buyers first, if improvement in all phases at the same time is too difficult. Then, the supplier has a chance to be selected.
Factors considered to specify purchasing and ordering strategy consist of supplier factor, competitor factor, part specification factor, management factor, production factor, storage of parts factor, personnel factor, economic factor, social and cultural factor, and rule and regulation factor. Hence, a buyer should consider these factors carefully to specify the purchasing and ordering strategy. From the study, supplier contract type, supplier development plan, cooperation, trade alliance and sourcing development are important strategies and affect the performance of buyers and suppliers. Hence, the buyer should apply these strategies in the organization, especially, source development which fits the present situation of purchasing from global sources (Kotabe and Murray 2004) and emphasizes the benefits from FTA agreements.
The result shows that supplier efficiency correlates to buyer efficiency in the same direction. In addition, the supplier's development makes a better efficiency of buyers. Thus, buyer should pay attention to activities related to the development of suppliers seriously.
The analysis of factors which affect supplier learning ability indicates that each factor has different effects on the learning rate in each phase. This result could be applied to research on supplier selection and purchasing strategy specifications based on the hypothesis that each supplier has the ability to improve itself.
In this study, we only focus on the automotive industry to see the overall picture of Thai industry after the FTA agreement was established. Hence, the future research should focus on other industries which this negotiation has an effect on. The organizations in the automotive industry should use the information from this study as guidelines for the development of supplier selection and strategy specification in purchasing.

8. References
[1] Amelia, S.C., and Larry, R.S. The Relationship of Strategic Purchasing to Supply Chain Management, *European Journal of Purchasing & Supply Management*, Vol. 5, pp. 43-51, 1999.

[2] Bowan, K. Dynamic outsourcing to Contract Manufacturers with Different Capabilities of Reducing the Supply Cost, *International Journal of Production Economics*, Vol. 86, pp. 63-80,2003.

[3] Chopra, S. and Meindl, P. *Supply chain management: strategy, planinng and operation*, Prentice-Hall, Upper Saddle River, NJ, 2003.

[4] Dickson, G.W. An analysis of vendor selection system and decision, *Journal of Purchasing*, Vol. 2, pp. 5-17, 1966.

[5] Gavious, A., and Rabinowitz, V. Optimal Knowledge Outsourcing Model, *Omega*, Vol. 31, pp. 451-457, 2003.

[6] Ghodsypour, S.H., and O'Brien., C. A Decision Support System for Supplier Selection using an Integrated Analytic Hierachy Process and Linear Programming, *International Journal of Production Economics*, 56-57, 199-212, 1998.

[7] Ghodsypour, S.H., and O'Brien., C. The Total cost of Logistics in Supplier Selection under Conditions of Multiple Sourcing, Multiple Criteria and Capacity Constraint, *International Journal of Production Economics*, Vol. 73, pp. 15-27, 2001.

[8] Hong, J.D., and Hayya, J.C. Just-in-Time Purchasing: Single or Multiple Sourcing?, *International Journal of Production Economics*, Vol. 27, pp. 175-181, 1992.

[9] Humphreys, P.K., Li, W.L., and Chan, L.Y. The Impact of Supplier Development on Buyer-supplier Performance, *Omega*, Vol. 32, pp. 131-143, 2004.

[10] Jaturongkakul, A. *Purchasing*, Chulalongkorn University Press, BKK, 2004.

[11] Jamornman, U. *Questionnaire: construction and using*, Funny Publishing, BKK, 2001.

[12] Kotabe, M., and Murray, J.Y. Global Sourcing Strategy and Sustainable Competitive Advantage, *Industrial Marketing Management*, Vol. 33, pp. 7-14, 2004.

[13] Krause, D.R. The Antecedents of Buying Firms' Efforts to Improve Suppliers, *Journal of Operation Management*, Vol. 17, pp. 205-224, 1999.

[14] Li, W.L., Humphreys, P.K., Chan, L.Y. and Kumaraswamy, M. Predicting Purchasing Performance: the role of Supplier Development Program, *Journal of Materials Processing Technology*, Vol. 138, pp. 243-249, 2003.

[15] Masato, A. Buyer Perceptions, Relationship Commitment, and buyer Behaviors Among Japanese-owned Manufacturers and their Suppliers in the Automotive Parts Industry in Thailand, *Thesis (Ph.D.) Faculty of Commerce and Accountancy Thammasat University*, 2004.

[16] Pan, A.C. Allocation of order quantity among suppliers, *Journal of Purchasing and Materials Management*, Vol. 25, pp. 36-39, 1989.

[17] Pual, D.L., and Jack, K. Single Sourcing and Supplier Certification, *Industrial Marketing Management*, Vol. 27, pp. 73-81,1998.

[18] Ramsay, J., and Wilson, I. Sourcing/contracting Strategy Selection, *International Journal of Operation & Production Management*, Vol. 10, pp. 19-28, 1990.

[19] Smith, J.M. Item Selection for Global Purchasing, *European Journal of Purchasing & Supply Management*, Vol. 5, pp. 117-127, 1999.

[20] Telgen, J. Inzicht en Overzicht:de Uitdagigen Van Besliskundeen Inkoopmanagement, *Academical adress at the university of Twente, Enschede, Netherlands*, 1994.

[21] Valluri, A., and Croson, D.CAgent Learning in Supplier Selection Models, *Decision Support System*, Vol. 39, pp. 219-240, 2003.

[22] Watts, C.A., and Haln, C.K. Supplier Development Program: an Empirical Analysis, *International Journal of Purchasimg and Materials Management*, Vol. 29, pp. 11-27,1993.

[23] Weber, C.A., Current, J.R., and Benton, W.C. Vendor Selection Criteria and Methods, *European Journal of Operation Research*, Vol. 50, pp. 2-18, 1991.

[24] Weber, C.A., and Current, J.R. A Multiple Objective Approach to Vendor Selection, *European Journal of Operation Research*, Vol. 68, pp. 173-184, 1993.

[25] Yelle, L.E. Estimating Learning Curves for Potential Products, *Industrial Marketing Management*, Vol. 5, pp. 147-154, 1976.

[26] Yuupo, S. *Purchasing and inventory management*, Big 4 Press, BKK, 2001.