Forecast Information Quality and Supply Chain Performance: An Empirical Study of Air Conditioning Industry

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Abstract: This paper presents an empirical study of the perceived forecast quality of a supplier and uses that quality to explain the impact of forecast information access and forecast information quality (FIQ) on supply chain performance. Forecast information quality (FIQ) was defined with 4 variables, in time, accurate, convenient to access, and reliable, derived from the theoretical framework of FIQ (English, 1999; Petersen, 1999; Moberg et al., 2002). Supply chain performance deals with 3 dimensions, corrective actions, preventive actions and customer service related metrics which reflect cost, tied-up capital and customer service (Brewer and Speh, 2000). The analysis in this research was based on a survey of the most important suppliers of Thailand air-conditioning manufactures. A t-test was used to analyze the significant differences in supply chain performance between suppliers with access to customer forecasts and suppliers without access to forecasts and Pearson correlation and linear regression were used to analyze the correlation between supply chain performance and FIQ. The findings showed that supply chain performance was positively correlated with FIQ but there was not a significant difference in supply chain performance between suppliers with access to customer forecasts compared to suppliers without access to forecasts. The study also indicated less than 40% of variability in supply chain performance was explained by perceive FIQ and more than 60% would be explained by other factors. FIQ also showed quality deficiencies on some variables, which indicates that there is room for improvement in forecasting. Customers and supply managers should consider the perceived forecast quality in order to reduce supplier costs and provide good customer service and also reduce the total cost of the supply chain.
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1. Introduction

A number of studies have emphasized the importance of sharing information between customers and suppliers in supply chains, especially point-of-sale (POS) and forecast data (Stank et al., 1996; Kelle and Akbulut, 2005; Christopher and Towill, 2000; Cachon and Fisher, 2000; Lee et al., 1997). However, most studies discuss the general importance of having access to forecast information along the supply chain from customer's point of view. Fewer studies examine the impact of the quality of forecast information on supply chain performance and from the supplier point of view (Helena Forslund and Patrik Jonsson, 2007). As a supplier, it is not enough only to have access to customers' forecasts. The interpretation and possible use of the forecast data depend on the quality of the forecast information (Forslund, 2004). The forecast could, for example, be available too late to be used in the planning process, be changed so often that the supplier does not trust it, or exchanged in an inappropriate format, for example, as a faxed document that needs much further processing before the supplier can make use of it.

Supply chain performance is typically related to metrics reflecting cost, tied-up capital and customer service (Brewer and Speh, 2000). The supplier might need to use internal actions to compensate for poor customer service, corrective actions, such as re-scheduling and overtime, or preventive actions, for example, higher safety stocks and extra capacity. Using corrective actions can deal with increased costs while using preventive actions can also deal with problems that result in "increased" tied-up capital and costs that are necessary to prevent future deficiencies in customer service. The use of corrective and preventive actions allows for good customer service performance even though the planning environment is uncertain as a result of lacking or quality deficient forecast information. Consequently, they combine with the effect of costs and tied-up capital in order to produce good customer service.

2. Overview: Why the Air Conditioning Industry and Why Thailand?

Air-conditioning is an industry with high potential in Thailand that can compete in the global market. With a 9% share of the global market (see Figure 1), Thailand is the second largest exporter in the world with $2,289 million US. (The highest

exporter is China with a 24.7% share in the global market) (Kasikorn Research Center: 16Mar2007). Thailand's export volume has also contributed 2% of total Thailand export segment in 2004 (with $2,000 million US) with growth of 40% over the past year and continuous growth of 10.27% in 2005 ($2,200 million US) and 10% in 2006 (Kasikorn Research Center: 24 May, 2006).

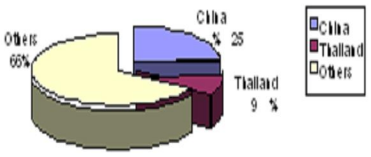

Figure 1. Thailand Air-Conditioning Export

The domestic market is also growing continuously. With the geographic and warmer weather situation, Thailand's Air-conditioning Market has grown by 10 to 15% each year over the past 10 years with the exception of 2006 and 2007 when there were a lot of negative political factors, economic and fuel price factors (Kasikorn Research Center: 16 March, 2007).

Air-conditioning can be separated to 4 categories from usage point of view, Room air, SKY air, Packaged Air and VRV (Appendix A). It requires a lot of parts and close collaboration with suppliers in order to develop and assemble one set of finished product. In the case of Room Air, for example, it requires approximately 450 – 540 parts to complete one unit, and these can be separated into indoor units (sometimes called Fan Coils Units) with approximately 240 – 286 parts and outdoor units (some called Condensing Units) with approximately 210 – 254 parts (Daikin Ltd.). Suppliers really need forecast information about future demand from customers in order to meet customers' requirement at the right time, the right quantity, the right place and the right products.

Figure 2 shows a typical air conditioning assembly line. The air conditioning assembly line starts with the main body and all other parts are assembled to it at different assembly points on the assembly line. The readiness of parts is important, since the first process must be completed before passing to the second assembly point, and so on. If a part is not available at the assembly point then the process must stop and wait for that part to become available before proceeding further.

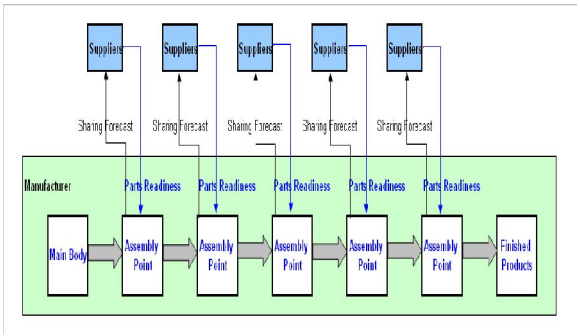

Figure 2. Air Conditioning Assembly Process

To have parts ready the quality of demand information provided to the supplier in relation to a specific assembly point is important. If the quality of demand information shared from the assembly point to the supplier is not in time or in time but not accurate, changes frequently, or the format needs to be modified or changed before processing, then the supplier needs to use internal actions to provide and serve customer. They might hold more safety stock to serve unpredicted demand which will affect their tied up capital, or they may need to have workers work overtime which will increase their costs.

'As a supplier, it does not suffice to only have access to customers' forecasts but the interpretation and possible use of the forecast data depend on the quality of forecast information' (Forslund, 2004).

The purpose of the present study is to extend the work of Forslund and Jonsson (2007) to describe and explain the impact of forecast information access on supply chain performance and the impact of forecast information quality (FIQ) on supply chain performance in Thai air conditioning industry.

The forecast information used in this paper is the collaboration point between air conditioning manufactures and their suppliers, as show in Figure 3.

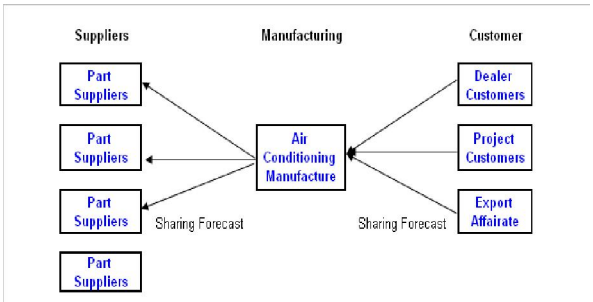

Figure 3 Scope of the study

The major air conditioning manufactures in Thailand are 6 leading company who have 60% of the market (Data as of 31st Dec. 2007). A list of suppliers was taken from the group of major Thai air

conditioning manufactures. The parts made and the size of company varied considerably.

3. Literature Review and Research Hypotheses

3.1 Sharing Forecast Information

The issue of sharing forecasts in the supply chain has been studied from some different perspectives, for example, the collaborative planning forecasting and replenishment (CPFR) approach and modeling-based approaches. A survey of Swedish manufactures in different industries was conducted by Sandberg (2005) which showed that 95% of companies exchange forecast information monthly. Apart form that study, no other broad description of forecast information sharing was identified. The literature on CPFR discusses the inter-organization and intra-organization issues in collaboration on the forecasting process. The major objective was to develop a common plan for the supply chain as a whole (Helms et al., 2000; McCarthy and Golicic, 2002). Most CPFR studies adopted as retailer perspective. A study conducted by Holmstron in 2002 showed that suppliers are more interested in sharing information and collaborating in the forecast process than are the retailers. They also found that suppliers gain most of the benefits of increased information sharing. A model based study was done by Cachon and Fisher in 2000. The analysis showed that the performance effects of sharing information are low when demand is predictable, as compared to the situation where demand is unpredictable. In Zhao (2002) argued that the supplier capacity constraints impact on the possibility of the supplier successfully using the customer forecast. These studies show that a forecast received from customers could result in positive results, but it depends on different conditions prevailing, i.e., how the forecast information is used in the supplier's planning process.

3.2 Supply Chain Performance

Some of the modeling-based studies on sharing forecasts in supply chains link forecast exchange to supply chain performance. Lee et al. (1997) and several others have shown that the demand variability can be amplified upstream in the supply chain when accurate forecasts are not available or not shared with the suppliers. Zhao et al. (2002) concluded that the value of information sharing is significantly influenced by the demand pattern, the forecasting model used and the supplier's capacity tightness, i.e., its total production capacity in relationship to the total demand to be satisfied, but that the suppliers usually can improve their total costs and customer service dramatically through information sharing under all conditions. Aviv (2001) compared local forecasting with exchange of collaborative forecasts and concluded that the supply chain costs were reduced when exchanging forecast information. McCarthy and Golicic (2002) made an exploratory study of collaborative forecasting, which was defined as a long-term relationship among organizations actively working together on forecasting (Mentzer et al., 2000), and identified substantial impact on supply chain performance. Improvement in customer service performance, such as shorter lead times, improved inventory availability and better response to fluctuations in demand, was found. Furthermore, improvements in cost and capital were found which could be related to reductions in safety stock. Supply chain performance is typically related to metrics reflecting cost, tied-up capital and customer service (Brewer and Speh, 2000). Forslund and Jonsson, (2007) defined supply chain performance with the 3 performance variables: corrective action, preventive action and customer service as a goal to fulfill customers' requirement.

In the 3 dimensions of Supply Chain Performance: corrective action, preventive action and customer service, the corrective and preventive action variables are based on the work of Lindau and Lumsden (1993), Ericsson (1997), Fahle´n (1997), and Mattsson (2002) Corrective action was defined as (a) subcontracting; (b) expediting; (c) part delivery; (d) re-scheduling; (e) reservation breaking; (f) overtime; and (g) express transport. Preventive action was definded as (a) safety stock in raw material inventory; (b) safety stock in finished goods inventory; (c) safety capacity; (d) safety lead time; and (e) over-planning. The customer service variables dealt with (a) promised lead time; (b) on-time delivery; (c) use rush orders when needed; (d) promised inventory availability; (e) accurate orders; and (f) availability of delay information; these were all based on Stock and Lambert (1992) and Mattsson (2002).

3.3 Forecast Information Quality

The study by Forslund (2004) showed that information quality cannot be measured objectively, but must be judged by the supplier. **The s**upplier might be uncertain regarding FIQ and forecast error. FIQ is not the same as forecast error, which can be measured by the difference between forecast and actual demand. The information quality dimensions can be derived from the seven rights of logistics (Wied's in 1916), right place, time, quantity, quality, price, condition and customer. In Lindau and Lumsden's 1993 study, they focused on 3 information quality dimensions derived from the rights, correct information, timely information and complete information. But, no study measuring FIQ was found. Petersen in his study in 1999 measured information quality in terms of it being current, accurate, complete, compatible and convenient to

access. Forslund and Jonsson (2007), developed a framework for describing and analyzing the FIQ as well as the definitions and measures of supply chain performance, along with the generation of hypotheses. Forslund and Jonsson (2007) defined forecast information quality (FIQ) with the four information quality variables: in time, accurate, convenient to access, and reliable. Numerous studies emphasize the positive impact of forecast information exchange, but there is an absence of studies that explain the performance impact of forecast exchange and quality of forecast information empirically.

In accordance with the theoretical framework, the model framework and hypotheses have been generated based on the study o Forslund and Jonsson (2007), to analyze the impact of forecast information access and forecast information quality (FIQ) on supply chain performance, as shown in Figure 4.

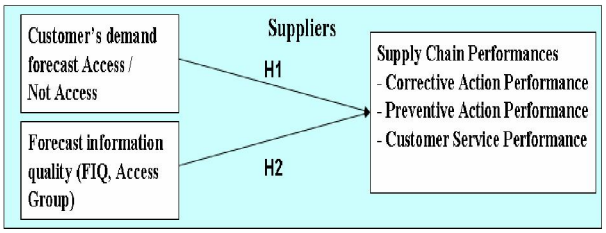

Figure 2. Conceptual Model

Figure 4 presents two main hypotheses. The first hypothesis deals with the performance impact of suppliers with access to customer forecasts compared to suppliers without access to forecasts.

H1. Supply chain performance is higher for suppliers with access to customer forecasts compared to suppliers without access to forecasts.

In accordance with hypothesis H1, the paper deals with 3 sub hypothesis H1.1 – H1.3 with in-depth analysis of the performance impact of suppliers with access to customer forecasts compared to suppliers without access to forecasts, as shown in Figure 5.

Hypothesis two deals with the performance impact of FIQ, and it is expected that improved FIQ will be linked to the use of corrective action, preventive action and customer service in a way that has a positive impact on the supply chain performance. This results in the following hypothesis:

H2. Supply chain performance is positively correlated with FIQ.

Figure 6 shows the model framework for hypothesis H2. The paper deals with 3 sub hypotheses H2.1 – H2.3 with in-depth analysis of the performance impact of FIQ on each of the supply chain performance variables.

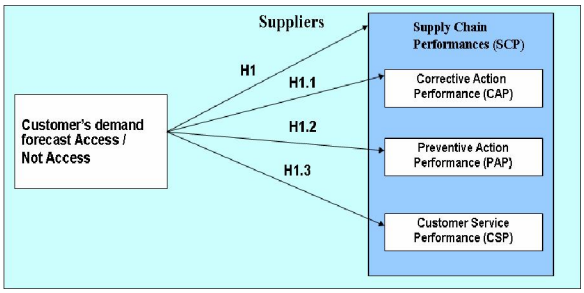

Figure 5. Sub Model for Hypothesis 1

H1.1 Corrective Action Performance (CAP) is higher for suppliers with access to customer forecasts compared to suppliers without access to forecasts.

H1.2 Preventive Action Performance (PAP) is higher for suppliers with access to customer forecasts compared to suppliers without access to forecasts.

H1.3 Customer Service Performance (CSP) is higher for suppliers with access to customer forecasts compared to suppliers without access to forecasts.

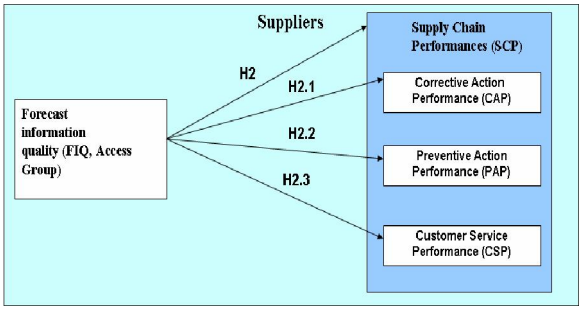

Figure 6. Sub Model for Hypothesis 2

H2.1 Corrective Action Performance (CAP) is positively correlated with FIQ.

H2.2 Preventive Action Performance (PAP) is positively correlated with FIQ.

H2.3 Customer Service Performance (CSP) is positively correlated with FIQ.

4. Methodology

When deciding the research approach for a study, the researcher can choose between several approaches, all characterized by specific strengths and weaknesses. The most important condition for choosing an appropriate approach is to identify the type of research questions that should be answered. Researchers in the area point out that there is a difference between surveys and survey research. While a survey can be made for many reasons not connected to research, such as political opinion investigations and TV viewing polls, survey research aims to increase the scientific knowledge in a research area. Thus, this paper applies survey research, which aims to increase the scientific knowledge. Statistical techniques were used to

analyze and describe data according to the study objectives, as recommend by McCarthy and Golicic (2002).

In the study, a questionnaire was selected as the most suitable method to collect the empirical data, and the questionnaire was distributed via e-mail and fax to air-conditioning manufacturing suppliers. Air-conditioning manufacturing companies were selected from the major air-conditioning companies in Thailand which contributed about 66% of the total Thai market as of 31st Dec. 2007.

5. Survey Instruments

Table 1-4 show the questions and definitions of the variables related to FIQ, corrective action, preventive action and customer service that are analyzed in this paper.

The FIQ variables were derived from the theoretical framework of FIQ (English, 1999; Petersen, 1999; Moberget al., 2002). The corrective and preventive action variables are based on the works of Lindau and Lumsden (1993). The customer service variables are based on Stock and Lambert (1992).

Likert scales from 1 to 7 were used for all variables, measured on ordinal scales:

The questions asked and definitions of scales for the respective variable are included in Tables 1-4.

The average of the four information quality variables was defined and used as an overall FIQ index (FIQ).

The average of the six corrective action variables was defined and used as an overall corrective action performance index (CAP).

The average of the five preventative action variables was defined and used as an overall preventative action performance index (PAP).

The average of the five customer service variables was defined and used as an overall customer service performance index (CSP).

A Cronbach's value of 0.70 was found to be acceptable for any scale (Hair et al., 1998).

Question: Forecasts received from the customer are: (a) in time; (b) accurate; (c) convenient to access; and (d) reliable; scale: seven point Likert scale from 1 (strongly disagree) to 7 (strongly agree).

Table 1 Variables of Forecast Information Quality

Variable	Definition
In time	Arriving in the agreed time – within the supplier's planning horizon
Accurate	Free from obvious mistakes
Convenient to access	Easy access without further processing
Reliable	The probability that a forecast remains unchanged

Question: To perform the promised customer service we use: (a) subcontracting; (b) expediting; (c) part delivery; (d) re-scheduling; (e) reservation breaking; (f) overtime; and (g) express transport; scale: seven point Likert scale from 1 (to very low extent) to 7 (to very high extent).

Question: To perform the promised customer service we use: (a) safety stock in raw material inventory; (b) safety stock in finished goods inventory; (c) safety capacity; (d) safety lead time; and (e) over-planning; scale: seven point Likert scale from 1 (to very low extent) to 7 (to very high extent).

Table 2 Variables for Corrective Actions

Corrective Action Variable	Definition
Subcontracting	Short-term, as a result of unforeseen overload
Expediting	Finding and rushing "hot" jobs through production
Part delivery Re-scheduling	Smaller batches in production or delivery re-plan
Reservation breaking	Already reserved material (for another customer) is used earlier
Overtime	Short-term
Express transports	A faster and more expensive means of transportation is used to speed up a delivery

Table 3 Variables for Preventive Actions

Preventive action variable	Definition
Safety stock in raw material inventory	Stock kept as a reserve to guard against material shortage because of uncertainties in supply, demand and lead time
Safety stock in finished goods inventory	Stock kept as a reserve to guard against material shortage because of uncertainties
Safety capacity	The reservation of extra capacity, i.e., plan with under-capacity utilization to protect against unforeseen events
Safety lead time	The order starts earlier to be finished before its due date
Over-planning (demand hedges)	Instead of safety stock or safety lead time, a larger quantity than known demand is planned

Question: For our most important customer we perform perfectly: (a) promised lead time;

(b) on-time delivery; (c) use rush orders when needed; (d) promised inventory availability; (e) accurate orders; and (f) availability of delay information; scale: seven point Likert scale from 1 (strongly disagree) to 7 (strongly agree).

Table 4 Variables for Consumer Service Performance

Customer Service Performance variable	Definition
Promised lead time	The time between placing and receiving an order
On-time delivery	Orders are delivered at agreed time
Rush orders when needed	
Promised inventory availability	To what degree orders can be delivered from inventory
Accurate orders	The right number of items ordered arrives
Availability of delay information	

6. Statistical Treatment of Data

A t-test was performed to test H1 to test the significance of differences in supply chain performance between suppliers with access to customer forecasts and suppliers without access to forecasts (H1).

To test H2, Pearson correlation and linear regression were used to analyze the significance of correlations between supply chain performance and FIQ. Pearson Correlation reflected the degree of linear relationship between FIQ and CAP, PAP, CSP at a defined level of significance and linear regression was used to explain this relationship with a straight line fit to the data at a defined level of significance.

7. Data Analysis

7.1 Response Rate

The supplier questionnaire was developed. Supplier lists were examined from the perspective of customers. 97 Thai air-conditioning supplier companies were found. Iit was then decided to address the entire population. Some 54 usable responses were received, corresponding to a respond rate of 56.2 percent. The distribution by product group (air-conditioning parts) and company size varied.

43 of 54 supplier responses (79.63%) indicated that they were receiving forecast information. The average perceived FIQ by suppliers for each variable is shown in Table 5.

Table 5 Perceived Forecast Information Quality of all suppliers

Perceived FIQ by all suppliers			
FIQ Variable	N	Mean	SD
In Time	43	5.07	1.28
Accurate	43	4.81	1.22
Convenient to access	43	4.65	1.29
Reliable	43	4.58	1.12
Average FIQ		4.78	1.23

The in-time variable is significantly higher (i.e., arriving in the agreed time – within the supplier's planning horizon) when compared to other variables, while the reliability (i.e., the probability that a forecast remains unchanged) was lowest. This could imply that since the planning horizon was agreed between suppliers and customers, forecast arriving in the agreed time is important for suppliers in order to advance production planning and output. The low score of reliability, however, could be interpreted as forecast error. This could mean that although the forecast was submitted within the agreed planning horizon, the forecast kept changing.

7.2 The performance impact of forecast information access and forecast information quality

In order to test H1 (Supply chain performance is higher for suppliers with access to customer forecasts compared to suppliers without access to forecasts) and sub hypotheses, Paired Sample t-tests were used to analyze the significant differences in supply chain performance between suppliers with access to customer forecasts and suppliers without access to forecasts. Tables 6 and 7 present the results from testing H1.

The findings for H1 (Table 6) indicated that suppliers without access to forecasts use less corrective action and preventive action than suppliers with access to forecasts for all variables (except only for safety stock in finished goods inventory), but most of the relationships are not statistically significant.

Only overtime and safety stock in raw material inventory were significantly different, and suppliers without access to forecasts use less of both than suppliers with access to forecasts.

However, the results from Table 7 indicate that CAP (the average of the six corrective actions) and PAP (the average of the five preventative action variables) are not statistically significant (Sig 2 tailed > 0.05) between suppliers with access to forecasts and without access. This result indicates that sub-hypotheses H1.1 and H1.2 were not verified. In term of performing customer service, there were indications that suppliers with access to forecasts perform better than suppliers without access to forecasts on Availability of delay information (Sig 2 Tailed = 0.028* < 0.05), and Table 6(b) also indicates that suppliers with access to forecasts perform customer service (CSP-average of Customer Service) better than suppliers without access to forecasts (Sig

2 Tailed of SCS = 0.026* < 0.05) which verifies H1.3.

It is difficult to understand the finding that the extent using of corrective action and preventive action are not significantly different between suppliers without access to forecasts and suppliers with access to forecasts. The only significant difference in performing customer service related to providing Availability of delay information. Suppliers who received customer forecasts see to be more likely to provide information and feedback to customers if delay occurs in production or shipment and this results in better customer satisfaction and higher results on the SCS-average of Customer Service.

However, H1 was not supported since the only significant difference was in H1.3, CSP-average of Customer Service but no significant difference for H1.1, CAP (the average of the six corrective actions) and H1.2, SPA (the average of the five preventative action variables).

Table 6 Results of Hypothesis 1 Test

		Mean Suppliers access to Customer's Forecast	Mean Suppliers not access to Customer's Forecast	Mean Difference	T-Value	Sig 2 Tailed
Corrective Action Variable						
Subcontracting	**4.1**	3.8372	3.1818	0.655	1.062	0.293
Expediting	**4.2**	4.8372	4.6364	0.201	0.408	0.685
Part delivery	**4.3**	3.7674	3.5455	0.222	0.331	0.742
Re-scheduling	**4.4**	2.4419	2.0000	0.442	1.445	0.155
Reservation Break	**4.5**	4.3023	3.9091	0.393	0.612	0.543
Overtime	**4.6**	5.1860	3.9091	1.277	2.215	0.031*
Express transports	**4.7**	***Take Out				
Preventive Action Variable						
Safety stock in raw	**5.1**	5.2326	4.0909	1.142	2.070	0.043*
Safety stock in finis	**5.2**	3.7907	3.9091	-0.118	- 0.189	0.851
Safety capacity	**5.3**	4.8605	4.4545	0.406	0.778	0.440
Safety lead time	**5.4**	5.1628	4.3636	0.799	1.638	0.107
Over-planning	**5.5**	4.6977	4.1818	0.516	0.922	0.361
Customer Service Performance Variable						
Promised lead time	**6.1**	6.0000	5.5455	0.455	1.266	0.211*
On-time delivery	**6.2**	6.2558	5.7273	0.529	1.733	0.089
Rush orders when	**6.3**	***Take Out				
Promised inventory	**6.4**	5.3023	5.0000	0.302	0.826	0.413
Accurate orders	**6.5**	5.9070	5.2727	0.634	1.695	0.096
Availability of delay	**6.6**	5.5116	4.5455	0.966	2.257	0.028*

*(*Significant at the p <0.05 level)*

Table 7 Results of Hypothesis 1 Test

		CAP	PAP	SCP
Mean	Suppliers access to Customer's Forecast	4.0620	4.7488	5.7953
	Suppliers not access to Customer's Forecast	3.5303	4.2000	5.2182
Mean Difference		0.5317	0.5488	0.5771
T-Value		1.4800	1.3410	2.2930
Sig 2 Tailed		0.1450	0.1860	0.026*

Note: CAP-average of Corrective Action Variable (except Express transports)
PAP-average of Preventive Action Variable
CSP-average of Customer Service (except Rush orders when needed)

(Significant at the p <0.05 level*

Table 8 Results of Hypothesis 2 Test

		CAP	PAP	SCP
FIQ	Pearson Correlation	-0.352	-0.326	0.387
	Sig 2 Tailed	0.020*	0.033*	0.010*
	N	43	43	43

FIQ average of the four information quality
CAP average of Corrective Action Variable (except Express transports)
PAP average of Preventive Action Variable
CSP average of Customer Service (except Rush orders when needed)

(Significance at the p < 0.05 level)*

Table 8: Result from testing H2 indicate that a significant correlation was existed for all 3 sub hypotheses H2.1 (FIQ->CAP), H2.2 (FIQ->PAP), and H2.3 (FIQ->CSP) at the level p < 0.05. The Pearson correlation showed a negative value –0.352 and –0.326 for H2.1 (FIQ->CAP) and H2.2 (FIQ->PAP) respectively. That means that a supplier uses less corrective action and preventive action when that supplier perceived the forecast to be of better quality. There was also a positive Pearson correlation (0.387 > 0) for H2.3 (FIQ->CSP); a supplier can perform better in order to satisfy the customer if they perceive the forecast to be of better quality. On the other hand, supply chain performance was better, in lowering costs, using less tied-up capital and increasing customer service (Brewer and Speh, 2000) when the supplier perceived better forecast quality.

The results from Table 9, the ANOVA result, and Figures 7, 8 and 9, after testing for a linear relationship at the level P<0.05, were that all Sub Hypotheses (H2.1, H2.2 , H2.3) and H2 were supported. There were linear relationships with the same results as with the Pearson correlation analysis. This produces a model to represent linear equation between FIQ and each of CAP, PAP and CSP; relationships and equations were significantly accepted with ANOVA testing at a significance level F<0.05.

Table 9 Results of ANOVA Test

		CAP	PAP	SCP
FIQ	Significance F	0.020*	0.033*	0.010*
	R Square	0.352	0.326	0.387
	Coefficients			
	Intercept	5.91	6.384	4.523
	X Variable 1	-0.387	-0.342	0.266

*Note: * Significant at significance level F<0.05*

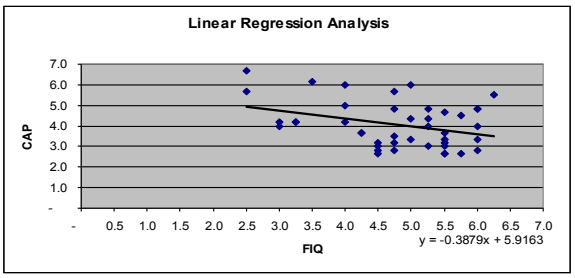

Figure 7 Linear Regressions of Corrective Actions Perception and Forecast Information Quality

Figure 7 indicates the linear relationship can be explained by the model Y = -0.3879X + 5.9163 (Y = SCA, X=FIQ). The model can be accepted at a significance level of F<0.05.

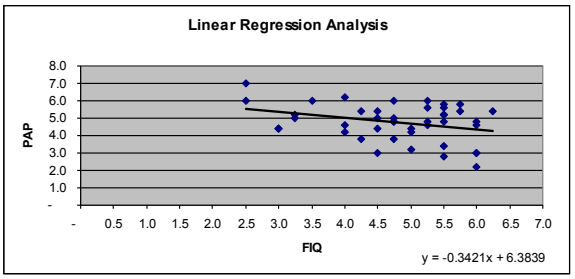

Figure 8 Linear Regressions of Preventive Actions Perception and Forecast Information Quality

Figure 8 indicates the linear relationship can be explained by the model Y = -0.3421X + 6.3839 (Y = SPA, X=FIQ), at a significance level of F<0.05.

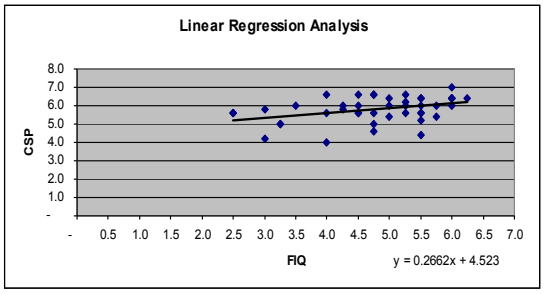

Figure 9 Linear Regressions of Customer Service Perception and Forecast Information Quality

Figure 9 indicates the linear relationship can be explained by the model Y = 0.2662X + 4.523 (Y = SCS, X=FIQ), at a significance level of F<0.05.

In conclusion, the study reported in this paper indicates that H1 was not supported. Supply chain performance does not appear to be significantly better for suppliers with access to customer forecasts than for suppliers without access to forecasts. H2, however, was verified at a significance level of F<0.05. Supply chain performance is positively correlated with FIQ.

8. Conclusion and Implications

The research objective set out at the beginning of this paper was to study 1) The impact of forecast information access on supply chain performance and 2) The impact of forecast information quality (FIQ) on supply chain performance, in the Thai air conditioning industry.

The measures were tested and used with reliable results in the empirical study. The empirical findings indicated a large proportion of suppliers (79.63%) received customer forecasts. They also showed that reliability was considered to be the biggest forecasting deficiency, while in-time was considered to be the highest forecast quality variable. The performance of suppliers with and without access to forecasts was not significantly different. There is only significant difference on performing customer service, especially in providing availability of delay information. Suppliers who received customer forecasts could provide and feedback to customers if delay occurred on production or shipment, and that resulted in better customer satisfaction and higher results on the SCS-average of Customer Service. But the empirical findings indicated that a significant correlation existed for all 3 sub hypotheses H2.1 (FIQ->CAP), H2.2 (FIQ->PAP), and H2.3 (FIQ->CSP) which indicated the significant positive relationship between supply chain performance and forecast information quality (FIQ).

9. Intended Theoretical Contributions and Managerial Implication

The findings from the empirical study result in a better understanding of the impact of forecast information quality (FIQ) that is related to organization metrics reflecting cost, tied-up capital and customer service (Brewer and Speh, 2000). FIQ also shows quality deficiencies on all variables, which indicates room for improvement in forecasting. Customers and supplier managers should consider the perceived forecast quality in order to reduce supplier costs and provide good customer service and also reduce the total cost in the supply chain.

The findings should also be useful for practitioners or managers in the following ways:

1. The findings from the empirical study provide and improved understanding of the impact of

forecast information quality (FIQ) that related to organization metrics reflecting cost, tied-up capital and customer service (Brewer and Speh, 2000).

2. FIQ also shows quality deficiency in each forecast quality variable, which indicates room for improvement in forecasting. Customers and Supplier managers should consider the perceived forecast quality in order to reduce supplier costs and provide good customer service, and also to reduce total costs in the supply chain.

3. This can guide the manager to a better understanding of forecast information quality (FIQ) characteristics and the performance impact of FIQ in the Thai air-conditioning industry.

10. Limitations

The research reported in this paper has a number of limitations. There is very little research available on forecast information quality in Thailand. This paper is the first attempt to explain forecast information quality (FIQ) derived from theory, and to examine the impact of forecast information access and the impact of forecast information quality (FIQ). This may lead to a lack of understanding of the concepts and a lack of cooperation and difficulty in data collection.

It was not possible to include all supplier companies in the air-conditioning industry because of time constraints and limitations in data available. The questionnaires were distributed to 97 air-conditioning suppliers who, between them, had a 60% market share of air-conditioning finished products covering all 4 products categories. As the sample was drawn from only one industry it cannot be considered representative of other industries that have a different context.

The study covered a lot of products variation (air conditioning parts) i.e. compressors, panels, pipes, etc. Also, it did not focus on homogeneous companies, and the companies varied in size. This study did not take into account the customer's own forecasting process nor the processes of production or assembly, which may vary in the usage objective of forecast information and the perceived quality of forecasts.

11. Future Research

With reference to the potential for future research, since this study has not revealed information about the customer's own forecasting process, it would be worthwhile to repeat this study, but to extend it to include collaborative forecasting, rather than simply ask whether forecast information was transferred or not.

The study still revealed the need for more studies in the area of FIQ and Supply Chain Performance. The potential area of future research should deal with:

- Explaining the causes of high or low perceived FIQ, and
- Examining how FIQ contribute to Supply Chain Performance.

More detailed research questions in these two areas could be related to the actual demand pattern and the processes related to forecasting by the customer, the transmission of information from the customer to the supplier, the registration of data at the supplier and the characteristics of the processes and actors using the forecast data.

The results of the ANOVA testing reported in Table 8 showed that less than 40% of the variance in Supply Chain Performance variables considered was explained by perceived FIQ. This leaves considerable scope for future studies that might help to identify the factors that explain the remaining more than 60%.

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APPENDIX

Four categories of Air-conditioning (From usage point of view)

(Source: www.daikin.co.th)

1) Room air: Set of air-conditioning in Wall, Ceiling and Floor with less than 28,000 BTU.
2) SKY air: Set of air-conditioning in Duct, Ceiling and Cassette type with more than 28,000 BTU.
3) Packaged Air: Air-conditioning in Duct and High Floor with more than 47,000 BTU used in factory.
4) VRV: Variable Refrigeration Volume air-conditioning with high technology in energy savings and one unit control.

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