

Analysis of Factors Influencing the Composition of Oil Tanker Fleet of Domestic Refinery Companies

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Abstract : *The international oil majors have been reducing the size of their own oil tanker fleet since early 1980s. Like international oil majors, the Korean refineries are becoming more dependent on tanker chartering rather than tanker ownership for their oil transportation since the 1990s. They also prefer spot charter to time charter and this kind of trend has continued up to now. Consequently, this paper attempted to find the factors influencing changes in tanker fleet composition. To attain the object of the paper, an empirical study is adopted using the ten decision-making factors derived from preceeding studies. The findings are that MARPOL and OPA 90, and transportation costs are the most important factors influencing an oil tanker fleet composition.*

Key words : *Transportation logistics, Oil tanker fleet composition, Oil majors, Tanker ownership and chartering, Logistics decision-making factors, Korean refineries*

1. Introduction

Most of this paper is devoted to analyzing and understanding tanker fleet ownership and chartering policy for Korean oil refineries such as Hyundai Oilbank Corporation, and Incheon Oil refinery, S-Oil Corporation, LG-Caltex Oil Corporation and SK Corporation.

To gain a competitive edge, domestic oil refinery companies are required to adjust the composition of their tanker fleets properly in an economical way for oil transportation. Fleet composition consists of two types, which are tanker ownership and chartering. The idea of forming tanker fleet composition is effected by logistics transportation decision-making factors.

Because oil transportation, be it by tanker, is not a source of profit, but a cost of doing business. Chartering managers in charge of arranging marine transportation are oriented toward cost containment whether ownership or chartering vessels from independent tanker owners or tanker owning companies(Tusiani, Michael D., 1996). Therefore, the oil company's decision about fleet composition is very important in terms of both economics of transportation costs and risk management.

The number of tankers owned by international majors¹⁾ has been decreasing since the 1980s, while the number of tankers chartered by them is increasing. Korean oil refineries have been doing the same since the 1990s. They also prefer spot charter to time charter and this kind of trend has continued until the present(Drewry, 1995), (Drewry, 1999).

Therefore, the following question is raised: Why have

Korean oil refinery companies been much more dependent upon chartered tankers than owned tankers since the 1980s? This paper has tried to answer the above question. In other words, this paper sought to tackle the above question using the following approach.

First, it will find out which factors have seriously influenced the tanker fleet composition of domestic oil refinery companies using the ten transportation logistics decision-making factors derived through review of a preceding study(Bek, Gihon, Tae W. Lee and Young T. Chang, 2002). Secondly, it will make some helpful suggestions regarding tanker fleet composition policy of the oil companies on the basis of the results.

2. Oil transportation logistics decision-making factors

To begin with, the derived procedures of oil transportation logistics decision-making factors(factors hereafter) which will be used for this empirical study are as follows(See(Bek, Gihon, Tae W. Lee and Young T. Chang, 2002)). First, a pilot test for the original questionnaire was undertaken by the working level personnel of LG-Caltex using the factors derived from previous literature. Secondly, the questionnaire is partially amended and the survey was carried out among four domestic oil companies.

The number of factors derived till now is 18 through a frequency analysis and marks from factor transformed. Thirdly, an experience survey by experts related to oil transportation was adopted to select the optimal factors

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1) It indicates that British Petroleum, Exxon, Gulf, Mobil, Shell, Chevron and Texaco (Total 7 majors).

among those 18 factors. As a result, the 10 factors were finally derived as shown in Table 1.

Table 1 Decision making factors derived from overall analysis

Logistics decision-making factors	
1. Economy prosperity	6. Favorable financial conditions
2. Expansion of refining capacity	7. Rise of oil prices
3. Strengthening tanker safety	8. Rise of transportation costs
4. Rise of WS index	9. Application of MARPOL and OPA 90
5. Deterioration of vessel	10. Active oil exploration

There is not much previous literature in reference to the factors up until now. The factors used are sufficiently varied. Therefore, this paper tried to make an effort to derive factors which can be generally accepted. In addition, the meaning of each factor diverted to an affirmative way for an empirical study.

To the greatest extent, this paper tried to pick independent factors which are not related to each other, but Evans's(1994) research contribution to the point, revealed some inevitable relationships among factors relating to tanker operations(Evans, J. J., 1994).

Next, how have the derived 10 factors effected the tanker fleet composition of domestic oil refinery companies.

3. Empirical study upon derived factors

3.1 Analyses by questionnaires

1) Organization and data gathering of questionnaires

To find phenomenons causing oil refinery companies to heavily depend on chartering tankers, an empirical survey was executed utilizing factors listed in table 1.

The questionnaires consist of 2 parts. The former is designed for the analysis of ranking of importance and frequency. The latter is designed for finding factors influencing changes in ownership and chartering decisions. The marks for ranking importance were given on a 1 to 5 point scale. 1 point being the lowest mark and having the slightest effect on tanker composition policies.

A selection of the samples are limited to domestic oil refinery companies which are SK, LG-Caltex, Hyundai and Incheon Refinery, and S-Oil. The total number being four. With reference, Incheon refinery is an incorporate, but it merged with Hyundai so that Incheon is operated under the same management.

Before sending out questionnaires, a pilot test was done

by the Crude/Product Operations Team of LG-Caltex. The sending and receiving of questionnaires was done by e-mail or fax. For the questions not answered companies were visited or interviewed over the telephone. Respondents were the managers of the chartering departments, and the survey was carried out in September, 2000.

2) Methods of analysis

Based on the substance of the questionnaires, the analysis was conducted and adopted using a descriptive statistics methodology. For the procedure of the analysis, first, it will examine the ranking of importance and frequency per all 10 factors. Then compares that analysis with the importance scale of 5 points in the next analysis. That can test the reliability of the questionnaire's response.

Secondly, to select the factors which will affect the increase or decrease of tanker chartering and ownership, the degree of importance with the 5 point scale will be analyzed. Thirdly, a frequency analysis will be conducted in the following 4 decision-making categories:

- ① (a) Category: Decreasing tanker ownership
- ② (b) Category: Increasing tanker chartering
- ③ (c) Category: Increasing tanker chartering and ownership simultaneously
- ④ (d) Category: Decreasing tanker chartering

The objective of the paper is to find out the factors so that ① and ② data become the core of the analysis, and utilize ③ and ④ for references. At the same time, the marks of importance per each factor will be added. The highest mark is considered the most important factors effecting oil tanker fleet composition. Also, the frequency will be added and compared with marks to point out the right factors. The kinds of analysis used often in this paper are marks, ranking of importance, and frequency of the factors.

3.2 Analysis of factors

Analysis of factors is carried out to find which factor is affecting the increasing and decreasing of tanker fleet and the ratio of chartering and ship owning.

The historical review of the oil majors shows that oil majors owned 21% of the world tanker fleet in the 1970s. But, by 1994, oil majors controlled only 9% of the world tanker fleet. That indicates that the average percentage of ownership among majors was 44% in the 1970s and 23% in the 1990s. The proportion of time charter tonnage decreased from 53% in the 1970s to 10% in the 1990s. In contrast, the spot tonnage increased from 3% to 19% during the same

period((Clarkson, 2000), (Drewry, 1999), (Drewry, 1995), (Drewry, 1995), (Drewry, 1999).

There are no data of long-term time series in relation to domestic oil refinery companies, so it is not possible to compare it with majors. But, the following data(Bek, Gihon and Tae W. Lee, 2002) were gathered through a questionnaire survey in the year 2000.

- S-Oil and Hyundai/Inchon depend on chartering oil tankers 100%. LG-Caltex and SK have oil tankers, but its proportion of ownership is 7% and 5% respectively. The proportion of ownership is lower than the majors.
- The proportion of time charter for LG-Caltex, SK and S-Oil is below 8%, and 32% for Hyundai/Inchon. Excluding Hyundai/Inchon, the proportion of time charter is similar to the majors.
- The proportion of spot ranges from 70% to 90%. That proportion is higher than the majors, but it is the same in respect to the highest proportion among the different kinds of chartering. The same proportion is going to rise as oil trade increases and domestic refinery companies make efforts to not raise the proportion of owned oil tankers.

In this section, analysis per factor is carried out to find the factors influencing the oil tanker fleet composition in relation to the facts mentioned above using the derived 10 factors.

1) Analysis by ranking of importance and frequency

Table 2 shows the ranking of importance of each domestic oil refinery company. Advanced ranking means that the factor is affecting the fleet composition a little more than the next ranking.

Table 2 Ranking of importance on each decision making factor

Factors	Ranking of importance			
	SK	LG	S oil	Hyundai Inchon
Active Oil exploration	9	10	9	8
Expansion of refining capacity	1	3	3	7
Strengthening tanker safety	3	2	2	3
Rise of WS index	2	1	4	1
Deterioration of vessel	5	8	1	9
Economic prosperity	6	7	7	4
Favorable financial conditions	7	9	8	5
Rise of transportation costs	8	6	10	2
Rise of oil prices	10	4	6	10
Application of MARPOL and OPA 90	4	5	5	6

The above table shows each oil refinery has an

analogous tendency in ranking of importance. Following is an analysis of the factors ranking range from 1 to 5. The number in the () represents frequency.

- 1st factors: Expansion of Refining Capacity(1), Rise of WS Index(2), Deterioration of Vessel(1)
- 2nd factors: Strengthening Tanker Safety(2), Rise of WS Index(1), Rise of Transportation costs(1)
- 3rd factors: Expansion of Refining Capacity(2), Strengthening Tanker Safety(2)
- 4th factors: Rise of WS Index(1), Economic Prosperity(1), Rise of Oil Prices(1), Application of MARPOL and OPA 90(1)
- 5th factors: Deterioration of Vessel(1), Application of MARPOL and OPA 90(2), Favorable Financial Conditions(1)

Therefore, expansion of refining capacity, rise of WS index, deterioration of vessel, strengthening the tanker safety, and rise of transportation costs were selected as the most important factors by the domestic refinery companies.

As has been indicated above, strengthening tanker safety and the rise of WS index factors came out 4 times, expansion of refining capacity, and application of MARPOL and OPA 90 factors came out 3 times, deterioration of vessel factor came out 2 times and the rise of transportation costs and other factors came out 1 time in frequency.

In sum, strengthening tanker safety, expansion of refining capacity, rise of WS index, application of MARPOL and OPA 90, deterioration of vessel, and rise of transportation costs are regarded as the most important factors to tanker fleet composition so far. Next, this result will compare with marks of importance on the 5 point scale.

2) Analysis of each factor by mark of importance

Here, the mark of importance per factor which has a 5 point scale is analyzed. Table 3 set out aggregated marks checked by each domestic oil refinery company.

In marks of importance, table 3 shows that strengthening tanker safety and the rise of WS index factors got 18 points respectively which is the highest marks considering the most important factors. Expansion of refining capacity, rise of transportation costs, and application of MARPOL and OPA 90 are regarded as the next important factors with 16 points. Those factors are similar to the factors which came out in table 2 from an importance point of view. Consequently, we can tentatively conclude that the above mentioned factors are affecting the decisions relating to tanker fleet composition.

Table 3 Aggregated marks of importance per decision

making factor

Factors	Marks				Total
	S-oil	SK	LG	Hyundai/ Inchon	
Active oil exploration	2	1	4	4	11
Expansion of refining capacity	3	4	4	5	16
Strengthening tanker safety	4	5	4	5	18
Rise of WS index	4	5	5	4	18
Deterioration of vessel	4	2	4	5	15
Economic prosperity	3	2	4	5	14
Favorable financial conditions	3	2	3	4	12
Rise of transportation costs	3	4	4	5	16
Rise of oil prices	4	2	4	3	13
Application of MARPOL and OPA 90	4	4	4	4	16

For final conclusions, it should adapt the following frequency analysis with 4 categories, presented in the next section. After that, the factors, derived from the frequency analysis, will be compared with the factors regarded as the most important ones till now.

3) Frequency analysis concerning 4 categories

In this section, the derived 10 factors were analyzed in 4 categories. Next, set out the factors of ranking of importance by frequency analysis, and then grasp the relationship among the factors. The sum of the results are presented in table 4.

According to categories (a) and (b), application of MARPOL and OPA 90, and the rise of transportation cost factors have a frequency of 7 and 6 respectively. That

means those 2 factors are the most important ones influencing changes in decreasing tanker ownership and increasing tanker chartering decisions in the 4 big oil refinery companies. The reason for analyzing categories (a) and (b) is to attain the goal of this paper.

In table 4, the last total column illustrates 8 times for expansion of the refining capacity factor, 6 times for strengthening tanker safety factor, and 5 times for active oil exploration, deterioration of vessel, and economic prosperity factor in frequency.

The active oil exploration factor does not occur in (a) and has just 1 in (b). Deterioration of vessel, and the strengthening tanker safety factor have occurred in both (a) and (d). Favorable financial conditions and economic prosperity factors appeared in (d). The rise of WS index factor has no frequency in (a) and (b). Even though, expansion of refining capacity factor has frequency in (b), and also has it in (c). Even if strengthening tanker safety, rise of WS index, expansion of refining capacity, and deterioration of vessel are regarded as important factors in ranking of importance and frequency, and mark of importance in prior analysis, these factors have frequency in (d). So, it can be concluded that these factors are not suitable for the aim of the paper.

4) Summary of analysis per company

(A) Hyundai/Inchon

This company gave 3 points for the rise of oil price factor and 4 points for active oil exploration, favorable financial condition, rise of WS index and application of MARPOL and OPA 90 factors in marks of importance. And,

Table 4 Frequency analysis concerning 4 categories

Factors	Category																Total	
	(a) Ownership decreasing				(b) Chartering increasing				(c) Chartering/ ownership increasing				(d) Chartering decreasing					
	①	②	③	④	①	②	③	④	⑤	①	②	③	④	①	②	③		④
Active oil exploration					√				1	√		√		√			√	5
Expansion of refining capacity					√	√	√	√	4	√	√	√	√					8
Strengthening tanker safety		√	√	√				√	4					√	√			6
Rise of WS index											√		√	√		√		4
Deterioration of vessel's age		√		√					2					√	√	√		5
Economic prosperity						√			1		√		√	√			√	5
Favorable financial conditions														√	√	√	√	4
Rise of transportation costs	√		√	√	√		√	√	6									6
Rise of oil prices	√								1									1
Application of MARPOL and OPA 90	√		√	√	√	√	√	√	7									7

Note: ① = Hyundai/Inchon ② = SK ③ = LG-Caltex ④ = S-oil ⑤ = Sum of frequency in categories (a) and (b)

it also gave 5 points for the rest of the factors. This tendency is similar to the result from table 2.

Factors based on the questionnaire analysis, influencing changes in ownership and chartering decision of Hyundai/Inchon are as follows;

- (a) Category: Rise of transportation costs, Rise of oil prices, Application of MARPOL and OPA 90
- (b) Category: Active oil exploration, Expansion of refining capacity, Rise of transportation costs, Application of MARPOL and OPA 90
- (c) Category: Active oil exploration, Expansion of refining capacity
- (d) Category: Active oil exploration, Economic prosperity, Strengthening tanker safety, Rise of WS index, Deterioration of vessel, Favorable financial conditions

According to the interview with the tanker operator, in the case of chartering increasing, the preferred types are spot and CVC(Consecutive Voyage Charter), and in the case of chartering decreasing, the preferred type is time charter. In general, the leading factors in decreasing tanker ownership are the rise of transportation costs and application of MARPOL and OPA 90. The rise of WS index and strengthening tanker safety factors which were considered the most important influenced the decrease in chartering.

(B) SK

This company gave 1 point for the active oil exploration factor which was classified as unimportant, and gave 5 points for the rise of WS index and the strengthening of tanker safety factors in marks of importance. It also gave 3 points for application of MARPOL and OPA 90, rise of transportation costs, expansion of refining capacity factors, and gave 2 points for the remaining factors. This tendency is similar to the result from table 2.

Factors based on the questionnaire analysis, influencing changes in ownership and chartering decisions of SK are as follows;

- (a) Category: Strengthening tanker safety, Deterioration of vessel
- (b) Category: Expansion of refining capacity, Economic prosperity, Application of MARPOL and OPA 90
- (c) Category: Expansion of refining capacity, Rise of WS index, Economic prosperity
- (d) Category: Deterioration of vessel, Favorable financial conditions, Strengthening tanker safety

According to the interview with the tanker operator, in the case of chartering increasing, the preferred types are also spot and CVC, and the rise of WS index factor leads to a preference of time charter. Strengthening tanker safety

and deterioration of vessel factors are in both ownership decreasing and in the chartering increasing category, but these two factors are also in the decreasing chartering category. In general, if the favorable financial conditions factor is good, it leads to a tanker chartering decrease.

The factors considered important at analysis of ranking of importance, such as the rise of WS index and expansion of refining capacity factors are also present in the category of increasing tanker chartering and ownership simultaneously.

(C) LG-Caltex

This company gave 5 points which is the highest mark for rise of WS index and gave 3 points for favorable financial conditions, and 4 points for the rest of the factors. Judging from the marks of importance only, no differences in importance could be seen.

Factors based on the questionnaire analysis, influencing changes in ownership and chartering decision of LG-Caltex were as follows;

- (a) Category: Strengthening tanker safety, Application of MARPOL and OPA 90, Rise of transportation costs
- (b) Category: Expansion of refining capacity, Rise of transportation costs, Application of MARPOL and OPA 90
- (c) Category: Expansion of refining capacity, Active oil exploration
- (d) Category: Rise of WS index, Deterioration of vessel, Favorable financial conditions

According to the interview with the tanker operator, strengthening tanker safety and WS index factor affected the preference for CVC, COA(Contract of Affreightment) and time charter rather than spot. The rise of transportation costs, rise of oil price, application of MARPOL and OPA 90, and expansion of refining capacity factors which increases chartering leads to a preference for spot charter.

The factors considered important at analysis of ranking of importance, such as expansion of refining capacity is the factor which increases both chartering and ownership. The strengthening tanker safety factor affects on ownership decreasing and rise of WS index factor resulted from the category of increasing tanker chartering and ownership simultaneously.

(D) S-oil

This company gave 2 points for active oil exploration factor which is the lowest mark and gave 3 points for favorable financial conditions, rise of transportation costs, economic prosperity and expansion of refining capacity factors for marks of importance. And, gave 4 points for the rest of the factors. There are no factors having 5 points

which is the highest mark.

Factors based on the questionnaire analysis, influencing changes in ownership and chartering decisions of S-oil are as follows;

- (a) Category: Rise of transportation costs, Deterioration of vessel, Application of MARPOL and OPA 90, Strengthening tanker safety
- (b) Category: Rise of transportation costs, Expansion of refining capacity, Application of MARPOL and OPA 90, Strengthening tanker safety
- (c) Category: Rise of WS index, Expansion of refining capacity, Economic prosperity
- (d) Category: Active oil exploration, Economic prosperity, Favorable financial conditions

According to the interview with the tanker operator, spot is preferred when chartering increases, and CVC is the second choice. Strengthening tanker safety, application of MARPOL and OPA 90 and the rise of transportation costs are the most important factors affecting both chartering increases and ownership decreases. The factor, expansion of refining capacity, considered important at analysis of ranking of importance resulted from the category of increasing tanker chartering and ownership simultaneously.

3.3 Some remarks about the results

In this paper, due to average marks of importance ranging from 3 to 4.5 on the 5 point scale, the selection of factors in explaining the changes of tanker fleet composition has validity to some degree. The results from previous analysis by descriptive statistics, showed that expansion of refining capacity, strengthening tanker safety, rise of WS index, rise of transportation costs, application of MARPOL and OPA 90 and the rise of oil prices factors are the most important ones influencing oil tanker fleet composition of domestic refinery companies.

Among the factors, strengthening tanker safety acts as a factor affecting chartering decreases, and expansion of refining capacity having the highest frequency 8 and the rise of WS index factors turned out to be increasing elements for both chartering and ownership. The rise of WS index also acts as a factor affecting chartering decreases and has a low frequency of 4 points. Therefore, the rise of WS index factor is not suitable for the object of the paper.

Judging from the analysis, application of MARPOL and OPA 90, the rise of WS index, rise of transportation costs and strengthening tanker safety were regarded as uncontrollable factors on the level of individual enterprise. On the contrary, active oil exploration, deterioration of vessel and expansion of refining capacity were regarded as controllable factors on the level of individual enterprise, and

the companies responded with these factors were less important than preceding uncontrollable factors in general.

In addition, it was analyzed that the economic prosperity and favorable financial conditions factors belonging to a part of macroeconomics were low in relative importance compared with other factors. From this, external elements are affecting the change of tanker fleet composition much more than internal elements. Active oil exploration and deterioration of vessel factors showed somewhat big differences in importance among individual oil refinery companies. It can be found that in accordance with whether or not oil refinery companies participate in oil exploration, tanker owning or not, that each company's estimation of importance can be different.

4. Conclusion

It is not easy to get a definite conclusion owing to limited documentary data in relation to the subject and small population for questionnaires which were the four oil companies. However, the in-depth interviews with experts overcome the limitations of the surveys and questionnaires.

The object of this study was to find the factors influencing the oil tanker fleet composition of domestic refinery companies using 10 decision-making factors derived from previous literature, questionnaires, and experience survey.

The findings in this paper concluded that the most important decision-making factors which affect both chartering increases and ownership decreases for the tanker transportation logistics of Korean oil refineries are application of MARPOL and OPA 90, and the rise of transportation costs. Reasons for the factor selection by the companies are as follows. First, this is because the MARPOL and OPA 90 factor is free from responsibilities and burden of expenses when an oil spill occurs. Also, it has no significant capital outlay for new building, and no problems with idle tonnage in a low demand market. Secondly, the rise of transportation costs factor can save expenditures caused by tanker owning that are operating costs, capital costs, periodic maintenance costs and employees' wages for company's operations.

The next important factors were expansion of refining capacity and strengthening tanker safety.

In summary, the reason chartering is preferred over ownership, in general, is that ownership has lack of flexibility but chartering and spot fixing provides flexibility and choice. However, the current way of fleet composition seems to neglect time charter considering respect to cost advantages caused by relying upon spot in the 1970s. And also seems to ignore merits from tanker owning.

So, diverse tanker fleet composition will be needed on the level of not overlooking the merits of tanker owning. And, in the short term, because it is not possible to change the ratio of tanker fleet composition in chartering and ownership, long-term strategy of tanker fleet composition should be set up for future market fluctuation.

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