

## Risk Priority and Allocation of Private Investment in Port Development

Yu-Chang Seong\* · Myung-ou Youn\*\* · Jong-Soo Keum\*\* · Inoue Kinzo\*\*\*

\* Graduate school of Kobe University, Kobe, 658-0022, Japan

\*\* Professor, Division of Maritime Transportation System, Mokpo National Maritime University, Mokpo 530-729, Korea

\*\*\* Professor, Faculty of Maritime Sciences, Kobe University, Kobe, 658-0022, Japan

**Abstract :** *The Port Development has been achieved by the Government because it needs large scale of funds. However, since 1994, the Government has been implementing private investments for constructing and operating the ports and so on. Although the Government had high expectation that it could expedite the expansion of the port facilities, there were many problems in view of construction, management, financial and social environment. This study figure out that most of the important reasons are the uncertainty of risk allocation between private investors and the Government, using with Analytic Hierarchy Process. It is expected that the results of this study will encourage more private investors to participate in port private investments in the future.*

**Key words :** *Port development, Private investetment, AHP, Priority of risk, Allocation of risk*

### 1. Introduction

The Korean Government has concerned and propelled in Social Overhead Capital(SOC) business according to the law of 「Private investment promotion law for social overhead capital equipment in 1994 and 1998」 regarding port private investment business. In case of private investment on ports, it is the Government that becomes burdened with the risks in many parts because it requires the support of the Government whenever risks occur.

Therefore, it can be said to say that the risk-allocation is the important thing for the successful performance of the private investment making a priority among the main risk-taking parts on private investment. However, there are not lots of researches about the problem on how the risks are shared among the Government, private sectors, and others. This is why it has always been controversial.

The purpose of the research is to understand the reasonable way to allocate risks among the Government, the privates, and etc; analyzing the main risks at process that enforce the private investment of port systematically by comparing relative importanc of each risk.

This study analyzes the concerned literatures and the previous research on the private investment businesses first, so that we can determine, using the questionnaires

and interviews, how to distribute the risks.

In addition, it utilizes hierarchy analysis as a means to numerous priority-analysis, to have various given-standard for the private investment business. It measures relative priority with the questionnaires. Therefore, the targets of the questionnaires are concerned of the Government, the private businesses, the experts in relation with the port that are under construction or are operated at present.

The questionnaires analyze riskhierarchy and distribution through the direct interviews with the selected experts in the private investment to grasp the characteristics of the risks and the priority.

### 2. Characteristic of Port Development

#### 2.1 Concept of Port Development

We generally think that the Government must take charge of supply in the SOC, which includes such as ports, roads, and communications, because the SOC would be effective in the construction and management of public facilities. However, in order to reduce the risks of the Government failures and increase the efficiency of the management, the Government is actively promoting port investment at present.

\* Corresponding Author : Yu-Chang Seong, smileseong@hanmail.net, 042)635-6940

\*\* ymo@mmu.ac.kr

\*\* jskeum@mmu.ac.kr, 065)240-7075

\*\*\* k-inoue@maritime.kobe-u.ac.jp

## 2.2 Form of Port Investment

The private investments in the social overhead facilities, such as ports, are divided as follows by the existence, non-existence of duration and style of ownership.

**BTO (Build-Transfer-Operate):** The Government owns the facilities as social overhead capital, but the private sector operates and manages facilities for a limited period.

**BOT (Build-Own-Transfer):** Ownership is delegated to the private when social overhead facilities are completed. Facility ownership is returned to Government after the expiration of the period.

**BOO (Build-Own-Operate):** These are the factors allowing private company a ownership when social-overhead facilities are completed.

**BLT (Build-Lease-Transfer):** A private company rents the social overhead facilities from the constructor for a limited period after completion.

**ROT (Rehabilitate-Operate-Transfer):** The Government gives managing rights to the private owner who rehabilitates the facilities.

**ROO (Rehabilitate-Own-Operate):** The Government authorizes ownership of the facilities to the private who has serviced existing facilities.

**BTL (Build-Transfer-Lease):** The form by which the private leases the managing rights for a given period when the social overheadis completed, but the Government has ownship of the facility.

**RTL (Rehabilitate-Transfer-Lease):** The form by which the private leases the managing rights for a given period and enforces the improvement and repair of the social facilities where the Government has ownership of the facilities.

## 2.3 General Risks of Private Investments on Ports

The general problems with private investments in ports are summarized below. First, the characteristics of the port construction and the management process are as follows:

1) The expected service year of the investment facilities seems to be long, and the refund period for the investment fund seems long as well.

2) Large-scale investments become necessary with an increase of the financial scale during the construction period, and the interest rate standard tends to rise as well.

3) It shows the difference between the original plan and the actual progress of private investing in ports, and there is a point at which the withdrawal of the investments is more difficult than the other social overhead facilities.

4) Under the given condition which the corresponding ports faced in terms of area and type, the characteristics of the investment projects would be changed, too.

In management, the risks are shown under the situation where the expectations according to the original demands for the ports service have not been reached, and service-fees exceed expectation. It has actually happened at private investment ports that are managed and are at present, as well.

As the operational period of the private company might be long, unexpected changes in policy or concerned regulations may become obstacles could that keep away lively private investments too.

Especially during the private investment negotiation processes, decisions are made as to who (The Government, the private companies, etc.) shares the risks (in case these happen) and any controversy is discussed. It would cause many disputes later if the risk were not divided beforehand at the investment negotiation.

## 3. Classification of Risks

### 3.1 Previous Research on Risk

The following are the previous researches on the classification of the risks. Walker and Smith(1995) classified the risks of private investment as three kinds of big risks, Financial, Political, and Social. Ha(1998) maintained that it must be applied properly for efficiency of the private investments as depending on a standard. He classified risks as Construction, Management, Market, Product, Finance, International condition and a few more.

In sharing the risks, Kay(1997) researched that the efficiency of the businesses has made to be an enlargement in accepting of risk by private parts. UNITRAL reported on the standard on allocation of the risks in 2001. In the report, one of risk-standard is that the parts capable to manage or to possess managerial skills charge the creteria risks after having a through grasp of the characteristic of them.

### 3.2 Classificaton of the Risks on Ports

Though the previous researches show the allocation and the management of risks, they did not present how to do it specifically. Paticularly, in private investments of ports, there have been few of such a research. Therefore, this study tries to examine the relative priority, to distribute main constituent of each risk element.

According to the classification of the risk reviewed so far from the theory analysis, it is possible to group risk into four type, constructiont, management, financial and social.

From this classification in the paper, we call this as four kind risks, and the elements of each risk are taken as the comparative evaluation objects, when they overlap with equal to or more than twice in the previous researches.

Table 1 Risk of Construction

Risk	Content
Wrong estimation of cost	Wrong estimation carried out on cost of construction
Mistake of schedule	Difference between plan on first stage and actual process.
Unexpected occurrence on construction	The condition of existence and the construction of the facility is different from expectation
Wrong design at first stages	Wrong design at first stages and additional cost for redesign are needed
Contract(for work) problem	In relation with Contract problem; Not undertaking by construct
Environmental problem	The trouble in relation with environment on construction
Act beyond control	Matter beyond human control(through an Act of God)

Table 2 Risk of Management

Risk	Content
Quantitative lack of cargo flows	In case a difference occurs between the estimated quantity of cargo and the actual quantity
Unexpected additional fee	Unexpected additional cost on management;
Low quality of service	The loss by low quality of service
Problem of managing equipment	The problem in relation with the performance of crane, the facilities
Unsuitable management	Improper management by a facility administrator
Change of managing method	In case the replacement cost according to the change of the management method is needed
Change of profit	The change of the profit concerned with port management

Table 3 Risk of Finance

Risk	Content
Problem of credit	Problem of credit by Government, Private, etc
Fluidity problem	The problem when the flow of cash not being appropriate
Inflation	The danger of the inflation by the rise of prices
Excessive debt	The problem according to lots of debt
Change of exchange rate	The problem generated by the rapid change of the exchange

Table 4 Risk of Social Environment

Risk	Content
Trouble on custom and trade	The problem in relation with trade friction and customs between the states
Change of related regulation	Change of related regulation on port investment
Work trouble	The problem according to work trouble as strike.
Petition	The problem which concerns a petition in case of construction of the port and management
Unstable society	The problem generated by society's being unstable

#### 4. Risk Priority and Allocation of Private Investment

##### 4.1 Questionnaire

To grasp the risk standard of each risk in the port private investment business, we completed the questionnaires twice. It was pre-examined whether or not the questionnaire was rational and difficult to understand by the discussion of experts(Researchers concerned on university, Person concerned on Govern., Private part). And the contents of the questionnaire were corrected and deleted before distributing first questionnaire.

The research assesses the standard of the main risks through the first investigation of the questionnaire. It is composed of fifth grade; Degree of risk is very high, high, middle, low and very low. When thinking that it is very high risk, you check at degree 5.

Table 5 Example of 1st questionnaire Main risk-taking part and the standard measurement on a relation question

Wrong estimation of cost	risk-taking	(Government)	(Private)	(Other)	Private
	degree of taking	(5)	(4)	(3)	(2)

The purpose of first questionnaire is generally investigated of the standard and level of the risk. The questionnaire is examined again to determine the relative priority among each risk, rearranging the risks identified through the 1st questionnaire data, to use a hierarchy analysis.

Table 6 Example of 2nd questionnaire Risk-priority selection between each item

	Strong	--	Equivalent	--	Strong	
Fluidity problem	⑨		⑦ v		⑤	③
					①	③
					⑤	⑦
					⑨	
						Credit Problem

The questionnaires were sent to 100 persons concerned with the private investment businesses. 52 questionnaires were returned at a rate of 52%. The distribution of questionnaires showed the following table 7.

Table 7 Distribution of repliers on questionnaire

Repliers on questionnaire	Num.
1. Private part(Port development Company of Mokpo and Busan)	15
2. Government concerned(Province of genra)	12
3. Researchers of university	17
4. The others(Including The concerned on Finance)	8
Total	52

4.2 Hierarchy Analysis(AHP:Analytic Hierarchy Process)

AHP mechanism proposed by Satty (1994, 1980, 1977) was known as an effective tool to support the multiattribute decision-making. From its versatility in dealing with qualitative factors, and multiple objectives, the decision makers were resulted in an impressive array of applications such as energy planning, conflict resolution, banking, architecture, etc.

It was a compositional approach where a multiattribute problem was first structured into a hierarchy of related elements, and then a pairwise comparison of elements in terms of their dominance was licited. The weights were given by the eigenvector associated with the highest eigen value of the reciprocal ration matrix of pairwise comparisons. A detail description of the AHP algorithm was given into four steps as follows.

Step1 : Pairwise comparison matrix A

Where,  $a_i$ ,  $i = 1, 2, m$ , means the alternative or location requirement. Then,  $a_{ij}$  indicates how much more important the  $i$ th alternative is than the  $j$ th alternative for constructing the column vector of importance weighting of alternatives (location requirements). For all  $i$  and  $j$ , it is necessary that  $a_{ii} = 1$  and  $a_{ij} = 1/a_{ji}$ . The possible assessment value of  $a_{ij}$  with the corresponding interpretation is shown in Table 5.

$$A = \begin{bmatrix} a_{11} & a_{12} & \dots & a_{1m} \\ a_{21} & a_{22} & \dots & a_{2m} \\ \vdots & \vdots & \dots & \vdots \\ a_{m1} & a_{m2} & \dots & a_{mm} \end{bmatrix} \quad (1)$$

Step2 : Generalization of pairwise comparison matrix A

In this step, each entry in column  $i$  of A was divided by the sum of the entries in column  $i$ . This yields a new matrix  $A_w$ , in which the sum of the entries in each column is 1.

$$A_w = \begin{bmatrix} a_{11}/\sum_{i=0}^m a_{i1} & a_{12}/\sum_{i=0}^m a_{i2} & a_{13}/\sum_{i=0}^m a_{i3} & \dots & a_{1m}/\sum_{i=0}^m a_{im} \\ a_{21}/\sum_{i=0}^m a_{i1} & a_{22}/\sum_{i=0}^m a_{i2} & a_{23}/\sum_{i=0}^m a_{i3} & \dots & a_{2m}/\sum_{i=0}^m a_{im} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ a_{m1}/\sum_{i=0}^m a_{i1} & a_{m2}/\sum_{i=0}^m a_{i2} & a_{m3}/\sum_{i=0}^m a_{i3} & \dots & a_{mm}/\sum_{i=0}^m a_{im} \end{bmatrix} \quad (2)$$

Step3 : Average vector C

Compute  $c_i$  as the average of the entries in row  $i$  of  $A_w$  to yield column vector C.

$$C = \begin{bmatrix} c_1 \\ c_2 \\ \vdots \\ c_m \end{bmatrix} = \begin{bmatrix} \frac{a_{11}/\sum_{i=0}^m a_{i1} + a_{12}/\sum_{i=0}^m a_{i2} + a_{13}/\sum_{i=0}^m a_{i3} + \dots + a_{1m}/\sum_{i=0}^m a_{im}}{m} \\ \vdots \\ \frac{a_{m1}/\sum_{i=0}^m a_{i1} + a_{m2}/\sum_{i=0}^m a_{i2} + a_{m3}/\sum_{i=0}^m a_{i3} + \dots + a_{mm}/\sum_{i=0}^m a_{im}}{m} \end{bmatrix} \quad (3)$$

Step4 : Consistency check for A and C

To check for consistency in a pairwise comparison matrix, the substeps are required as follows

$$A * C = \begin{bmatrix} a_{11} & a_{12} & \dots & a_{1m} \\ a_{21} & a_{22} & \dots & a_{2m} \\ \vdots & \vdots & \dots & \vdots \\ a_{m1} & a_{m2} & \dots & a_{mm} \end{bmatrix} \begin{bmatrix} c_1 \\ c_2 \\ \vdots \\ c_m \end{bmatrix} = \begin{bmatrix} x_1 \\ x_2 \\ \vdots \\ x_m \end{bmatrix} \quad (4)$$

Consistency Index(CI)  $CI = \frac{\lambda_{max} - m}{m - 1}$

Consistency Ratio(CR)  $CR = \frac{CI}{RI}$

Note) Consistency Ratio (CR), Average Random Consistency Index =  $m^{-1}$

$m$	2	3	4	5	6	7	8	9	10
RI	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.51

Compare CI to the random index (RI) for the appropriate value of  $m$  to determine if the degree of consistency is satisfactory. If CI is sufficiently small, the decision maker's comparisons are probably consistent enough to give useful

estimates of the weights for the objective function. If  $CI/RI < 0.10$ , the degree of consistency is satisfactory, but if  $CI/RI > 0.10$ , serious inconsistencies may exist, and the AHP may not yield meaningful results. The reference values of the  $RI$  for different numbers of  $m$  are shown below (Kim and Lee, 2003)

### 4.3 Empirical Analysis

Table 8 Priority of 4 Risks

	Construction	Management	Finance	Social
Weighting	0.245	0.288	0.283	0.184

Through the analysis results, the risky status of the management and the finance is shown as higher(0.28) than the construction(0.24) and social(0.18). in the main risk-taking classification, In construction risks, the wrong estimation of cost is analyzed as more important(0.38) than the other risks. Then, it is analyzed for environment related problems (0.29). It shows a high degree of danger compared with problems of schedule estimation and unexpected occurrences on construction.

In the risks of the management, the problem of management by the quantitative lack of cargo flows (0.8) is higher than any other risks. Then, other high risks that are given priority are, in order, unsuitable management, change of profits, and additional charges.

For the financial risks, fluidity problems and excessive debts are rated as (0.51) and (0.36), respectively. The inflation is not seen as a highly dangerous risk.

Analyzing the detailed items under the social risk, which was relatively classified as lower than other risks, related regulations changes and petitions are higher (0.38 and 0.35, respectively). The work trouble is shown to be (0.26).

The result of a questionnaire does not become meaningful and is not consistent as a standard of analysis if CR figure is not less than 0.1. All the results of CR in the paper were less than 0.1 and the analysis was verified to be consistent.

### 4.4 Allocation of Risk

In this research on the private investments of ports, we aim to determine risk-standards, It was investigated how the risk-taking is distributed from the questionnaires and the risks are allocated in order based on the result.

The allocation-standard, as shown below, defined that the certain risks must only be assigned to the corresponding participants when the questionnaire result shows the risk might be burdened with oddity of 70%. The risks are

shared among risk-taking participants when the result of the questionnaire is less than 70%.

Table 9 Risk Allocation of Construction

Risk	Result(%)	Risk-taking
Wrong estimation of cost	Government : 22 Private : 75 Others : 3	Private
Mistake of schedule	Government : 32 Private : 67 Others : 1	Private
Unexpected occurrence on construction	Government : 43 Private : 56 Others : 1	Govern., Private
Wrong design at first stages	Government : 29 Private : 69 Others : 2	Private
Contract problem	Government : 8 Private : 89 Others : 3	Private
Environmental problem	Government : 58 Private : 42 Others : 0	Govern., Private
Uncontrollable work	Government : 82 Private : 14 Others : 4	Government

The construction risks that the private business must be charged include, wrong estimation of cost, mistake on schedule, contract problem for construction. The risks that the Government should take the occurrence of inevitable accidents, additional expenses, and interruption in construction.

The risk that the private business and the Government both should share together, unexpected environmental problem is shown.

Table 10 Risk Allocation of Management

Risk	Result(%)	Risk-taking
Quantitative lack of cargo flows	Government : 34 Private : 58 Others : 8	Govern., Private
Unexpected additional cost	Government : 16 Private : 77 Others : 7	Private
Low quality of service	Government : 3 Private : 96 Others : 1	Private
Problem of managing equipment	Government : 7 Private : 90 Others : 3	Private
Unsuitable management	Government : 4 Private : 95 Others : 1	Private
Change of managing method	Government : 25 Private : 73 Others : 2	Private
Change of profit	Government : 12 Private : 84 Others : 4	Private

The management problems the private business should take is unexpected additional costs, low quality of services due to immaturity in the management, profit changes by managing methods and so on. Then, the risk to be burdened by the Government is identified quantitative lack of cargo flows.

Table 11 Risk Allocation of Finance

Risk	Result(%)	Risk-taking
Problem of credit	Government : 21 Private : 63 Others : 16	Govern., Priv., Others
Fluidity problem	Government : 21 Private : 76 Others : 3	Private
Inflation	Government : 65 Private : 32 Others : 3	Govern., Private
Excessive debt	Government : 36 Private : 57 Others : 7	Govern., Private
Change of exchange-rate	Government : 48 Private : 46 Others : 6	Govern., Private

The financial risks that the private business and the Government should share together are inflation, excessive debts, and sloppy changes of exchange rate. It is the fluidity problem that the private enterprise must take. Then, the credit problem is analyzed as responsibility of the Government private, and the other main risk-taking part (the financial part).

Table 12 Risk Allocation of Social Environment

Risk	Result(%)	Risk-taking
Trouble on custom and trade	Government : 86 Private : 8 Others : 6	Government
Change of related regulation	Government : 92 Private : 8 Others : 0	Government
Work trouble	Government : 21 Private : 72 Others : 7	Private
Petition	Government : 13 Private : 76 Others : 11	Private
Unstable society	Government : 86 Private : 11 Others : 3	Private

The social risks that the private part take include work problems, such as labor strikes and petition. The customs troubles, trade faults, the changes of related laws and

regulations, and the instability of the society must be burdened by the Government according to the questionnaire.

## 5. Conclusions

In the paper, we used AHP (the hierarchy analysis process) and classified the four main risks by the risk taker, private sectors, Government, and the other sector, construction, management, finance and social, with a goal to enforce private investment in ports. The main risks are broken down into the specific risks and the ratings are assigned to each of them.

To summarize the importance-priority analysis results for each of the four main risks, it is seen that management risk and finance risk were more important (0.28) than the other two.

In analyzing the characteristics of the main risks, the biggest problem was wrong expense estimation at (0.38). In the case of the management risk, the problem of a lack of cargo flows is estimated at (0.58). The fluidity problem in finance risk has been determined as the most important element at (0.51). Then, the changes of related laws and regulations was determined to be the most important of the social risk.

For an upcoming research, we suggest that much deeper analysis must be concerned with risks regarding investments in ports and harbors, and the studies should be of actual cases of foreign investments.

At the same time, to give priority to risks on private investments in ports, were researches of many cases of port investments would be needed. Then from the researches to be conducted in the future, we can suggest more efficient management skills and knowledge for private investments on ports.

## Reference

- [1] Cho, C. H. (1990), "Reformation of port facility by private investment", Ministry of Maritime Affairs and Fisheries (Korea of republic).
- [2] Ha, H. G. and Ahn, J. H. (1998), "Evaluation and reformation of private investment", Korea transport institute.
- [3] Kim, G. S. and Lee, G. C. (2003), "Fuzzy AHP and FCM driven Hybrid Group Decision Support Mechanism", Journal of information application & management, pp.239-250.
- [4] Kim, S. G.(1995), "Issue on Social Overhead Capital Construction of Inchoen air port", Korea transport

- institute.
- [5] Lee, S. M. (1997), "Science of management analysis and application for decision making", Bummun Pub..
- [6] Nho, S. K. and Jeong, W. H. (1997), "Improvement for infrastructure in private investment", Korea development institute.
- [7] Park, J. J. (2002), "How to encourage Private Investment", Graduate school of civil science - Seoul metropolitan university.
- [8] Philippe, J. (1997), "*Value at Risk, The New Benchmark for Controlling Market Risk*", New York: McGraw Hill.
- [9] Port development report (2000), Ministry of Maritime Affairs and Fisheries (Korea of republic).
- [10] Private Finance Panel (1996), *Risk and Reward in PFI Contracts*, U.K.
- [11] Thomas, S. (1998), *The Analytic Hierarchy Process*, McGraw-Hill.
- [12] UNCITRAL (1998), Legislative Guide on Privately Finance Infrastructure Projects.
- [13] Walker, C. and Smith, A. J. (1995), "Privatized Infrastructure: the BOT Approach", London: Thomas Telford Publication.
- [14] Yang, J. C. (1998), "Improvement of infrastructure and participating", Korea research institute for human settlements.
- [15] Youn, M. O. and Keum, J. S. (2003), "Port management" Haein Publication.

---

Received 10 July 2006

Accepted 10 October 2006