

# A Study on the Identification of Key Role Players in Enhancing Port Competitiveness

- Focused on Busan Port -

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**Abstract :** *The analytical hierarchy process (AHP) enables decision makers to represent the interaction of multiple factors in complex and unstructured situations. The process requires the decision maker to develop a hierarchical structure of the factors in the given problem and to provide judgments about the relative importance of each of these factors and ultimately to specify a preference for each decision alternative with respect to each factor. The research presented in this paper applies the AHP to identify key players in promoting port competitiveness. The literature survey revealed four major criteria and 15 sub-criteria. The four factors are cost, service quality, facility/capacity and economic-social variable. 150 questionnaires suitable for AHP analysis were made and 77 were returned.*

*It is found that in terms of cost, the first key player is terminal operator and the second key player is shipping companies calling Busan port; in terms of service quality, the first key player is terminal operator, and the second key player is shipping companies calling Busan port; in terms of facility/capacity, the first key player is port authority and the second key player is terminal operator; in terms of economic-social variable, the first key player is terminal operator, and the second key player is shipping companies calling Busan port.*

**Key words :** *Analytical hierarch process, Port competitiveness, Role ambiguity, Role playing, Port authority, Service quality, Port cost*

## 1. Introduction

There are various factors that determine a port's competitiveness. No consensus, however, has been established on the key role player for each factor related to the competitiveness. It naturally follows that clear responsibility can not be assigned to the organization that is addressed. Many sorts of actors are interacting in the process of port management. For example, government plans overall port development; regional MOMAF is operating and controlling each region's port management. BPA(Busan Port Authority) is managing Busan Port in the area of commercial operation and management only while each terminal operators are practically operating the terminals of Busan Port. There exist role ambiguities among actors around a port because port competitiveness factor comprises not only planning strategy which is high level concept but also it comprises low level of, for example, port operations. The role players do not figure out their own roles in enhancing port's competitiveness.

Each organization's task has been defined to some extent in the laws such as 'The Law of Port Authority', 'Port Law', 'Law of Open Port Order', etc. For example, regional MOMAF has the responsibility of 'shipping and fishery policy, control and administration, water area management

and port operation in the waters of its own control'. Here is, however, a confusion in terms of port competitiveness because port facilities are managed by different organizations. MOMAF controls the facilities of outer water area and facility for approaching water way. The other facilities such as terminal and berthing facility is maintained by BPA.

This kind of mundane problem arises and it triggered this research. AHP method will be adopted for identifying the key role player for each factor on port competitiveness of Busan. AHP was proposed by Satty to solve complicated and unstructured situations. Zimmermann(1991) analysed that it is basically composed of two procedures so as to be applied to multi-criteria decision making process: firstly, to judge the decision making alternatives and goals, and secondly to decide the rankings among alternatives according to comprehensive judgement.

## 2. Literature Survey

The method of AHP has been rarely applied to the field of logistics, some of which are discussed here.

Yedla and Shrestha(2003) utilised the AHP to select the environmentally-friendly transport systems in India. Chou and Liang(2001) used the AHP to create a model capable of

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evaluating the performance of shipping companies.

AHP method, however was barely applied to shipping and port fields. Lirn and Thanopoulou(2004) has dealt with the problem of trans-shipment port choice by global shipping companies under multiple criteria.

Willingale(1982) surveyed 20 European shipping companies to find out the port selection criteria, which were 'port accessibility', 'route', 'size of the port', 'terminal operation & capacity' and 'route pattern'.

Murphy et al.(1992) showed that the rank of port selection factors are port facility, equipment and port time.

Lirn et al.(2004) tried to find out the selection criteria of transshipment port and found the factors are port facility, network, port operation & management, and ship calling frequency.

Port evaluation factors used by Song et al. are the number of TEU handled, port facility, the position of the port and the level of service.

Table 1 Port competitiveness factors from various studies

researcher	evaluation factors
Willingale	<ul style="list-style-type: none"> <li>- port accessibility</li> <li>- route</li> <li>- size of the port</li> <li>- terminal operation &amp; capacity</li> <li>- route pattern</li> </ul>
Murphy et al.	<ul style="list-style-type: none"> <li>- port facility</li> <li>- equipment</li> <li>- port time</li> </ul>
Lirn et al.	<ul style="list-style-type: none"> <li>- port facility</li> <li>- network</li> <li>- port operation &amp; management</li> <li>- ship calling frequency</li> </ul>
Song et al.	<ul style="list-style-type: none"> <li>- the number of TEU handled</li> <li>- port facility</li> <li>- the position of the port</li> <li>- the level of service</li> </ul>

### 3. The Research Procedures

#### 3.1 AHP Analysis

AHP was suggested for the planning under the circumstance of insufficient data. It is mainly adopted in the situation of multi-criteria with multi-alternatives.

Saaty found that AHP contains 10 characteristics, which are unity, complexity, interdependence, hierarchy structure, measurement, consistency, synthesis, tradeoffs, judgement and consensus, process repetition(Saaty et al., 2001).

The process of problem analysis needs to draw out the attributes of the problem with systematic and hierarchical

manner. AHP requires to reduce the complicated problem to hierarchical structure, and the relationship between factors are analysed by pairwise comparison, which might be arbitrary and qualitative, but finally to draw out quantitative data.

AHP has been used for the analysis of multi-criteria and multi alternatives(i.e. multi-criteria decision making), but the highest advantage of AHP is that it can be used also for complicated problems, which can be sub-divided into major factors and detailed factors, and the importance of each criteria can be determined by pairwise comparison.

Pairwise comparison should be done first to determine the relative importance of factors, to produce pairwise comparison matrix  $A_{n \times n}$ .

$$A=[a_{ij}] = \begin{pmatrix} W_{11} & W_{12} & \dots & W_{1n} \\ W_{21} & W_{22} & \dots & W_{2n} \\ \dots & W_{n1} & W_{n2} & \dots \\ \dots & W_{nn} & & \dots \end{pmatrix} \quad (1)$$

where  $a_{ij}$  is relative weight of factor  $i$  for factor  $j$

Matrix  $A$  is multiplied by  $V^T(=v_1, v_2, \dots, v_n)$ , which is weight showing relative importance among evaluated items.

$$A \cdot V = n \cdot V \quad (2)$$

where  $n$  is maximum eigenvalue of matrix  $A$ .

It now becomes eigenvalue problem that can resolve an equation with  $n$  variables. The vector  $V$  means relative importance among evaluated items.

After deciding the relative importance of evaluation criteria, the effectiveness of the set of criteria should be examined. This can be done by calculating consistency ratio. If the consistency ratio is zero, then the respondents did pairwise comparison with perfect consistency. Saaty found that consistency ratio less than 0.1 proves consistency.

The following diagram reveals the general process of AHP. All the calculations done for this analysis has been executed by Microsoft Excel.

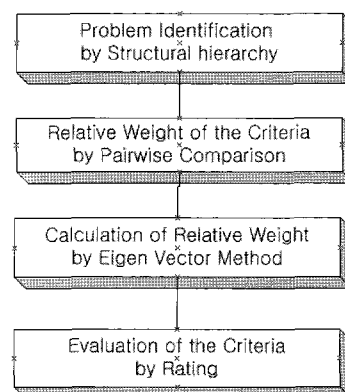


Fig. 1 The process of AHP analysis

### 3.2 Survey design

In order to evaluate port competitiveness, 4 major factors and 15 detailed factors were identified via a literature survey. The 4 major factors identified are cost, service quality, facility capacity and environment factor. Port competitive factors are shown in Table 2.

**Table 2** Port competitiveness factor

major factor	cost	service quality	facility capacity	environment factor
detailed factor	<ul style="list-style-type: none"> <li>• loading/berthing</li> <li>• storage</li> <li>• communication</li> <li>• long term discount</li> </ul>	<ul style="list-style-type: none"> <li>• speed/safety</li> <li>• on-time arrival</li> <li>• customs and inland transport</li> <li>• other service</li> </ul>	<ul style="list-style-type: none"> <li>• port entrance/berthing</li> <li>• loading/discharging</li> <li>• computer &amp; communication</li> <li>• storage</li> </ul>	<ul style="list-style-type: none"> <li>• port cargo quantity</li> <li>• hinterland connectivity</li> <li>• stability of operation environment</li> </ul>

4 key role players influencing port competitiveness selected via a literature survey are government, port authority, terminal operators and shipping companies calling Busan Port.

Questionnaires has been distributed to the specialists in port and shipping fields to find out the relative weight among port competitiveness factors. Statistical sampling was done and 150 questionnaire sets were posted, and 50 e-mail questionnaire sets were sent. 77 sets were collected, of which 32 are from shipping and port industries 21 from researchers including professors, and 24 from civil servants.

**Table 3** Summary of respondents

shipping and port industries	researchers	civil servants	sum
32	21	24	77

### 3.3 Evaluation Procedure

Here is shown the example of the evaluation procedure in case of 'cost' only because the procedures of other factors are the same.

Firstly, basic evaluation matrix should be formulated. This basic relative evaluation table was drawn from the questionnaires of the respondents. Table 4 shows various numbers that mean relative importance. '3' means that

'loading/berthing' is 3 times more important than 'long-term discount'.

**Table 4** Basic evaluation matrix

cost	loading/berthing	storage	communication	long term discount
loading/berthing	1	6	9	3
storage	0.167	1	2	0.167
communication	0.111	0.5	1	0.111
long term discount	0.333	6	9	1

All the numbers in Table 4 are summed to make Table 5 whose total sum is adjusted to be '1'. The most important factor is found to be 'loading/berthing' whose importance is 55% while that of 'communication' shows 4.5% in terms of importance.

**Table 5** Relative importance of factors

Evaluation factor	Value
loading/berthing	0.54875
storage	0.07793
communication	0.0449
long term discount	0.32842
sum	1

Whether evaluation factors have consistency or not can be decided by consistency ratio(CR). CI(consistency index) can be calculated by using  $\lambda_{max}$ .  $\lambda_{max}$  was calculated and found to be 4.165463.

$$CI = (\lambda_{max} - n) / (n - 1)$$

where CI = 0.055154 because the number of evaluation factors is 4.

Therefore

$$CR = CI / RI = 0.06128266^{1)}$$

It is acceptable because CR is below 0.1 as is discussed earlier.

### 3.4 The example for an evaluation on major players(in the case of 'loading/berthing')

The case for 'loading/berthing' was selected for the example of the analysis procedure. Relative evaluation table was made from the analysis of the questionnaires received from the respondents in the case of 'loading/berthing',

1) RI is 0.90 when n=4.

whose results are shown in Table 4.

**Table 6** The example for an evaluation on major players(the case of 'loading/berthing')

	government	port authority	terminal operator	shipping company
government	1	0.5	0.33333	1
port authority	2	1	0.5	2
terminal operator	3	2	1	3
shipping company	1	0.5	0.33333	1

#### 4. The identification of major players by unitary evaluation

In terms of 'cost', terminal operator is regarded to be the most responsible because its general average is 51.3% compared with other role players. The least-responsible organization was identified as 'government'.

**Table 7** Key role players in terms of cost

players	loading/berthing	storage	C&C	long term discount	general average
government	0.141	0.048	0.167	0.119	0.119
port authority	0.263	0.108	0.167	0.179	0.179
terminal operator	0.455	0.585	0.5	0.513	0.513
shipping company	0.141	0.259	0.167	0.189	0.189

note: C&C = computer & communication

In terms of 'service quality', terminal operator is regarded to be the most responsible for 'cargo dealing'; 'terminal operator' and 'shipping company' for 'on-time arrival'; 'government' and 'port authority' for 'customs and inland transport'. General average shows that 'terminal operator' is the most responsible one.

**Table 8** Key role players in terms of service quality

players	cargo	on-time arrival	customs and inland transport	other service	general average
government	0.054	0.042	0.396	0.108	0.150
port authority	0.160	0.089	0.396	0.259	0.226
terminal operator	0.437	0.434	0.148	0.585	0.401
shipping company	0.349	0.434	0.060	0.048	0.223

The response on 'facility capacity' shows that 'port authority' and 'terminal operator' should play a key role in enhancing the competitiveness of the port.

**Table 9** Key role players in terms of facility capacity

players	port entrance/berthing	loading/discharging capacity	C&C	storage	general average
government	0.128	0.095	0.118	0.136	0.119
port authority	0.414	0.442	0.395	0.387	0.410
terminal operator	0.414	0.409	0.395	0.417	0.410
shipping company	0.044	0.054	0.092	0.060	0.062

note : C&C = computer & communication

The response on 'socio-economic environment' shows that 'port authority' should play a key role in terms of 'cargo quantity', 'government' and 'port authority' in terms of 'hinterland connection' while 'port authority' is primary responsible for 'operation environment'.

**Table 10** Key role players in terms of socio-economic environment

players	port cargo	hinterland connection	operation environment	general average
government	0.125	0.430	0.197	0.251
port authority	0.375	0.430	0.533	0.446
terminal operator	0.125	0.100	0.197	0.141
shipping company	0.375	0.041	0.073	0.163

#### 5. The identification of major players by AHP evaluation

##### 5.1 Relative importance of criteria

The highest important criteria have been identified to be 'loading/berthing'(54.8%) among 'cost' factors; 'on-time arrival'(58.0%) among 'service quality' factors; 'computer & communication'(53.6%) among 'facility capacity' factors; and 'port cargo quantity'(76.4%) among socio-economic environment factors.

The lowest important criteria have been identified to be 'communication'(4.5%) among 'cost' factors; 'speed/safety'(4.5%) among 'service quality' factors; storage(6.2%) among 'facility capacity' factors; and 'hinterland connectivity'

(7.0%) among socio-economic environment factors.

That sort of relations described above can be depicted as Fig. 2.

Table 11 Relative importance of criteria

major criteria	cost	importance	servicequality	importance	facility capacity	importance	socioeconomic environment	importance
detailed criteria	loading/berthing	0.548	speed/safety	0.045	berthing/unberthing	0.320	port cargo quantity	0.764
	storage	0.078	on-time arrival	0.580	loading/discharging	0.082	hinterland connectivity	0.070
	communication	0.045	customs and inland transport	0.106	computer & communication	0.536	stability of operation environment	0.166
	long term discount	0.328	other service	0.267	storage	0.062		

Table 13 Weighted average

players	cost	service quality	facility capacity	socioeconomic environment
government	0.112	0.098	0.120	0.158
port authority	0.183	0.171	0.405	0.405
terminal operator	0.458	0.444	0.404	0.135
shipping company	0.245	0.287	0.071	0.302

5.2 consistency

If CR of major criteria becomes more than 0.1 then total research methodology is not credible. The CR of 'cost' is 0.061 which is the largest, but less than 0.1. It means that the overall consistency is fairly acceptable.

Table 12 The consistency of major criteria

	cost	service quality	facility capacity	environment
CI	0.055154	0.03025	0.073958	0.027199
CR	0.061283	0.033611	0.082175	0.046896
lamda(max)	4.165463	4.09075	4.221873	3.054399

5.3 The comparison of weighted average

The research procedure to find out major role players by using AHP analysis method came to the conclusion as Table 11. Whether the calculation has been done accurately can be validated if the sum of weighted average is 1(one). It can be confirmed in Table 11 that the sum of columns is 1(one).

It is found that in terms of cost, the first key player is terminal operator and the second key player is shipping companies calling Busan port; in terms of service quality, the first key player is terminal operator, and the second key player is shipping companies calling Busan port; in terms of facility/capacity, the first key player is port authority and the second key player is terminal operator; in terms of economic-social variable, the first key player is terminal operator, and the second key player is shipping companies calling Busan port.

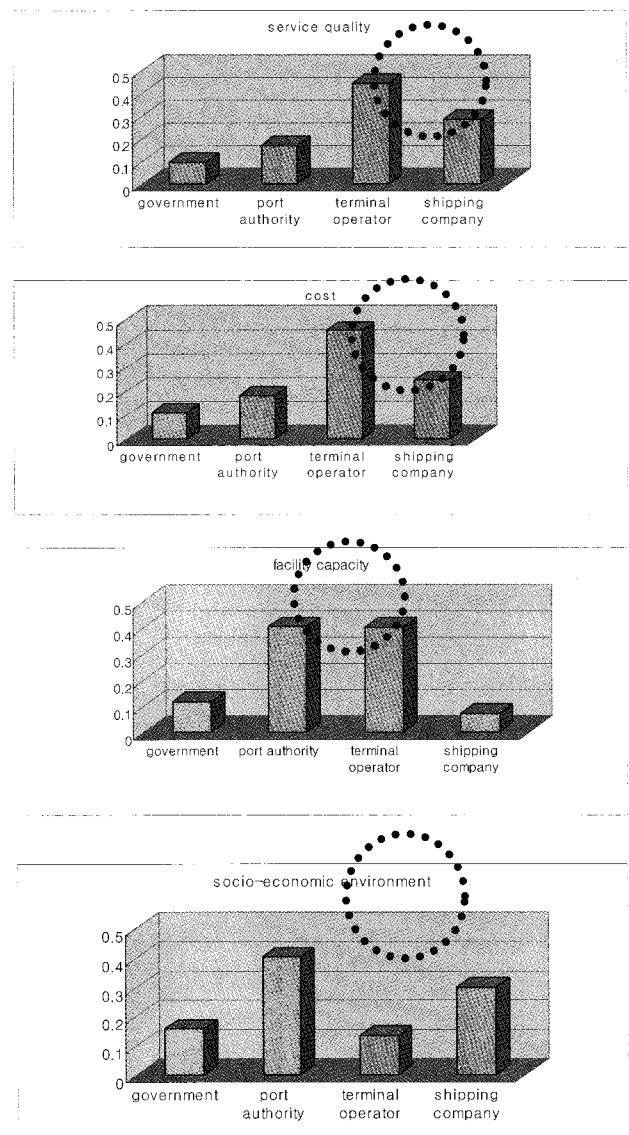


Fig. 2 Key role players by criteria

The original research goal was to identify the major role players only, but here are shown the second role players as well, which is shown in Table 12.

Table 14 major players & second players

major criteria	major players	second players
cost	terminal operator	shipping company
service quality	terminal operator	shipping company
facility capacity	port authority	terminal operator
socio-economic environment	port authority	shipping company

### 6. Conclusion and application

This study has been planned to find out the key role player that should exert its effort to enhance the competitiveness of Busan Port. In order to find out the key role players, decision criteria was selected and after some calculation we reached to the conclusion.

Busan Port should try its best in terms of cost, service quality, facility capacity and socio-economic environment. In terms of cost, terminal operator should go first; in terms of service quality terminal, operator; in terms of facility capacity, port authority and terminal operator; in terms of socio-economic environment, port authority should feel the responsibility.

Special concern has been given to shipping company because it is comprehended that shipping company had nothing to do with the port competitiveness. Shipping companies, however, are asked to play the second major role in enhancing the competitiveness of Busan Port. Therefore Busan port authorities are asked to invite shipping companies when they prepare strategic plan for the port's competitiveness.

Conclusively speaking, there exists some role ambiguity between role players, which means that some idea should be prepared to reduce the ambiguity. This study advises that Busan Port should set up "competitiveness committee", which will assign tasks related to competitive edge to various organizations, which altogether might produce synergy in the direction of Busan Port's competitiveness.

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