한국항해항만학회지 제39권 제2호
J. Navig. Port Res. Vol. 39, No. 2 : 99-105, April 2015 (ISSN:1598-5725(Print)/ISSN:2093-8470(Online))
DOI : http://dx.doi.org/10.5394/KINPR.2015.39.2.99

A Case Study on Investment Evaluation of Hadong T/P(Thermal Power) Port

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Abstract : *Until recently, thermal power plants have used high-rank coals to generate electricity. The switched to low-rank coals, primarily because of the rising coal price and the advancement of combustion technology. Therefore the thermal power plants need more fuels aspect of quantity and they are going to build extra infrastructure to deal with the increased fuel demand in their specialized ports. This paper introduces the process of the economic analysis as a case study for Hadong T/P(Thermal Power) Port. This study also evaluates investment for mew projects in ports. We analyze the costs and benefits of the port investment project using various information. And then we conduct the economic analysis using NPV(net present value), B/C ratio and IRR grounded in a financial theory. Out result of the economic feasibility shows that the new project of constructing a third berth in Hadong T/P Port has positive economic value. Additionally, this study conducts the sensitivity analysis of the major variables like cost, benefit and discount rate.*

Key words : *port investment, Hadong T/P Port, economic feasibility, NPV, B/C ratio, IRR, sensitivity analysis*

1. Introduction

The KOSPO (Korea Southern Power Co., Ltd.) is planning to build a third berth in Hadong T/P (Thermal Power) Port. Hadong T/P Site, a division of the KOSPO, has a total of eight thermal power plants for Korean standard coal generation. The maximum generation capacity of Hadong T/P Site is 4,000MW, and the fuel type is bituminous soft coal. The Hadong T/P Port, completed in 1999, is a specific port with two berths for coals and a CTS berth for limestone.

The global power plants have recently changed their fuel for electricity generation from high-rank coal to low-rank coal, because low-rank coal prices are lower and provide better cost-per-unit energy than higher-rank coal. The increased demands of low-rank coal are also due to the advancement in combustion technology. Compared with high-rank coal, low-rank coal requires a higher quantity for electricity generation due to the difference in calorific power. Rising demands for low-rank coal lead to rapidly increasing throughputs in Hadong T/P Port. The recent berth occupancy of Hadong T/P Port is reported to be over 95%, and the berth congestion has become aggravated. Therefore, the KOSPO suggested that Hadong T/P Port construct its third berth to deal with coal with the capacity of 180,000 DWT to meet the increased fuel demands. This new project was estimated to cost more than about 205 billion won.

Since 1999, KDI (Korea Development Institute) has ruled that any new project of public institutions or the government should become the object of a prefeasibility study when the budget is estimated to be over 50 billion won. The majority of new projects for port investment are large-scale projects, and thus are the objects of prefeasibility study.

In this paper, we provide an example of the economic analysis as a part of the prefeasibility study of the port investment project. In the next section, we show a project overview and analyze basic data. We will present demand forecast as an empirical analysis, cost analysis and benefit estimation, economic feasibility assessment and sensitivity analysis for major variables for Hadong T/P Port in Section 3. The consequence of this study, along with directions for future research, will be discussed in the last section.

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Note) This research was carried out as a part of the project titled “Pre-Feasibility for the Third Fuel Berth of Hadong T/P(Thermal Power) Port(2014)” by Korea Development Institute (KDI).

2. Project overview and basic data analysis

Hadong T/P Site is a Korean-type concluding plant for standard coal generation. There are eight generators using soft coal as their main fuel. Each generator has a capacity of 500㎿, and the total capacity of Hadong T/P Site is 4,000 ㎿ per year. It is 6% of the national generation capacity and 46% of the company's whole generation capacity. #1~#4 units were completed in March 1999, #5~#6 units in November 2001, and #7~#8 units in June 2009. The production level of electric power has reached about 96% since 2010.

The Hadong T/P Site is located in a seaport, and all of the coal used as fuel is imported from foreign countries like Indonesia and Australia. The first berth was built in 1996 and second, 2000.

Table 1 compares the capacity of Hadong T/P Site with three similar power sites. Each power plant has the same generation capacity of 4000㎿ with 8 units. However, Hadong T/P Port has only poor port size and unloading capacity, compared with those of other plants.

Table 1 Comparison of four T/P plants

item		Hadong	Boryoung	Taean	Dangjin
number of generators		8	8	8	8
generation capacity(㎿)		4,000	4,000	4,000	4,000
Berth 1	size(dwt)	135,000	150,000	150,000	150,000
	unload capacity	1,500t/h×2	1,600t/h×2	1,800t/h×2	1,500t/h×2
Berth 2	size(dwt)	135,000	150,000	150,000	150,000
	unload capacity	1,500t/h×2	1,600t/h×2	2,000t/h×2	1,500t/h×2
Berth 3 (plan)	size(dwt)	180,000	200,000	200,000	200,000
	unload capacity	2,700t/h×2	2,700t/h×2	2,000t/h×2	1,500t/h×2
coal yard operation rate		68%	50%	56%	61%

source : KOSPO(2013).

Recently, global power plants are increasingly turning to cheaper low-rank coal for stable fuel supply due to the rising price of high-rank coal. Reflecting this recent trend, Hadong T/P Site has changed their fuel combustion system from 6,080kcal/kg, as initially designed, to 5,400~5,800kcal/kg. It means that Hadong T/P Site now requires more fuel to generate electricity due to the difference in calorific power than it did in the past.

Table 2 describes the recent performance of Hadong T/P Port. The throughput is recorded as over 13 million tons with 95% occupancy level since 2010. The demurrage has increased and reached 12 billion won in 2013.

Table 2 Performance of port operation

year	throughput (million ton)	Number of ships	queueing time (day)	berth occupancy	demurrage (₩million)
2008	9.9	114	122	75.7%	1,920
2009	12.1	142	239	85.8%	3,760
2010	13.0	149	290	96.7%	3,900
2011	13.4	154	480	97.2%	7,630
2012	13.2	135	745	95.7%	12,220

source : KOSPO(2013).

The factors of port congestion in Hadong T/P Port are listed in table 3. According to the source, port congestion is mainly caused by queueing berth, breakdown, dust, storage shortage and weather.

Table 3 Factors of port congestion

(unit : days, (%))

factors	2008	2009	2010	2011	2012
queueing berth	122.5 (34.2)	141.8 (40.6)	185.7 (48.3)	249.0 (60.4)	276.5 (56.6)
queueing berth+ breakdown, dust	44.5 (12.4)	18.3 (5.2)	30.8 (8.0)	32.9 (8.0)	56.5 (11.5)
breakdown, dust	56.0 (15.6)	58.7 (16.8)	56.8 (14.8)	29.4 (7.1)	-
breakdown, dust + yard shortage	-	3.3 (0.9)	8.2 (2.1)	5.5 (1.3)	3.5 (0.7)
queueing berth + yard shortage	-	32.2 (9.2)	14.0 (3.6)	57.9 (14.0)	119.9 (24.5)
waiting loading, storage shortage	126.9 (35.4)	55.5 (15.4)	39.9 (10.4)	28.3 (6.9)	18.0 (3.7)
weather + other things	8.3 (2.3)	39.8 (11.4)	49.3 (12.8)	9.6 (2.3)	14.8 (3.0)
total	358.3 (100)	349.5 (100)	384.7 (100)	412.6 (100)	489.2 (100)

source : KOSPO(2013).

The KOSPO suggested a new project to construct the third berth as 180,000 DWT for dealing with low-rank coal in order to both resolve the port congestion problem and meet the increased fuel demands.

3. Economic analysis

3.1 Demand forecast

1) The basis of traffic forecast

The traffic of Hadong T/P Port is adjusted by the energy policy of the government. The quantity of fuel is decided only by the level of electricity generation, which will be the future demand of Hadong T/P Port. Unlike other ports, there is no regular trend and pattern in traffic data for Hadong T/P Port.

KDI (2001) suggests that port demand is estimated by mathematical modelling including time series analysis. Total national demand is also considered when deciding the final demand for the future of individual ports. However, building the mathematical model is not appropriate for estimating the future demand of Hadong T/P Port. Therefore, we need to investigate the government's energy policy and KOSPO's strategy to prepare for the future.

According to the 6th National Electric Power Plan of the Ministry of Knowledge Economy (2013), the goal is to build thermal power plants until 2027, for many people have turned against nuclear power plants since the Fukushima nuclear accident. KOSPO does not have plans to close or increase the number of the thermal power plants.

Considering the national demand for electric power, the generation capacity of Hadong T/P Site and electricity production plan of KOSPO, we estimate the final future demand to be at the current level of generation. Table 4 shows that every year for the past three years, the production of generation is over 3.8 million ㎿ and the generation rate is over 95.7% for Hadong T/P Site.

Table 4 Generation performance of Hadong T/P Site

(unit: thousand ㎿)

year	2010	2011	2012
capacity	4,000	4,000	4,000
generation performance	3,826	3,829	3,842
generation rate	95.7%	95.7%	96.1%

source : Korea Power Exchange(2014).

This study assumes that the electricity supply will be maintained with a generation rate of 95.6% for the future. All fuel will have to be imported from other countries. The traffic as only fuel in the Hadong T/P Port is calculated by the electricity supply and the calorific value of fuel.

2) Scenario settings

In this study, the cases for the future demand are classified by whether the power plants will be replaced by new ones by the end year of their lifetime. Table 5 explains the completion, life time and replacement timing of the eight plants. It also shows that the calorific value of the new plants is 5,000㎉/㎏.

Table 5 Plants' lifetime and new calorific value

plants	1～4	5～6	7～8
completion	Mar. 1999	Nov. 2001	Jun. 2009
life(30 years)	Feb. 2028	Oct. 2030	May 2038
capacity	500㎿×4	500㎿×2	500㎿×2
replacement timing	2029	2031	2039
new calorific value	5,000㎉/㎏		

source : KOSPO(2013).

① Scenario 1 : Suppose the power plants will not be replaced after 30 years of working. The calorific value is 5400～5600kcal/kg as the operational goal of the KOSPO. (KOSPO, 2013)

② Scenario 2 : Suppose the power plants will be replaced by new ones after 30 years of working. The plants are replaced by the end year of their lifetime. New plants have calorific value of 5000kcal/kg because of technological advancement and the present trend of coal demand. (KDI, 2013; KOSPO, 2013)

3) The result of demand forecast

According to the KOSPO, the designed capacity is a 6,080㎉/㎏ in the every plants. The operational plan is a 5,400㎉/㎏ in #1～#6 and 5,600㎉/㎏ in #7～#8. The demand is calculated as follows in detail.

- Demand for #1～#6 plants : 183ton/h × 6,080/5,400㎉/㎏ ×24h × 6 ≒ 30 thousand ton/day
- Demand for #7～#8 plants : 180ton/h × 6,080/5,600㎉/㎏ ×24h × 2 ≒ 9 thousand ton/day
- Demand for all plants : 30 thousand ton/day + 9 thousand ton/day ≒ 39 thousand ton/day

The total daily demand is calculated as 39 thousand ton using the calorific values of operational plan and designed capacity. 39 thousand ton multiplied by the generation rate of 95.6% and 365 days is about 13,623 thousand ton of yearly demand. The process of calculation follows that.

- 39 thousand ton/day × 365 day × 95.6% ≒ 13,623 thousand ton/year

The result of demand forecast is showed in Table 6. The future traffic reaches 13,623 thousand ton per year during 30years similarly to scenario 1. However the future traffic is 13,623 thousand ton from 2018 to 2028, 14,176 thousand ton from 2029 to 2030, 14,453 thousand ton from 2031 to 2038 and 14,843 thousand ton from 2039 to 2047 by scenario 2.

Table 6 Result of demand forecast

(unit: thousand ton/year)

year	scenario 1	scenario 2
2018~2028	13,623	13,623
2029~2030	13,623	14,176
2031~2038	13,623	14,453
2039~2047	13,623	14,843

3.2 Benefit estimation

This paper measures the social benefits of the "with case" scenario by comparing it with the "without case" scenario. The "with case" scenario supposes that the third berth will be built, while the "without case" scenario supposes that the third berth will not exist in the future. The benefits that this project is expected to bring to Hadong T/P Port are estimated by the three pillars in this paper. The first benefit is a cost reduction in port. The second benefit is a cost reduction of inland transport. The last benefit is an effect of operating large vessels.

1) Benefit of cost reduction in port

The first benefit is a gap in the staying cost in port between the "with case" scenario and the" without case" scenario regarding the third berth of the Hadong T/P Port.

Firstly, suppose that there are only the 1st and 2nd berths without the 3rd berth. The real unloading days (0.00002126 day) are measured using the standard berth occupancy and W/S ratio of the UNCTAD (1985). The product of the real unloading days multiplied by expected daily charterage is the staying cost in port.

$$TC_{without} = E(C)\sum_{t=0}^{n}(WS_t \times OT_t) \qquad (1)$$

Where $TC_{without}$ is the total costs in port without the 3rd berth, $E(C)$ is the expected daily charterage, WS_t is the W/S ratio at timing t and OT_t is unloading days in berth at timing t.

Secondly, suppose that there are the 1st, 2nd and the 3rd berth. We apply E2/E2/1 distribution to seek the W/S ratio for the 3rd berth by UNCTAD (1985). The result recommends that the 3rd berth deal with up to 8,164,800 tons per year, while the remaining two berths handle the other demands. The W/S ratio for two berths is calculated by E2/E2/2 distribution.

$$TC_{with} = TC_3 + TC_{1,2} \qquad (2)$$

Where TC_{with} is the total costs in port with the 3rd berth, TC_{3rd} is the cost of the 3rd berth and $TC_{1st,2nd}$ is the cost of 1st and 2nd berth. Each TC_i is calculated by the same way above mentioned.

KDI(2001) recommends that we estimate the staying cost in port by using the expected daily charterage. We calculate the expected daily charterage through a fleet portfolio by different ship sizes. The expected daily charterage is 22.49 million won in the "without case" scenario and 22.64 million won in the "with case" scenario. It is calculated by using internal sources from KOSPO.

2) Benefit of reduction in inland transport cost

This study assumes that the throughputs over 100% of berth occupancy rate could not be handled in Hadong T/P Port. In that time, the soft coal is unloaded to POSCO terminal of Gwangyang port and then transported by 12-ton trucks from POSCO terminal of Gwangyang port to Hadong T/P Port, for the POSCO terminal of Gwangyang port is the nearest specific port to Hadong T/P Port.

$$LC_{without} = \sum_{t=0}^{n}(TP_t + OR_t) \qquad (3)$$

Where $LC_{without}$ is the road transport cost without 3rd berth, TP_t is the transport costs from Gwangyang port to Hadong T/P Port by truck at timing t and OR_t is the loading and unloading costs from Gwangyang port to Hadong port at timing t.

① Cost of transportation

The trucks of over 8 tons have been classified as large trucks in KDI (2008). However, some empirical studies have categorized the trucks of average 12 tons as large trucks (KDI, 2006). We assume that a 12-ton truck is a large truck. The unit cost of road transport by a large truck is 504.05 won per ㎞, when the large truck runs at a speed of 50km/h by a study of KDI (2008). The shortest distance between the POSCO terminal of Gwangyang port and Hadong T/P Port is 14.8 kilometers.

② Loading and unloading cost

We apply the guideline that the loading and unloading cost for coal is 2,764 won abroad and 2,502 won inland. It is the guideline for the harbor loading and unloading of Ministry of Land, Transport and Maritime Affairs in 2012.

3) Benefits of operating large vessel

The effect of large vessels is calculated by the gap of maritime costs between the "with case" scenario and the "without case" scenario by using the expected daily charterage after investigating the weight of fleet, type of ship and turnaround time.

$$MC=\sum_{t=0}^{n}\sum_{i=0}^{1}(N_{it}\times C_{it}\times D_{it}) \quad (4)$$

Where MC is the maritime transport cost, N_{it} is the number of i ships at t(i=0 : capesize, i=1 : panamax vessel), C_{it} is the daily charterage of i ship at timing t and D_{it} is the i size vessel's turnaround time from Hadong T/P Port to destination port at timing t.

Table 7 presents major variables for maritime costs. Expected daily charterage per ship is 23.24 million won for capesize and 22.03 million won for panamax vessel. The turnaround time is 45 days for Australia with capesize and 30 days for Indonesia with panamax vessel. The demand portion is led by a strategic plan of KOSPO.

Table 7 Variables for maritime costs

type of vessel	demand(portion)		daily charterage (million)	turnaround time (days)
	without berth 3	with berth 3		
capesize	55%	67%	₩23.24	45
panamax	45%	33%	₩22.03	30

Source: KOSPO(2013).

4) The results of benefit estimation

The results of benefit estimation are shown in Table 8 and 9 depending on scenarios

Table 8 Total benefits of scenario 1

(unit: ₩ million/year)

year	cost reduction		big size vessel effect	total benefits
	port	road transport		
2018~2047	21,147	-	2,770	23,916

In case of scenario 1, the cost reduction of port is 21,147 million won, the effect of big size vessel is 2,770 million won per a year. There is no cost reduction in road transport. Therefore the total economic benefit is recorded a fixed figures as a 23,916 million won per a year.

Table 9 Total benefits of scenario 2

(unit: ₩ million/year)

year	cost reduction		big size vessel effect	total benefits
	port	road transport		
2018~2028	21,147	-	2,770	23,916
2029~2030	26,357	541	2,882	29,781
2031~2038	26,313	2,862	2,939	32,113
2039~2047	26,260	6,137	3,018	35,415

In scenario 2, the cost reduction of port is 21,147 million won in from 2018 to 2028, 26,357 million won in from 2029 to 2030, 26,313 million won in from 2031 to 2038 and 26,260 million won per a year in from 2039 to 2047. The cost reduction of road transport is a zero in from 2018 to 2028, 541 million won in from 2029 to 2030, 2,862 million won in from 2031 to 2038 and 6,137 million won per a year in from 2039 to 2047. The effect of big size vessel is 2,770 in from 2018 to 2028, 2,882 million won in from 2029 to 2030, 2,939 million won in from 2031 to 2038 and 3,018 million won per a year in from 2039 to 2047. Therefore the total economic benefit is 23,916 million won in from 2018 to 2028, 29,781 million won per a year in from 2029 to 2030, 32,113 million won per a year in from 2031 to 2038 and 35,415 million won per a year in from 2039 to 2047. It is reached changing figures because of the demand's movement.

3.3 Cost analysis

The cost for constructing the new third berth as 180,000 DWT is classified by the total business costs and the costs of maintenance and operation according to the KDI(2001). The total business cost is estimated like Table 10.

Table 10 Total business cost[1)]

(unit: ₩ million)

items	costs
A. construction cost	201,940
B. incidental cost	17,090
C. cost of land compensation	-
Total(A+B+C)	219,030

1) The cost was conducted by Kunil Engineering, the construction supervision company in harbor and coast.

The business costs consist of the cost of construction, incidental cost, cost of land compensation and reserve budget. Each cost is estimated by guidelines of KDI(2008). The total business cost is about 219 billion won. The costs of maintenance and operation is 3,672 million won as a 2% of sum of the costs, excepted incidental cost, compensation cost, reserve budget and a value added tax.

3.4 Economic feasibility assessment

1) The basis for economic feasibility assessment

The variables for economic analysis are that an analysis period is 30 years (2018~2047) after completion, the basic year is the end of 2012 and a social discount rate is 5.5% (KDI, 2001; KDI, 2008).

2) The result of economic analysis

Table 11 describes the result of the economic analysis of the project. NPV is 29,414 million won, B/C ration is 1.12 and IRR is 6.86% in scenario 1. NPV is 73,687 million won, B/C ratio is 1.31 and IRR is 8.34% in scenario 2. Consequently, the result of economic feasibility assessment for building the third berth in Hadong T/P Port is positive.

Table 11 Result of economic analysis

variables	scenario 1	scenario 2
Discounted Benefits(₩ million)	265,958	310,230
Discounted Costs(₩ million)	236,544	236,544
B/C ratio	1.12	1.31
NPV(₩ million)	29,414	73,687
IRR(%)	6.86%	8.34%

3) Sensitivity analysis

This study conducts sensitivity analysis about the discount rate, cost and benefit variables. The result of sensitivity analysis is shown in Table 12.

Table 12 Sensitivity analysis

variables		scenario 1			scenario 2		
		NPV (₩ million)	B/C	IRR (%)	NPV (₩ million)	B/C	IRR (%)
discount rate (%)	3.5	95,451	1.35	6.86	167,971	1.61	8.34
	4.5	58,314	1.23	6.86	114,835	1.45	8.34
	5.5	29,414	1.12	6.86	73,687	1.31	8.34
	6.5	6,842	1.03	6.86	41,670	1.19	8.34
	7.5	-10,835	0.95	6.86	16,724	1.08	8.34
cost (%)	-20	76,723	1.41	9.62	120,995	1.64	10.92
	-10	53,068	1.25	8.13	97,341	1.46	9.53
	0	29,414	1.12	6.86	73,687	1.31	8.34
	10	5,760	1.02	5.95	50,032	1.19	7.31
	20	-17,895	0.94	4.77	26,537	1.09	6.40
benefit (%)	-20	-23,778	0.90	4.32	11,641	1.05	5.98
	-10	2,818	1.01	5.63	42,664	1.18	7.20
	0	29,414	1.12	6.86	73,687	1.31	8.34
	10	56,010	1.24	8.01	104,710	1.44	9.41
	20	82,605	1.35	9.10	135,733	1.57	10.43

In scenario 1, the economic assessment changes to negative when discount rate goes up to 7.5%, cost goes up to 20% and benefit goes down to 20%. Scenario 2, however, has positive results despite moving the variables.

4. Conclusions

This research has conducted the economic analysis using traditional DCF(discounted cash flow) method as an empirical analysis. We look for three items for benefit estimation. The first item of benefit is cost reduction by decreasing of the waiting time in the port. The second item is the elimination of inland transport cost. The last is an economic effect of operating the large vessel.

The project to build the third berth in Hadong T/P Port has economic benefit for investment using DCF method. The result is that NPV is 29,414 million won, B/C ration is 1.12 and IRR is 6.86% in scenario 1. NPV is 73,687 million won, B/C ratio is 1.31 and IRR is 8.34% in scenario 2. Additionally this study also provide the sensitivity analysis. The economic assessment changes to negative when discount rate goes up to 7.5%, cost up to 20% and benefit down to 20% in scenario 1. Scenario 2, however, has positive results despite moving the variables.

It is meaningful that the study provides an example to assess for projects in the port investment and have discussed about demand forecast, benefit estimation, economic analysis and sensitivity analysis for economic feasibility assessment.

The limitations of this paper are as follows. Firstly, there is still a discussion about the validity and relevance of the W/S ratio and standard berth occupancy in specific berth by UNCTAD. Kim et al.(1996) deals with the related issues using simulation method in a case study. Further research will be to consider about these issues. Secondly, there is a weakness of reality in the choice of the benefit's items for this paper. The effort is necessary to discover the alternative items for the economic benefit in the future research. Thirdly, we used the guidelines which were published a long time ago by KDI for the economic analysis. Following study needs to complement the guideline more realistically, as using the new data.

Acknowledgements

This study was conducted as a part of the results of the project titled “Pre-Feasibility for the Third Fuel Berth of Hadong T/P(Thermal Power) Port(2014)” by Korea Development Institute (KDI).

References

[1] KDI(2001), A Study on Standard Guidelines for Pre-feasibility Study on Port, p. 242.
[2] KDI(2004), A Study on Standard Guidelines for Pre-feasibility Study on Road and Railway Projects (4th Edition), p. 331.
[3] KDI(2006), Pre-feasibility for the Hinterland of Busan New Port, p. 273.
[4] KDI(2008), A Study on General Guidelines for Pre-feasibility Study (5th Edition), p. 438.
[5] Kim, C. G., Jang, H. B. and Yoon, D. H.(1996), “Analytic Approach on the Port Unloading Queueing System-A Case Study at Pohang and Gwangyang”, Ocean policy research, Vol. 11, No. 2, pp. 481-513.
[6] Korea Power Exchange(2014), Generation Performance, https://epsis.kpx.or.kr/
[7] KOSPO(2013), Pre-feasibility for the third berth of Hadong T/P(Thermal Power) Port, p. 145.
[8] Ministry of Knowledge Economy(2013), The 6th National Electric Power Plan(2013~2027), p. 84.
[9] Ministry of Land, Transport and Maritime Affairs(2012), Guideline for the Harbor Loading and Unloading, p. 36.
[10] UNCTAD(1985), Port Development, p. 227.

Received 1 April 2015
Revised 23 April 2015
Accepted 24 April 2015