

THE EFFICIENT ESTIMATE OF ENVIRONMENTAL MANAGEMENT COSTS IN THE CONSTRUCTION SITES

Hyuk Moon¹, Sung-Jin Kim², Jae-Jun Kim³

1 Associate Research Fellow, Korea Research Institute for Human Settlements, Anyang, Korea

2 Dongbu Corporation, 891-10, Daechi-4Dong, Gangnam-Gu, Seoul, Korea

3 Associate Professor, Dept. of Architectural Engineering, Hanyang University, Seoul, Korea

Correspond to hmoon@krihs.re.kr

ABSTRACT : Recently as people's values are changing from development phase into running stage after quality of life, so that the needs of environmentally friendly construction are gradually increasing. Also populace discontent about the pollution during construction process such as the noise and vibration caused by construction machinery is increasing. Even though it is impossible to eliminate the construction pollution fully, it is necessary to make efforts to reduce construction pollution to a minimum. In terms of construction site operating, the first possible step for solving these matters directly is that the necessary sum of expenses must be secured as the environmental management costs in the conceptual phase. However, in fact, the environmental management costs have not been secured in the budget. Generally it is the major reason not arising proper activities to prevent the pollution in the construction site. The purpose of this research is to suggest the efficient budgeting method regarding Environmental management costs to ensure the necessary sum of environmental management expenses. To provide an efficient budgeting method, interviews with the person in charge of environment management was conducted. 78 construction sites was surveyed and environmental management costs were analyzed through their historical data from the survey. According to the results of analysis, the ratio of environmental management costs is revealed 0.45% of construction cost as average comparing 0.2% of legal limit. And usually the environmental management cost was appropriated into the safety management budget. So it is needed to isolate environmental management budget securely and modify the ratio of Environmental conservation Costs in Construction Technology Management Act.

Key words : Environmental Management Cost, Environmental Conservation Cost, Budgeting Method

1. INTRODUCTION

1.1 Objective of the Study

Construction industry has been regarded as environmentally destructive, due to the many factors against environmental conservation. It is also true that the environmental problems have been overlooked from development driven economy policies in the past.

However, since the Rio Declaration on Environment and Development in 1992, all countries put a lot of efforts in environment protection to meet the new international economic order under the proposition of ESSD (Environmentally Sound and Sustainable Development).

And needs for environmentally friendly construction are increasing as people are more concerned with quality of life and environment issues. There is growing number of disputes applied to National Environmental Dispute Resolution Commission on construction pollution such as noise and vibration from construction sites, and this trend is observed to go further in the future.

With these inside and outside changes in construction environment, construction related interested parties are required to have changed mind accordingly on environment

of construction sites, and they need to try to minimize the pollution in construction sites.

For this, government had regulated that pollution in the construction sites must be minimized and the costs to properly dispose and recycle the construction wastes must be included in the construction budget, by amending the Construction Technology Management Law in August 2001. Therefore, in order for efficient environmental management in construction sites, establishment of environmental management costs should be preceded through clear prescription of environmental management cost items, effective estimation in the beginning stage and putting the estimated costs in the budget.

This study will provide the basic standards for how environmental management costs should be estimated in the planning stage, and how to effectively reflect and manage the costs.

1.2 Scope and Method of the Study

In a wider sense, environmental management costs include pre-evaluation costs, construction costs, management costs, and basic environmental facility costs for big scale business. This study will focus environmental manage-

ment costs in the construction stage, and only target “construction of new multi-households housings and others”, defined in the rate classification section from Calculating Standards of Environmental Management Costs in the Construction Technology Management Law.

The methods of the study are as follows;

(1) Research the standards for budgeting and calculating environmental management costs that current law defines and antipollution facility items through the studies that are already done.

(2) Interview staffs in charge of environmental management divisions of public owner-agencies and private construction companies, find out standards for calculating environmental management costs and antipollution facility items, and compare the findings with the law.

(3) Research actual data of environmental management costs from construction sites of public owner-agencies and private construction companies, in order to find out current status of environmental management costs in construction sites.

(4) Based on actual researched data from each construction site, calculate the environmental conservation costs, analyze how these costs are putting in the budget and what the problems are, and provide methods to improve the current status of environmental management costs.

2. LITERATURE REVIEW

2.1 Trend of the Studies

Past studies about environmental management costs are limited to only some done by Choi, Min-Soo (1997) and Kang, Woon-San (2004) from Construction & Economy Research Institute of Korea, Kang, Young-Hyun (1998) and Lee, Jae-Ho (2002) from Korea Environment Institute, and contents of these studies are as in Table 1.

The studies done by Choi, Min-Soo (1997) and Kang, Young-Hyun (1998) are the first studies that researched the status of environmental management costs, however, they are limited to be applied in actual cases since they are done before the budgeting environmental management costs became mandatory. The study of Lee, Jae-Ho (2001) did research the environmental management costs based on actual data, but it only covered construction order sheets of Korea National Housing Corporation, which made it also unavailable to be used in setting the cost rates in actual cases. The most recent study done by Kang, Woon-San (2004) provided suggested methods to establish the environmental management cost rates reflecting the practical needs, but as the study was focused on public works, the number of construction site samples picked up for architectural works was not enough for statistic analysis.

2.2 Definition of Environmental Management Costs

The amended rules of Construction Technology Management Law in force regulate environmental management costs to be separately listed in the budget as safety management costs, not as expenditures, and define it as follows;

(1) costs to install and operate environment related

facilities designed to conserve natural environment and ecosystem in construction sites

(2) costs to install and operate antipollution facilities in construction sites

(3) costs to dispose and recycle wastes in construction sites

As defined above, environmental management costs include costs to install, operate/manage and dismantle facilities to minimize environmental damage from using various equipments and carrying out construction works, dispose wastes, train/educate on environment issues, and for other environment related works.

Table 1. Trend of the Studies

Description	Researcher	Research Content
Studies on Environmental Management Costs	Choi, Min-Soo (1997)	Researched the status of budgeting environmental management costs targeting construction-owners, raised the problems and suggested methods to properly budget the costs
	Kang, Young-Hyun (1998)	Analyzed strong and weak points of the methods to budget the environmental management costs
	Lee, Jae-Ho (2002)	Analyzed environmental management costs based on actual data of Korea National Housing Corporation, and provided matrix of environmental management costs
Studies on Environmental Management System	Kang, Woon-San (2004)	Researched the status of environmental management costs targeting architectural and public work sites, and suggested methods to properly budget the costs
	Lee, Young-Joo (1998)	Raised the problems from introduction of ISO 14001 Environmental Management System, and suggested methods to improve
	Jeon, Jin-Koo (2001)	Provided actual results from introduction of environmental management system through case study
Studies on Environmental Management of Construction Sites	Lee, Sung-Hee (2001)	Provided direction to measure environmental accomplishments by selecting qualitative and quantitative items
	Construction & Economy Research Institute of Korea (1997)	Provided methods to conserve environment in construction business and policies to recycle construction wastes
	Park, Jae-Doo (2001)	Categorized environment related factors that may happen in multi-households housing units upon types of construction works

2.3 Environmental Investment Stats of Construction Companies

Recently the concept of environmentally healthy and sustainable development is widely recognized, and environmental investment is considered more importantly, research on environmental investment costs has been initiated by Bank of Korea.

According to Bank of Korea, the costs spent for environmental management in construction sites in 2002 was 302.1 billion won, 19 percent up from 244.8 billion won in 2001. It is expected that the investment to environment will keep increasing, considering the reinforced environmental

standards both nationally and internationally. By invested fields, the environmental investment to air took 40 percent, water took 24 percent, noise and vibration 22 percent, wastes 6 percent, and others took 8 percent.

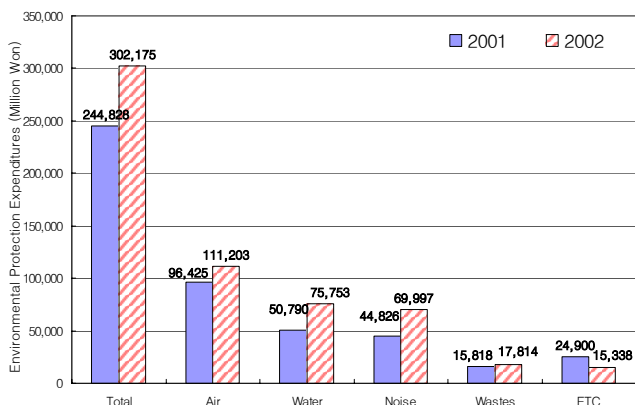


Figure 1. Environmental Protection Expenditures-Construction Industry

3. RESEARCH ON BUDGETING STANDARDS AND ITEMS OF ENVIRONMENTAL MANAGEMENT COSTS IN CONSTRUCTION WORKS

3.1 Current Standards for Budgeting Environmental Management Costs

What are regarded as environmental management costs in construction works are now defined in Construction Technology Management Law (Enforcement Regulations attachment 15). Environmental management costs in construction works consist of environmental conservation costs, waste disposal and recycling costs, and others.

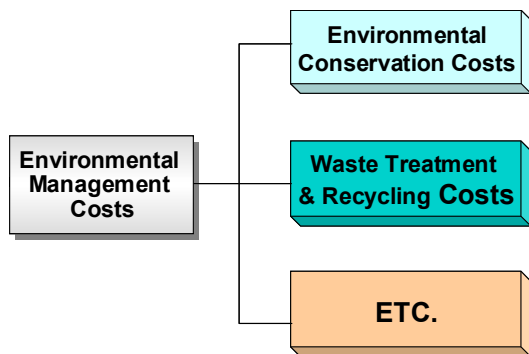


Figure 2. The composition of Environmental Management Costs

(1) Standards to Calculate Environmental Conservation Costs.

The costs for install and operate antipollution facilities in construction sites are called as environmental conservation costs, and they are calculated upon cost accounting (including method based on Government Standard of Estimate). When calculating by cost accounting is not available, they should be calculated based on the rates in Table 2 by types of constructions.

Table 2. Environmental Conservation Cost Rates by Construction Types

Construction Category	Construction Type	Rate (based on net construction costs)
Civil Works	Plant, water supply and sewer system, subway, railroad, road, bridge, tunnel, non-housing construction works	0.3% and above
	Harbor, dam, land development	0.5% and above
Architectural Works	Redevelopment and reconstruction	0.7% and above
	Multi-households housings and others	0.2% and above

(2) Standards to Calculate Waste Disposal and Recycling Costs

The costs to dispose and recycle wastes in construction sites are called as waste disposal and recycling costs, and it is required to divide them as costs for collection, transportation, interim disposal, and final disposal. These are to be calculated either by measuring the estimated volume of wastes or by government registered costs. When it is unavailable to calculate waste disposal and recycling costs by such methods, they should be calculated based on standards noticed by the construction owners, considering transportation distance, types of wastes, regional characteristics, and prices that are surveyed and announced by government-authorized price survey organizations.

(3) Standards to Calculate Other Costs

When antipollution facilities to conserve environment in construction sites are installed additionally, the costs can be requested to be added through confirmation of construction inspectors. In this case, owner agency must confirm the details and take necessary actions such as design change order.

3.2 Comparison of Current Budgeting Items of Antipollution Facilities

The current Construction Technology Management Law in force does not provide details about antipollution facilities for calculating environmental management costs, but only mentions about installation standards and requirements of each facility in environment related acts. The followings are the items that are regarded as antipollution facilities and put in the budget as environmental management costs by Government Standard of Estimate, public owner-agencies, and private construction companies.

(1) Antipollution Facility Items by Government Standard of Estimate

Antipollution facility items in the Government Standard of Estimate, used in cost accounting among methods to calculate environmental conservation costs are as in Table 3.

Table 3. Antipollution Facility Items

Description	Air	water	Noise/Vibration	Wastes
Items	Tire washer Watering facility Dust proof screen	None	Sound proof wall Sound proof screen	Trash chute

(2) Antipollution Facility Items by Public owner-agencies

Antipollution facility items that major public owner-agencies put in the environmental management costs are as in table 4. Since the types and characteristics of construction works by the agencies are different, the cost items in principle are also different.

Table 4. Antipollution Facility Items by Public owner-agencies

Agency	Air	Water	Noise/Vibration	Wastes
Korea National Housing Corporation	Tire washer* Watering facility Watering cart Dust-proof screen	Sewage and waste water treatment facility*	Sound proof wall Sound proof screen	Trash chute* Incineration facility Crusher
Korea Land Corporation	Tire washer* Watering cart* Watering facility Dust-proof screen* Dust-proof cover		Sound proof wall Sound proof screen	Incineration facility Construction waste material recycling facility Crusher
Korea Highway Corporation	Tire washer* Watering cart Dust-proof cover Dust-proof screen	Construction sludge treatment facility Slit protector Sewage and waste water treatment facility	Sound proof wall*	Incineration facility Construction waste material recycling facility
Korea Electric Power Corporation	Tire washer* Watering cart* Watering facility Dust-proof screen Dust-proof cover	Sewage and waste water treatment facility	Silencer* Elasticity supporting facility* Sound proof wall Sound proof screen	Incineration facility*
Korea Water Resources Corporation	Tire washer* Watering cart* Watering facility* Dust-proof screen	Construction sludge treatment facility Slit protector	Sound absorbing equipment	Incineration facility Construction waste material recycling facility*

Note) Facilities marked as * are items put in the budget in principle for all construction works, regardless of construction site conditions, size of construction works, construction methods and construction equipments used.

(3) Antipollution Facility Items by Private Construction Companies

Surveys are done, targeting environmental management staffs of 6 private construction companies, about antipollution facility items that are commonly put in the budget of multi-households housing and other new construction works, and the findings are as in Table 5.

Table 5. Antipollution Facility Items by Private Construction Companies

Description	Air	Water	Noise/Vibration	Wastes
Items	Tire washer Watering facility Watering cart Dust-proof screen	Sewage water treatment facility Waste water treatment facility Portable Potty	Sound proof wall Sound proof screen	Waste material collecting box

Especially for waste treatment facilities, it is found that all 6 companies basically put the cost in the budget only for waste material collecting box, and all other wastes from construction works are sent to outside vendors. According to the survey, it is because of difficulties in operating and managing the facilities and concerns about government checks and controls, when the incineration facilities and construction waste recycling facilities are installed within the construction sites.

3.3 Needs for Establishment Antipollution Facility Items and Unified Management

Since the Construction Technology Management Law does not indicate details about antipollution facilities, these facilities can be left out from environmental management costs.6)

In order to solve this problem, it is required to manage the facility items in one unified act, which are currently mentioned in several environment related acts, so that the owner-agencies are to put these items into the environmental management costs.

4. RESEARCH AND ANALYSIS OF HOW ENVIRONMENTAL MANAGEMENT COSTS ARE SPENT IN CONSTRUCTION WORKS**4.1 Summary of Research**

A research was done to find out how properly environmental management costs are put in the budget in construction works, after the standards for budgeting environmental management costs were established with the amendment of Construction Technology Management Law in August 2001.

The survey was carried out targeted total 78 construction sites of 1 public owner-agency and 5 private construction companies, and to secure credibility of the analysis, the data that environmental management costs are not clearly

inputted in the construction sites were excluded.7)

As shown in Table 6, the total construction site samples were 78, 23 for Korea National Housing Corporation, and 55 for private construction companies. As for the size of construction works, total average net construction costs were 41,127 million won, with 51,131 million won for new housing construction and 24,931 million won for non-housing construction should state concisely the most important propositions of the paper as well as the author's view of the practical implications of the results.

Table 5. Summary of Construction Sites Researched (unit : EA, million won)

Description		New Housings	New Non-Housings	Total
Public owner-agencies	Sample Size	23	0	23
	Average Net Construction Costs	18,060	0	18,060
Private Construction Companies	Sample Size	24	31	55
	Average Net Construction Costs	84,125	24,931	50,770
Total	Sample Size	47	31	78
	Average Net Construction Costs	51,131	24,931	41,127

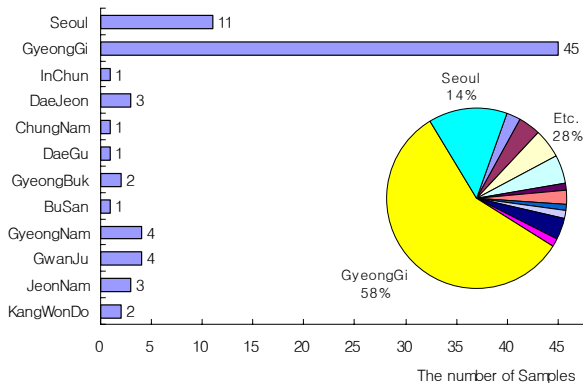


Figure 3. The number of samples by provinces

As shown in Figure 6, number of the surveyed samples was biggest in Kyunggi with 45 sites, followed by Seoul with 11 sites, making Seoul/Kyunggi region to take 72 percent of total samples and the other regions 28 percent.

4.2 Status Analysis of Budgeting and Spending Environmental Management Costs

The biggest problem of the current Construction Technology Management Law that regulated environmental management costs as mandatory budget items is that it uniformly applies the rates which are unrealistic.

In order to properly calculate and budget environmental management costs, current environmental management costs were analyzed through case study.

(1) Status of Budgeting Environmental Management Costs by Regions

The status of budgeting environmental management costs by regions is as in Figure 4. But, it should be noted that the number of samples from other regions than Seoul and Kyunggi was too small that it is not credible enough to represent the rates of regional environmental management costs.

According to the analysis of environmental management cost rates by Seoul, Kyunggi and others, there were no big differences among the regions, presenting 0.44% in Seoul, 0.43% in Kyunggi, and 0.49% in other regions.

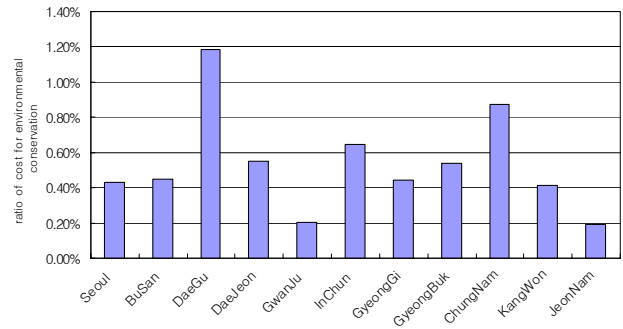


Figure 4. The ratio of cost for environmental conservation in construction cost by provinces

(2) Status Analysis of Environmental Conservation Costs by Rates

Total of 78 construction sites are analyzed such as apartments and other type of building works under the Budgeting Rate of Environmental Management Costs in Construction Technology Management Law.

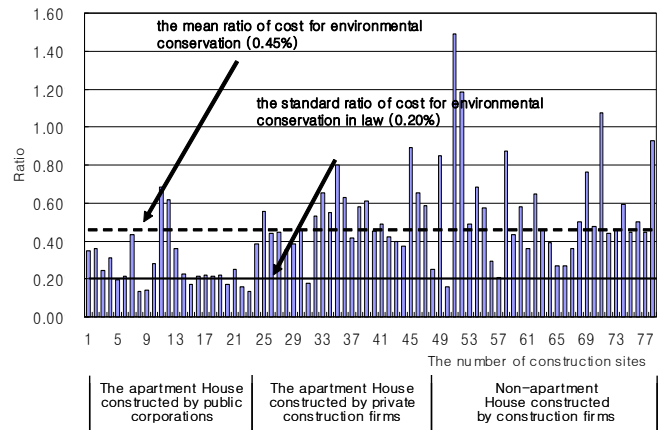


Figure 5. The ratio of environmental conservation in construction cost – apartment & non-apartment construction works

① New Construction Works of Apartments and Others

According to the analysis of data from 78 new construction work sites for apartment housings and others, it was found that most sites (69) except 9 were using higher rates than the standards (0.2%) by Construction Technology Management Law. And, the average rate of these 78 sites

was 0.45%, more than double the standard rates. It explains that the standard rates written in Construction Technology Management Law are not properly reflecting real costs, so the standard rates are required to become more realistic.

② Rate Comparison between Public and Private construction works

In order to find out the difference of environmental conservation cost rates between public construction works and private construction companies, a survey was done targeting 23 construction sites by public owner agencies and 24 sites by private companies.

The average environmental conservation cost rate of multi-households housing construction sites by public builders was 0.26 percent, a little higher than the standard rate exhibited in Construction Technology Management Law, but a way below than the average rate by private construction companies of 0.48 percent.

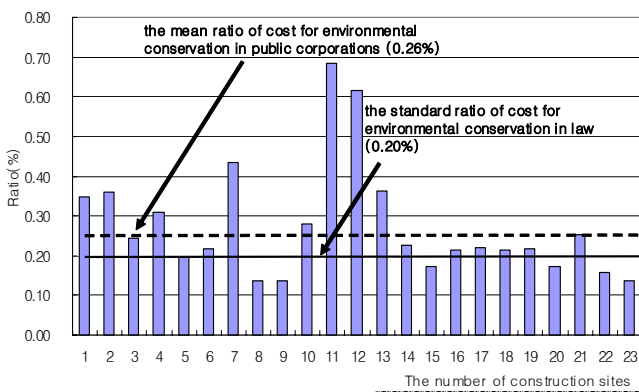


Figure 6. The ratio of environmental conservation in construction cost – public corporations

As featured in Figure 6 and 7, the difference of environmental conservation cost rates of public and private companies came not only from location characteristics of construction sites, but also from the antipollution facility items that were put in the budget.

As for public owner-agencies, the mandatory antipollution facility items that were put in the budget regardless of construction work sizes and methods were limited to tire washer, sewage and waste water treatment facility, and trash chute, and other facilities were found to be used upon the location characteristics of the construction sites. Especially, shown in Figure 6, among the sites that used lower rates than the standards of 0.2 percent by Construction Technology Management Law, Site 8, 9 and 15 did not put dust-proof screen in the budget, while Site 20, 22, and 23 did not put watering facility in the budget.

Differently from this, private construction companies did put costs for tire washer, watering facility, dust-proof screen, dust-proof wall, sewage treatment facility, and waste material collection box, basically for all construction works.

In order to solve this problem, as previously mentioned, the antipollution facility items should be uniformly managed. For basic environmental management, identification by law on mandatory antipollution facility items and additional facility items upon types of construction works should be

done.

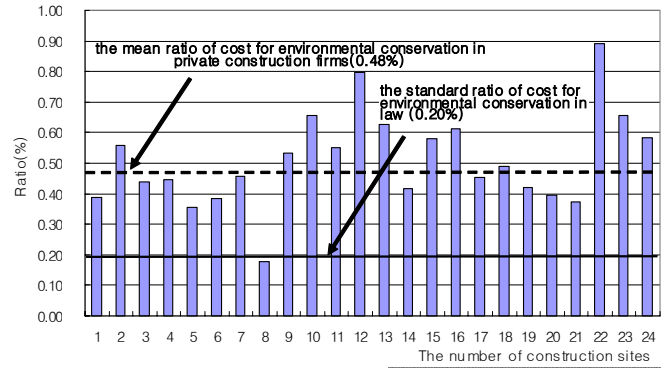


Figure 7. The ratio of environmental conservation in construction cost – private construction firms

(3) Status Analysis of Environmental Conservation Costs by Types of Construction Works

The Classification of Environmental Conservation Cost Rates section of Construction Technology Management Law in force uses the same rates for multi-households housings and other new buildings. In order to find out whether it is proper or not, a survey was done to compare and analysis environmental management cost rates, targeting 24 multi-households housing construction sites and 31 non-housing construction sites by private construction companies.

Table 7. Environmental Conservation Cost Rate Comparison between Multi-households Housing and Non-Housing Construction

Description	Unit : 1,000 won	
	Multi-Households Housing Construction	Non-Housing Construction
Average Net Construction Cost	84,145,000	24,931,000
Average Environmental Management Cost	403,557	118,757
Average Rate	0.48%	0.48%
Standard Deviation	0.15%	0.30%

As featured in Table 7, the rate was applied over the standard rate (0.2%), both for multi-households housing and non-housing constructions, while the both presented the same rate of 0.48%. But looking at the standard deviation, the environmental conservation cost rates vary widely upon the construction sites, as it is 0.15% for multi-households housing constructions and 0.30% for non-housing constructions.

This is analyzed that various construction work conditions such as construction methods, location characteristics and types of the buildings, affected the environmental conservation costs for non-housing constructions.

It can be concluded that the rates for multi-households housing and non-housing constructions should be differentiated, but still more detailed research is required.

(4) Status Analysis of Environmental Conservation Cost

by Construction Costs

In order to find out the correlation of environmental conservation costs and construction costs, simple regression analysis was done using SPSS12.0 based on actual data from each construction site upon types of construction works.

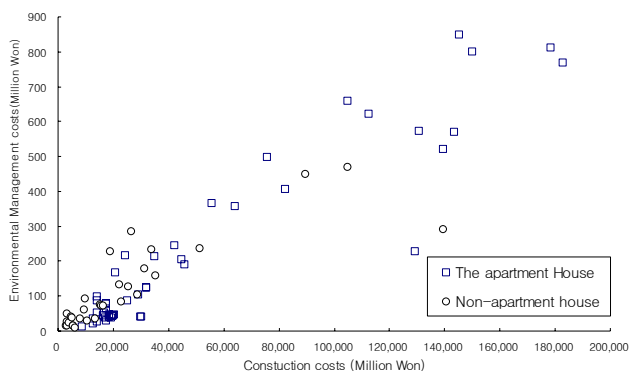


Figure 8. The scatter – Environmental management costs and Construction costs

Table 8. Result of Regression Analysis for Construction Costs and Environmental Conservation Costs

Description	r	R2	B	β	sig.
Multi-households housing construction	0.938	0.880	0.005	0.938	0.000
Non-housing construction	0.843	0.710	0.003	0.843	0.000
Total	0.924	0.853	0.004	0.924	0.000

r : Coefficient of Correlation
 R2 : Coefficient of Determination
 B : Coefficient
 β : Coefficient of Standardization
 sig. : Significance Level

As in Table 8, according to the regression analysis, the environment conservation costs compared to the construction costs that multi-households housing and non-housing constructions spent are pretty appropriate. When analyzed by coefficient of correlation (r), it was 0.938 for multi-households housing construction, which is pretty high, while it was 0.843 for non-housing construction, which is also pretty good. This is a quite opposite result from the previous study, and it is analyzed that the previous study did not catch the accurate relation between construction costs and environmental management costs from not enough number of samples for statistic analysis.

And as featured in Table 8, the coefficient was calculated as positive number (+), which means environmental management costs increase upon the increase of construction costs.

(5) Status Analysis of Environmental Conservation Costs upon Land Sizes

The land size can generally be the basis to easily estimate the construction costs before the construction order is made. In order to find out the correlation between land size and

environmental conservation costs, a simply regression analysis was done by types of construction works. Appendix should be placed between acknowledgment and References.

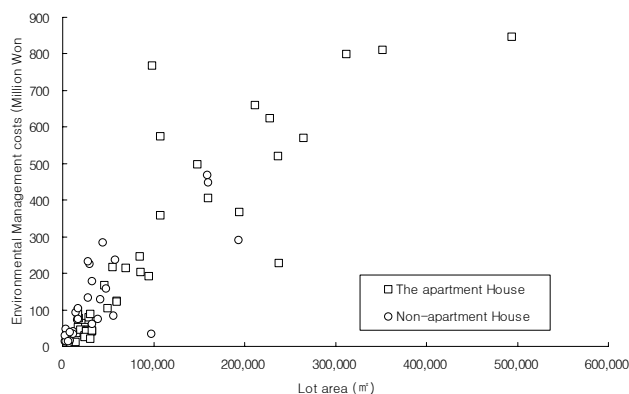


Figure 9. The scatter – Environmental management costs and Lot Area

Table 9. Result of Regression Analysis for Land Size and Environmental Conservation Costs

Description	r	R2	B	β	sig.
Multi-households housing construction	0.878	0.771	2093.55	0.878	0.000
Non-housing construction	0.788	0.622	1976.26	0.788	0.000
Total	0.875	0.766	2076.89	0.875	0.000

r : Coefficient of Correlation
 R2 : Coefficient of Determination
 B : Coefficient
 β : Coefficient of Standardization
 sig. : Significance Level

As shown in Table 9, the correlations of land size and environmental conservation costs were pretty good, with 0.878 for multi-households housing construction and 0.788 for non-housing construction.

The coefficient was calculated as positive (+), and the size of coefficient was larger than the one from analysis for construction costs and environmental conservation costs. So, we can see that the environmental conservation costs are more strongly influenced by land size than the construction costs.

(6) Analysis upon Construction Costs and Land Sizes

In order to determine the influence of construction costs and land sizes to environmental conservation costs, a multi regression analysis was done.

As featured in Figure 10, from the coefficient of standardization (β) which enables the influencing power in between independent variables, the β value was higher for net construction costs than for land sizes, both in the multi-households housing and non-housing constructions. So it turned out that influence of net construction costs to environmental conservation costs is stronger than that of

land sizes.

Based on this result, the environmental conservation cost rates by current Construction Technology Management Law should reflect the construction costs.

Table 10. Result of Multi Regression Analysis of Construction Costs and Land Sizes

Description		B	β	t	sig	R
Multi-Households Housing Construction	Land Size	674.195	0.283	3.101	0.003	0.950
	Net Construction Costs	0.003	0.696	7.636	0.000	
Non-Housing Construction	Land Size	114.956	0.046	0.168	0.868	0.843
	Net Construction Costs	0.003	0.800	2.937	0.007	
Total	Land Size	690.483	0.291	3.455	0.001	0.934
	Net Construction Costs	0.003	0.670	7.948	0.000	

B : Coefficient
 β : Coefficient of Standardization
 sig. : Significance Level
 R: Coefficient of Correlation

4.3 Current Problems of Budgeting Environmental Management Costs

According to the analysis of actual data from construction sites and interviews with experts, there are now problems in budgeting environmental management costs as follows;

(1) Antipollution Facilities Being Not Fully Planned

The antipollution facilities which should be checked and reflected in the planning stage are not adequately planned. It is because currently Government Standard of Estimate do not present all necessary facility items and establish the integration standards.

(2) Environmental Conservation Costs Being Not Fully Budgeted in Net Construction Costs

The environmental conservation costs are currently to be calculated by Government Standard of Estimate or suggested rates. When environmental conservation costs are calculated by Government Standard of Estimate, only part of the antipollution facilities can be included in the budget, and environmental management costs calculated by construction contractors may not be approved by construction owners. For more accurate cost calculation using Government Standard of Estimate, it is required to add up the antipollution facility items and to reform the calculating standards.

Calculating environmental conservation costs by certain suggested rates would be good for owner agency to control the budget, and convenient in budgeting, however, appropriate costs may not be budgeted from applying uniform rates, which will possibly result passive environ-

mental management in the sites.

(3) Importance of Post Environmental Influence Research Being Not Fully Recognized

Antipollution facilities suggested to be installed by environmental influence evaluation should be analyzed for its necessity upon construction works, to be determined whether it should be carry on or not. When there are unexpected influences to environment that environmental influence evaluation missed, and they are reanalyzed as necessary facilities upon construction works, they should be added through design modification and prevent damages from compensation for civil accusations and delay in construction works.

(4) Accounting System for Environment Related Costs Being Not Fully Established

In case of private construction companies, due to the insufficient accounting system for environment related costs, cost identification that are already spent for environmental management is done manually, which is not accurate. It can become hurdles to estimate environmental management costs for future construction works, and possibly make some antipollution facility items to be duplicated in the budget due to the unclear specifications among the antipollution facilities. There were some cases that some antipollution facility items being budgeted as other construction costs, not as environmental conservation costs, for examples, sound-proof wall, sound-proof screen and dust-proof screen were budgeted as temporary facilities.

5. SUGGESTION FOR IMPROVING ENVIRONMENTAL MANAGEMENT COSTS

The regulation on mandatory environmental management costs was designed to establish detailed items and standards for antipollution and waste disposal costs, etc., minimize the environmental pollution in construction sites, promote proper treatment and recycle of construction wastes, which and to build environmentally friendly construction industry.

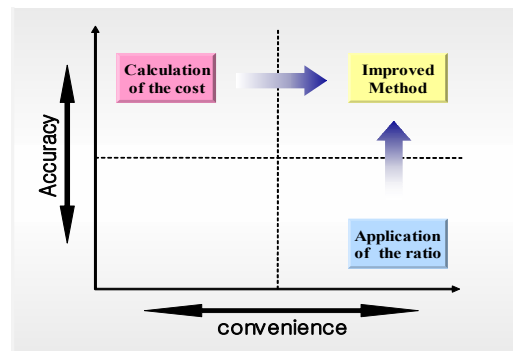


Figure 10. The budgeting method regarding Environmental management costs

Environmental management costs have rather pre-active meaning in preventing environmental pollution. The Figure 10 shows how the environmental management costs are budgeted. In order to promote accuracy and convenience of this system, the following suggestions are requested.

5.1 Improvement in Cost Accounting Methods

Because of the insufficient listing of antipollution facility items in the current Government Standard of Estimate, it is practically impossible to efficiently budget the environmental management costs using cost accounting methods based on Government Standard of Estimate. So, it is required that basic antipollution facilities to be commonly budgeted regardless of the types of construction works should be established, and detailed items upon the types of construction works should be determined to calculate the environmental management costs.

Table 10. Antipollution Facility Items Categorization

Description		Antipollution Facility Items
Mandatory Items	Air	Tire washer, dust-proof screen, dust-proof wall, portable watering facility
	Water	Sewage treatment facility, independent septic tank, portable potty
	Noise/Vibration	Sound-proof wall, sound-proof screen, sound-proof cover
	Waste Management	Trash chute, waste separation box, waste storage facility
	Others	Test measure equipment, etc.
Construction Work Types	Remodeling	Temporary road pavement preventing dust scattering, temporary drainage, slit protector, designated waste storage facility, grit chamber, sand outflow preventing facility
	Housing	Temporary drainage, grit chamber, machinery cleaning facility
	Non-Housing	Temporary drainage, grit chamber, machinery cleaning facility

Based on the interviews with environmental management staffs of private construction companies and Korea National Housing Corporation, the mandatory antipollution facility items for all construction works and facility items to be evaluated for installment before work orders, are categorized in Table 11. Acknowledgment should follow conclusions and its text should be preceded by bold face heading directly.

5.2 Improvement in Rate Application Methods

To more practically budget environmental conservation costs, it is required to keep the current methods with increasing the rates upon construction work sizes and types.

From the survey of 78 construction work sites, the correlations of environmental management costs and construction costs/land sizes turned out to be pretty high, while construction costs put more influence to environmental conservation costs. As for non-housing constructions, differently from multi-households housing constructions, deviation of environmental management costs by construction sites was rather big. So it can be concluded that, for architectural works, environmental management cost rates should be differentiated upon construction types

considering the work sizes. For this, a matrix should be made for suggested rates upon construction work types and sizes to effectively budget environmental management costs.

In the meantime, when environmental management costs exceed the designated rates, design change order could be approved to secure environmental management costs.

6. CONCLUSION

The amended enforcement regulations of Construction Technology Management Law in force regulate that environmental management costs should be budgeted separately, like safety management costs, not as expenditures. But there are problems in effective budgeting, due to absence of regulations for detailed antipollution facility items to budget environmental management costs and unrealistically low rates fixed for rate application. This study surveyed actual data of 78 construction sites, analyzed status of environmental management costs in construction sites, and provided suggestions to improve the current status. Here are some major conclusions analyzed by this study.

(1) According to the data analysis of 78 new construction works for multi-households housing and others, the average environmental management cost rate was 0.45%, which is more than twice higher than 0.2% of standard rates by law. So, the standard rates by law should become more realistic.

(2) According to the analysis of environmental conservation cost rates applied by public owner agency and private construction companies, the rates were 0.26% and 0.48, respectively. This gap came from different antipollution facility items that are put in the budget by construction owners. So, expansion of antipollution facility items and unified management of these items are required. For that, the antipollution facility items were suggested in the study.

(3) According to the analysis of environmental conservation cost rates by construction types, the average applied rates were similar for multi-households housing and non-housing constructions, however, the rates applied by each sites for non-housing constructions showed big deviation, compared to multi-households housing constructions.

(4) According to the analysis of correlation between environmental conservation costs and construction costs, as well as environmental conservation costs and land sizes, the correlations turned out to be pretty high for both factors, while environmental conservation costs were more strongly influenced by construction costs. Therefore, this study suggested that environmental management costs should be calculated using increased rates from current ones, considering construction costs.

This study can be used as a basic reference when establishing environmental conservation cost rates in law, and for determining environmental management cost rates by construction types, more surveys are required and they should be verified. Because of the insufficient listing of antipollution facility items

REFERENCES

- [1] Kang Man Ok, "An Introduction to Environmental Accounting", Samsung Economic Research Institute, 1997.
- [2] Kang Young Hyun, "Measures in appropriating system of environmental conservation costs", Korea Environment Institute, 1998
- [3] Kang Yoon San, "Problems and measures in appropriating system of environmental conservation costs", Construction & Economy Research Institute of Korea, 2001
- [4] Kang Yoon San, "Problems and measures in appropriating system of environmental conservation costs", Construction & Economy Research Institute of Korea, 2004
- [5] Min Dal Ki,, "A Study on the Improvement of Environmental Defrayment for Construction Trade", J. Korea Society of Environmental Administration Vol.5 (1), 1999
- [6] Park Jae Doo, "A Scheme for the Efficient Environmental Management of Building Construction Firms", The Architectural Institute of Korea Academic Conferences Vol21, 2001.10
- [7] Woo Soo Myung,, *SPSS for Window 10.0/11.0 with Mouse*, Human & welfare, 2003
- [8] Lee Sung Hee, "A Model for Environmental Performance Measurement at the Construction Phase", The Graduate School Chung-Ang University, 2001.
- [9] Lee Young Joo, "(A)study on the effectiveness of the adoption of ISO 14001 in a korean company", The Graduate School Korea University, 1997
- [10] Lee Jae Ho, "A Budgeting Method for Environmental Management Expenses by Historical Data", The Graduate School Chung-Ang University, 2002.
- [11] Chun Jin Ku, Kim In Ho, *Environmental Management of Construction*, Kumibook, 2003
- [12] Chun Jin Ku, "A Study on Application of EMS with Environmental Management System Model", Korean Society of Civil Engineering Academic Conferences, 2000.
- [13] Choi Min Soo, "Alternative measures to ameliorate environmental conservation in construction field, Construction & Economy Research Institute of Korea, 1997.
- [14] Choi Bong Soo, "A Research on the Problems and Improvement of Environment Management System : Concerning the ISO 14000", The Graduate School Soong Sil University, 2002.06