

# CHECKLIST FOR ENVIRONMENTAL FRIENDLY CONSTRUCTION MANAGEMENT IN DESIGN PHASE

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## Abstract

Construction project is necessary element for human life to upgrade the quality and convenience. However, due to its contradictory nature to the environment preservation, environmental pollution and damage, deterioration of natural scenery, noise/vibration, water quality pollution, etc. caused in the process of construction greatly affect the environment. For the building or construction project, its possible impact on environment during construction work and after completion must be predicted at its design phase, which will result in the completion of the architecture convenient for human being with its environmental pollution reduced to minimum level.

In this study, the checklist of environmental factors was suggested, which should be taken into account at its design phase in conducting the construction work. Proposed checklist was linked with the developed web-based system for the convenience of users like designer and construction manager, etc. It is expected that the checklist suggested by this study will help the designer and construction manager to continue the steady development from the environmental viewpoint during the design phase.

**Keywords** : Checklist, Environmental friendly, Construction Management, Environment Preservation, Web-based System

## 1. Introduction

### 1.1 Research Background and Objectives

Due to the recent unusual weather in Europe, July temperature in U.K. hit an all-time record, while 40 or more persons died from the severe heat of summer in France and Spain. Such situation touched off many people to seriously worry about the environmental issue in our planet today. Tendency of environment campaign once not being in the favored group but belonged to the monopoly of the unrealistic liberalist and radicals has vanished away. TESCO, one of the world three largest retail chain plans to reduce by 2010 half of the existing energy consumption based on its consumption in 2000 through the investment of 100,000,000 Pounds in their environment protection technology. Like this, as for the

company's performance index in management, the focus of world-renowned enterprises tends to be moved from existing economy and quality to their environmental friendliness. Construction project is necessary element for human life to upgrade the quality and convenience. However, due to its contradictory nature to the environment preservation, environmental pollution and damage, deterioration of natural scenery, noise/vibration, water quality pollution, etc. caused in the process of construction greatly affect the environment. Especially, during the construction work, environment preservation is not properly taken account, large-scaled national development projects are frequently delayed, causing environment-related disputes and public resentment, which finally delay, change or sometimes cancel the construction project. Following the increased interests in environment preservation both at home and abroad, environment management procedure and environmental impact review in relation to the construction project is reinforced. Furthermore, the people's demand for the pleasant environment also rises higher and higher, which stimulate the necessity for the construction project to be conducted in environmental friendly manner.

In case of the construction project detailed concept is decided in the design phase. Therefore it is possible at the design phase to prepare any plan shortening the construction period and maximize the quality. This is also applied to the environmental issue. For the building or construction project, its possible impact on environment during construction work and after completion must be predicted at its design phase, which will result in the completion of the architecture convenient for human being with its environmental pollution reduced to minimum level.

Following the tendency that the importance of such environmental management is highlighted, studies have been conducted from the various viewpoints regarding the environmental friendly construction management that can minimize the environmental pollution, etc. In fact, the impact of the project on the environment should be predicted from the initial stage of construction project so as to enhance its environmental friendly effect. However, most of the researches have suggested only the environment management plan to minimize the environmental pollution and environmental damage, etc. during the construction process. Accordingly, in this study, the checklist of environmental factors will be suggested, which should be taken into account at its design phase in conducting the construction work.

## **1.2 Research Methods and Scope**

In this research, the initial stage of construction project was limited to basic design phase and implementation design phase to suggest its research results. Planning and site locating phases were excluded because of its likelihood to imply the qualitative factors in judging the environmental impact. Checklist for the environmental fields to be considered was divided into each field of natural environment, living environment and socio-economy as defined in the preliminary environment review & environmental impact assessment system. Research was conducted under the following procedures and methods.

- (1) Existing research references were examined and analyzed for the theoretical survey on construction environmental management.
- (2) Preliminary environment review system and environmental impact assessment system were surveyed.
- (3) Environment-related acts and existing research references were analyzed to derive the environmental factors that should be considered in the construction project.

- (4) Checklists for environmental management were suggested for 23 items in three (3) environment fields.
- (5) Web-based system was developed to facilitate the user in their using the suggested checklist.

## **2. Literature Review**

### **2.1 Examination of Existing Researches**

Ministry of Construction & Transportation (2003), through "Development of Natural Ecology Preservation Technique and Restoration Technology in Construction Site" divided the target project regarding the plan/design guide for natural ecology preservation and restoration broadly into road construction project, site formation project and dam construction project, and prepared the construction environmental management standard specification as the construction standard. Park Jae-doo (2001), through "Method of Efficiency of Environmental Management for Construction Contractors", analyzed the environmental management plans and environment-related laws managed and applied in the actual sites, and through the interviews with the persons in charge of environment affairs at construction sites, investigated the influential factors in relation to the environment at the construction phase of the project, and then suggested the management plan through the checklist. Goh Gwang-il et al. (2004) through "Study on Noise/Vibration Control Plan in Construction Work," suggested the checklists after investigating the targeted construction noise vibration by construction project phases following the analysis of related laws and regulations. Jeong Gap-cheol (2000), through "Noise Control Measures in Construction Site", explained the lawful standard regarding noise vibration and judgment standard for the various physical damages, and introduced the examples of public resentment occurred in the actual sites, suggesting the measures against the public resentment for smooth promotion of construction as well as the problems of the laws in force. Through "A study on the estimation of noise, vibration and dust emitted from the construction sites and its reduction measures" (1998), Korea National Housing Corporation investigated the public resentment status and Environmental Impact of the noise, vibration and dust emitted from the construction work, reviewed the related standards both at home and abroad, and finally suggested an Environmental Guidance Manual on Noise, Vibration and Air Pollution from Building Works and Construction Sites.

While most of the existing studies focused on the environmental management of construction project, it is noteworthy that the present study suggests the detailed environmental factors in a specific sector of noise, vibration and dust. Something desired left, however, is that the entire environmental aspect is not taken into account, and furthermore as it mainly handles the in-process stage during the project promotion process, it lacks the research data useful for reviewing and reflecting the environmental impact at the initial stage of construction project.

### **2.2 Environmental Impact Assessment Systems**

Preliminary environment review system was introduced as the counter-solution of environmental impact assessment system which had the problems. This was introduced to accomplish essential reduction and improvement of environmental impact so as to realize

the continual and environmental friendly development through the consideration of environmental impact before the decision of the development project that will affect the environment.

Environmental impact assessment system can be said to be the process to find out the environmentally desirable project plan by general comparison and review of economy, technology and environmental factors of the relevant project in the course to establish and conduct the development plan. In 「Act on Impact Assessment of Environment·Transportation·Disaster, etc.」 environmental impact assessment is defined to be "To predict, analyze the harmful influence caused by the natural environment, living environment, socio-economic environment due to the implementation of the project, and prepare its measures". Thus, it means grasping the impact from the conduct of targeted project, and preparing the reduction measures.

Assessment items defined in these two systems broadly consist of 23 items in 3 fields like natural environment, living environment and socio-economy, etc. Review is conducted mainly in natural environment field and living environment field, except the case that socio-economic field is linked where necessary from the business characteristic.

### 3. Environmental Friendly Construction Management Checklist

Assessment items and environment-related laws/regulations being applied in the preliminary environment review and environmental impact assessment were looked into and analyzed to set up the major review items. Suggested review items were used to prepare the environmental friendly construction management checklist to observe a various environment-related regulations and standards.

#### 3.1 Review Field Setup

As the environment fields to be considered at the design phase, natural environment field, living environment field, and socio-economic environment field were set up, which is generally used in preliminary environment review and environmental impact assessment. Through this suggestion of three (3) fields as the environment management checklist, it is thought that there would require less additional effort to prepare the relevant items to cope with environmental impact assessment, etc. Likewise, Table 1 shows the checklist covering these 23 items in 3 fields.

Table 1. Review Field and Item for Environmental Friendly Construction Management

Field	Assessment Item
Natural Environment	Weather, Geographical/Geological Feature, Animal/Plant, Marine Environment, Water Utilization/Hydrology
Living Environment	Land Use, air quality, Water Quality, Soil, Waste, Noise Vibration, Filthy Odors, Radio Wave Propagation, Sunshine Obstacle, Recreation Scenery, Sanitary Condition, Health
Socio-Economic Environment	Population, Residence, Industry, Public Facility, Education, Traffic, Cultural Property

### 3.2 Main Consideration at the Design Phase

At the design phase, the appropriateness on the future development plan and preservation measures should be examined through the site characteristic finding from the survey of target site status, environmental impact review by development project type and scale. In addition, the environmental impact that can be occurred from the implementation of project should be predicted and assessed so that its measures can be reflected. Following is its brief summary.

- Checking Reviewing Action Restriction-Related Clause
- Checking Pollution/Emission Elements from Structure Construction/Operation & its Regulation Standard
- Soil Environment Assessment      • Ecology Preservation Method
- Checking if Pollution/Emission Elements from Structure Construction/Operation & Regulation Standard is met
- Reviewing Necessity of Management system & Planning
- Environment Damage Prevention/Minimization Method
- Coping with Preliminary Environment Review & Environmental Impact Assessment
- Observing Environmental Acts
- Environmental Friendly Design considering Operation, Dismantling/Withdrawal

### 3.3 Review of Environment-related Laws

In order to develop the checklist for the environmental friendly construction management, all the laws and associated regulations throughout the process of construction project should be reviewed. Environment-related laws consist of the acts governed by the Ministry of Environment and others. Figure 1 shows the acts governed by the Ministry of Environment.

Environmental Policy Act	Natural Environmental Management	<ul style="list-style-type: none"> <li>• Natural Environment Conservation Act</li> <li>• Act on Assessment of Impacts of Works on Environment, Traffic, Disasters, etc.</li> <li>• Special Act on the Ecosystem Conservation of Small Islands such as Dokdo Island</li> <li>• Natural Park Act      • Soil Environment Conservation Act</li> <li>• Wetland Conservation Act      • Wildlife Protection Act</li> </ul>	
	Emission Restriction & Management	Air Quality	<ul style="list-style-type: none"> <li>• Clean Air Conservation Act      • Noise &amp; Vibration Control Act</li> <li>• Indoor Air Quality Management Act      • Foul Odor Prevention Act</li> <li>• Special Act on Seoul Metropolitan Air Quality Improvement</li> </ul>
		Water Quality	<ul style="list-style-type: none"> <li>• Water Quality Conservation Act      • Sewerage Act</li> <li>• Act on the Disposal of Sewage, Excreta &amp; Livestock Wastewater &amp; Community Support</li> <li>• Act relating to Han River Water Quality Improvement</li> <li>• Act on Youngsan/Seomjin River Watershed Management &amp; Community Support(Geum, Youngsan/Seomin, Nakdong, etc.)</li> </ul>
		Wastes	<ul style="list-style-type: none"> <li>• Waste Management Act</li> <li>• Promotion of Husbandry and Recycling of Resources Act</li> <li>• Promotion of Waste Disposal Facilities &amp; Assistance, etc. to Adjacent Areas Act</li> <li>• Act on the Control of Trans-boundary Movement of Hazardous Wastes &amp; Their Disposal</li> </ul>
		Miscellaneous	<ul style="list-style-type: none"> <li>• Toxic Chemicals Control Act</li> <li>• Act on Special Measures for the Control of Environmental Offenses</li> </ul>
	Water Source Management	<ul style="list-style-type: none"> <li>• Water Supply and Waterworks Installation Act</li> <li>• Drinking Water Act</li> </ul>	
Miscellaneous	<ul style="list-style-type: none"> <li>• Development of &amp; Support for Environmental Technology Act</li> <li>• Environmental Dispute Adjustment Act</li> <li>• Act Relating to Special Accounting for Environmental Improvement</li> <li>• Environmental Improvement Expenses Liability Act</li> <li>• Environmental Management Corporation Act</li> <li>• Korea Environment &amp; Resources Corporation Act</li> <li>• Sudokwon Landfill Site Management Corporation Act</li> <li>• Act on Promotion of Purchasing Environmental Friendly Products</li> </ul>		

Figure 1. List of Environment-related Acts governed by the Ministry of Environment

In order to additionally examine the Environment-related laws not specified in Figure 1, the acts governed by the other authorities concerned like the Ministry of Construction & Transportation and Ministry of Maritime Affairs and Fisheries, etc. were examined to reflect to the checklist (Table 2).

Table 2. Environment-related Laws Governed by the Authorities Concerned Other than the Ministry of Environment

Sector	Name of Acts
Air Pollution	Road Transportation Act, Petrochemical Business Act, etc.(9)
Water Quality Pollution	Marine Pollution Prevention Act, River Act, Aggregate Picking Act, etc.(9)
Noise	Health Act, Civil Aviation Act, etc.(3)
General	Framework Act on National Territory, Building Act, Urban Park Act, etc.(16)
Agriculture	Agricultural/Fishery Area Maintenance Act , Farmland Act, etc.(6)
Livestock	Livestock Industry Act, Dairy Promotion Act and meadow land Act(3)
Fisheries*Harbor	Fisheries Act, Fisheries Promotion Law, Fishing Port Law, Harbor Act (4)
Forestry	Forest Law, Forest Erosion Control Act(2)
Misc.	Protection of Cultural Properties Act, Mining Act, etc.(11)
Marine Environment	Act on Marine Development, Marine Pollution Prevention Act, Coastal Zone Management Act, etc.(7)

Note) Ministry of Environment, Environment White Paper 2005

### 3.4 Checklist for Environmental Friendly Construction Management

Items mainly handled in the preliminary environment review and environmental impact assessment and the main regulatory clauses in environment-related acts were reviewed, and checklist was prepared based on those items derived from them, divided into natural environment, living environment, and socio-economic environment fields.

#### 3.4.1 Natural Environment Field

Natural environmental management represents the beautification of natural environment that was previously neglected in such manners as environment pollution and natural damage, ecology damage caused by the construction act, and preservation of various wild animals and plants so that people can enjoy pleasant life. Especially in our country, there is likelihood for its ecology to be rapidly deteriorated from the reduction and simplification of the habitat space for animals and plants due to the past careless development of national land. If once destructed, the natural ecology is not easily restorable, and therefore consistent management is essential. Accordingly it is necessary to pursue the sustainable development to trade off both natural environment protection and development.

In the natural environment field, checklist was prepared from 5 assessment items such as weather, geographical/geological feature, animal/plant, marine environment, water utilization/hydrology. Table 3 shows the checklist for marine environment items out of the natural environment field.

Table 3. Marine Environment Checklist in Living Environment Field

Construction Project Phase	Priority Review Points	Checklist
Basic & Implementation Design Phases	Grasping the influence by project characteristic	<ul style="list-style-type: none"> <li>-Grasping the affect of pollutive materials emitted from construction work or usage of facility on water quality of the relevant sea area, and establishing its measures</li> <li>-Grasping deterioration of damp ground following the project promotion and establishing its measures</li> <li>-Grasping changes in seawater flow status, seabed feature and depth following the project follow-up, and establishing its measures project</li> <li>-Grasping the reduction in water flow and seawater exchange rate and establishing its measures, when deciding the arrangement plan</li> <li>-Establishing the plan to minimize environmental impact at the construction, maintenance and dismantling phases</li> </ul>
	Establishing marine pollution reduction measures	<ul style="list-style-type: none"> <li>-Establishing marine pollution reduction measures, at the construction and operation phases</li> <li>-Checking the necessity of self-treatment facility for the wastes such as oil, etc. emitted from the marine facility.</li> </ul>

### 3.4.2 Living Environment Field

While natural environment field focuses on the preservation of ecological other than human sector, living environment field relates directly with the human life. In this study, checklist was proposed for eleven (11) living environment fields, Table 4 of which is the checklist associated with the air quality.

Table 4. Checklist for Air Quality in the Living Environment Field

Construction Work Phase	Priority Review Points	Checklist
Basic & Implementation Design Phases	Review of Project Characteristic	<ul style="list-style-type: none"> <li>-Facility location regulation depending on its fuel used.</li> <li>-Facility location regulation depending on its volume emitted</li> <li>-Facility location regulation depending on its land category</li> <li>-Grasping the environmental impact following the project characteristic</li> </ul>
	Review of Emission Facility	<ul style="list-style-type: none"> <li>-Whether it has air pollution emitting facility or not</li> <li>-Whether it has Volatile Organic Compounds emitting facility or not</li> <li>-whether the fugitive dust is emitted from the project or not</li> </ul>
	Review of Control System	<ul style="list-style-type: none"> <li>-Reviewing the type of control system and if it to be installed or not</li> <li>-Checking if there is any restriction provision for the installation of control system</li> <li>-Establishing the air quality reduction measures</li> </ul>
	Review of Fuel	<ul style="list-style-type: none"> <li>-In case the Low Sulfur Fuel is used</li> <li>-In case the fuel other than Low Sulfur Fuel is used.</li> <li>-In case clean fuel is used.</li> </ul>

### 3.4.3 Socio-Economic Environment Field

As previously examined from the survey of environmental impact assessment system, because of the low importance of socio-economic environment field, most of the studies have been conducted with priority for natural environment and living environment fields except the case it must be reviewed in the socio-economic environment field for its specific project characteristic. In general, necessary item(s) is selected and reviewed according to the relevant project characteristic out of seven (7) items such as population, residence, industry, public facility, education, traffic, cultural property, and in some case population, residence, industry, public facility, education, etc. are handled in a package. Table 5 is the example of checklist about the cultural property item out of the socio-economic environment field.

Table 5. Cultural Property Checklist in Socio-Economic Environment Field

Construction Work Phase	Priority Review Points	Checklist
Basic & Implementation Design Phases	Existence of Cultural Property	-Distribution Status -Cultural Property Designation Status -Location, Description, Nomination No. Distribution of Cultural Property by Types, Manager, etc.
	Cultural Property Reservation Area	-Grasping whether it is designated or not
	Survey of Geological Surface of Cultural Property	-Deciding whether to conduct or not
	Checking Relics When Surveying Geological Surface	-Conducting prospecting survey & Establishing its preservation plan
	When unidentified buried cultural property found	-Establishing the action plan& conducting the procedure of cultural property protection

## 4. Web-based System(ECMS) Development

Proposed checklist was linked with the developed web-based system(Environmental-friendly Construction Management System; ECMS) for the convenience of users like designer and construction manager, etc. Layer of developed web application consists of following elements.

- ASP.NET WEB FORM: \*.aspx
- ASP.NET WEB FORM CODE BEHIND: \*.aspx.cs (C#)
- ASP.NET USER-DEFINED CONTROL (Web User Control, Pagelet): \*.ascx
- ASP.NET USER-DEFINED CONTROL (Web Custom Control, Server Control)
- CLIENT SCRIPT AND OTHERS: <script> Block, \*.js, \*.htc, \*.css, Image File, etc.
- 3rd Party Control: ActiveX or WinForm Control, etc. for Chart, Grid, Report, etc.
- Granting authentication and authorization for the security from access of unspecified users and approach of users.

Logical Architecture is designed and realized with the application divided into more layers. Logically, as several layers are divided, each layer of them can be expanded if necessary. Although the servers are added gradually, the revision of application can be



minimized. (Figure 2). Figure 3 is the example of checklist and manual about the noise and vibration.

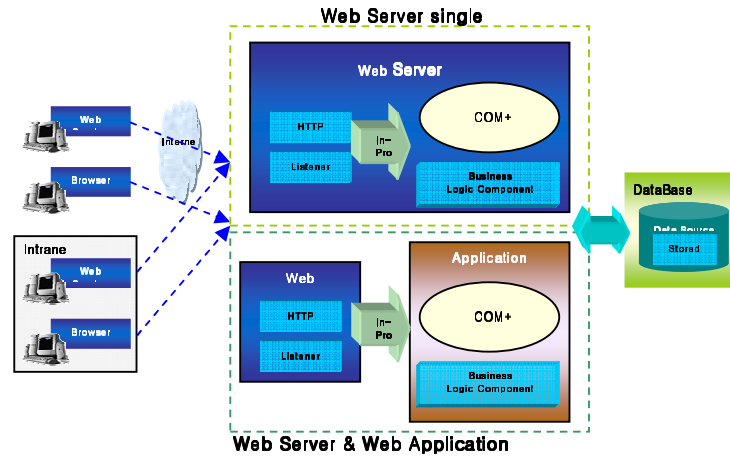


Figure 2. Logical Architecture

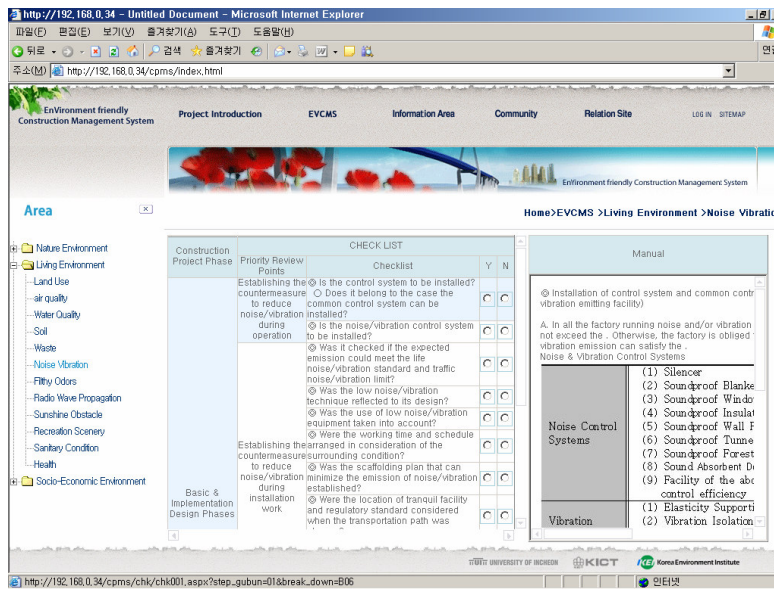


Figure 3. Checklist and Manual of Noise & Vibration

## 5. Conclusion

This study suggests the checklist of the environmental factors to be considered at the design phase during the construction work. For this, environmental factors were derived from theoretic survey on construction environment control; analysis of assessment items applied in the preliminary environment review and environment-related acts review. Results of this research are as follows.

As for the natural environment field, checklist for five (5) assessment items like geographical/geological features, animal/plant, marine environment as shown in Table 3

were prepared. In the living environment field, eleven (11) items like air quality, water quality, soil, waste, noise/vibration, etc. were chosen. On the other hand, for socio-economic environment field, three (3) items like population, residence, industry, public facility, education in one packaged item and two other items like transportation and cultural property were chosen. Proposed checklist was linked with the developed web-based system for the convenience of users like designer and construction manager, etc.

It is expected that the checklist suggested by this study will help the designer and construction manager to continue the steady development from the environmental viewpoint during the design phase. In this study, brief checklists to be considered at design phase for environmental-friendly construction management were suggested. In future study, however, the checklist that can be utilized at project planning phase and construction work phase should be investigated. Furthermore, the system developed in this study provides the checklist and the associated regulation. But system should be intellectualized that environmental checklist only suitable for the project characteristic against the target project could be suggested or the review report is automatically served.

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