

Evaluation Indicators for Green Libraries and Library Eco-friendliness

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ABSTRACT

This study aimed to determine eco-friendly factors on the aspects of library service, materials provided or handled by the library, and programs including educational programs. Furthermore, it was setup to perform a trial evaluation for the eco-friendliness of the library based on the determined evaluation standards by this study. Results are as follows; First, regarding the question of 'Do employees of the library think that establishment of green libraries is necessary?', the employees of the libraries responded yes by 65.52%, but only 4.6% responded that it would not be necessary. Second, in analyzing the most important evaluation areas of green libraries according to the opinions of the libraries' employees, they were ranked in order: the indoor environment, energy and prevention of environmental pollution, and material and resource areas. Third, 11 areas were determined to evaluate the level of greening in the libraries; the highest averages were scored 510 for the area of energy and prevention of environmental pollution, 415 for the area of library resource, and 320 for the area of indoor environment. Last, the libraries were graded based on actual data according to the results to measure the level of greening, two libraries were graded as Diamond, the highest grade, accounting for 15.39% of all libraries; Gold and Silver grades accounted for another 15.39%, together five Certified graded libraries accounted for 38.46%, which was the highest rate among the libraries. Any library scoring less than 20% when compared to the full score was graded as Non-certified, and one library, which scored 15.06% fell into this category. The results of this study set up to serve as basic data for the direction of development for green libraries in our country, as well as reference for the employees of libraries in constructing or remodeling library buildings, establishing service infrastructure, providing information service, and planning library duties in an eco-friendly way.

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1. Introduction

We define eco-friendliness as having little to no damaging or polluting effects on the natural environment. An eco-friendly green library is a structure that is designed, constructed, renovated, operated, and reused in an ecological and resource-efficient way (Cal Recycle, 2000). Therefore, construction of green library buildings should be a priority, as well as other eco-friendly aspects such as printed materials, non-book materials, library operations, and library service (Ahn, Kwak, & Noh, 2013).

Though there are a variety of methods for building green libraries, all essentially include the minimization of negative effects and maximization of positive effects on local environments. As a rule, they contain things like the maximal use of natural or renewable resources, reduced use of water and energy, integration of actual shade from trees and vegetation when designing the library buildings and sites, the use of drought-resistant Native Plants, and attention to sustaining a high standard of indoor air quality for improving library user health.

In reviewing research papers by several authorities and identifying cases of green libraries in foreign countries and directions for their development, the findings suggest that to establish eco-friendly libraries there is a need to increase the amount of digital materials over printed ones, expand access to information through the internet, reduce user visits to the library, and find new and more effective ways to save energy. However, it was difficult to find eco-friendly examples of libraries with these features domestically. All of the certified green libraries by the G-SEED system focused on architectural elements without consideration of green services or programs.

The idea of making an eco-friendly library is not a brand-new concept. Existing libraries have already been attempting to develop a higher level of environmental friendliness. Some libraries did feature eco-friendly components even if they did not embrace the full definition of eco-friendly or green libraries by foreign standards. For instance, OPAC use in libraries was considered eco-friendly by replacing paper lists with online lists to save natural resources and to help users search and borrow materials. It also helped reduce the amount of physical activity necessary within the library, which saved energy. Furthermore, OPAC use is often predicated by the library providing a website linking content and information.

This study investigated the eco-friendly elements of the library by analyzing domestic and foreign literature and examples. Based on the investigation, indicators for eco-friendly libraries were developed to certify libraries as green and eco-friendly. The current domestic and foreign indicators to evaluate the eco-friendliness of libraries were limited to standards of construction, and they did not assess the eco-friendliness of the services, materials, and programs provided by green libraries. Miller (2010) suggested indicators such as the service factor, material factor, and education factor to evaluate the eco-friendliness of libraries. In other words, the study implied that the construction factor was not sufficient to evaluate the eco-friendliness of libraries. Thus, this study aimed to determine eco-friendly factors in the aspects of library service, materials provided or handled by the library, and programs including educational programs. Furthermore, it was setup to perform a trial evaluation for the eco-friendliness of the library based on the determined evaluation standards. The results of this study will serve as basic data for the direction of development for green libraries in our country,

as well as a reference for the employees of libraries in constructing or remodeling library buildings, establishing service infrastructure, providing information service, and planning library duties in an eco-friendly way. Furthermore, while recently a number of libraries were eco-friendly certified, the previous evaluations only reflected the architectural aspects without taking into consideration the other characteristics of the libraries. The evaluation indicators for eco-friendly green libraries that were developed in this study based on the features of libraries should evaluate the eco-friendliness of the libraries with more accuracy.

2. Literature review

Scanty previous research has been performed in relation to the subject of green libraries, which implies a low interest of researchers in this topic. In analyzing the prior research, topic trends were divided by domestic and foreign. In addition, as this study set out to develop specific evaluation items for certifying a green library, research related to the certification standards for green library buildings were reviewed.

First, as to the foreign studies on the green library, Brown (2003) referred to the LEED certification system but additionally included cooperation, natural light, and natural air ventilation as essential elements of the green library. In other words, the study considered such things as cooperative support of local communities, lighting with natural sunshine, and installation of windows in the space for a bookshelf to remove dust and odor in the building and circulate the air. A researcher discussed characteristics of the Hillsdale green library located in Oregon State based on the LEED certification system (Mikkelsen, 2007).

Schaper (2007) focused on examples of operating green libraries and argued the necessity of constructing green libraries, introducing examples such as how to use toilet seats and the installation of a parking lot for bicycles and eco-friendly cars. Some researchers presented websites related to green libraries to quickly raise awareness of the green library. Pinkowski (2007) suggested a website containing some information on green libraries, and Jankowska (2008) presented a website including related information and examples of them. Jankowska (2012) summarized several activities performed for sustainable development from 1989 to 2011. In addition, Zhu, Lin, and Yuan (2010) introduced Shandong Transportation College Library, located in China, as an example of a green library.

Antonelli (2008) mentioned the necessity of constructing green libraries and introduced some programs provided by green libraries in local communities, and Schaper (2010) proposed strategies for building green libraries. The research often either suggested the necessity of establishing green libraries or introducing some examples intended to prove the effect of green libraries. In particular, Schaper (2003) addressed the effect of green libraries with a specific example that satisfied the standard of a sustainable place by improving traffic flow to the building and utilizing water resources effectively. Neal (2008) described the effects of saving paper, computers, and lighting in operating the green library, which were being over-consumed by existing libraries.

Domestically in Korea, initial research on green libraries was performed in 2012 (Ahn et al.,

2012); it investigated 50 libraries that were certified by the evaluation system for green libraries. This study was based on six specific evaluation items of the LEED certification system: an eco-friendly construction site, the effectiveness of utilizing water resources, energy and atmosphere, material and resources, the eco-friendliness of the indoor environment, and an eco-friendly interior design. The researchers insisted that the certification system focuses only on the architectural aspects rather than reflecting more aspects of eco-friendliness. The study implied that studies into a deeper level of eco-friendliness should be performed with consideration of such categories as services, contents, and supplies of the library. Further research was performed to analyze the directions and contents of the literature regarding green libraries and to suggest a direction of future studies (Ahn, Kwak, & Noh, 2013). This study proposed that future studies on green libraries consider the number of libraries that should be constructed in the region, their location, and such things as the space between the bookshelves, volume of materials for the collection in the stacks, and the users.

Meanwhile, a study on the status of green libraries, which investigated librarians' awareness of the green library, including the necessity for a green library, was performed for the first time (Hong & Noh, 2014). This study showed that library employees were not as aware of green libraries and the certification system necessary to qualify for this designation but were interested in the concept and appreciated its necessity. Furthermore, according to the survey results, library employees rated prevention of environmental pollution as the most important G-SEED assessor, followed by energy, ecological environment, and interior environment.

A review of the previous literature in foreign countries finds that the research was actively performed by practicing librarians and researchers. However, the domestic research on eco-friendly libraries was begun in earnest around 2012 by a few researchers. While some foreign examples were found for benchmarking in other libraries, domestic examples were hardly investigated; moreover the libraries certified as green libraries tended to be based on the architectural aspects. The specific evaluation items did not include other relevant features of the library.

3. Research Design and Methodology

3.1 Step 1.1: The process of determining specific evaluation items for green libraries

To evaluate the eco-friendliness of a library, this study collected related previous research and materials to determine specific evaluation items. As a result of investigating the materials, the specific evaluation items to measure the eco-friendliness of library buildings were already developed, applied, and utilized. However, research or indicators to evaluate the eco-friendliness of such things as library materials, services, and resources were never performed or developed. Moreover, the evaluation items of the eco-friendliness of library buildings were applied also to commercial buildings and other institutional buildings, but the items were hardly specific to the features of library buildings.

Thus, this study intended to develop indicators for eco-friendly libraries, considering the features of libraries, using the following processes: First, it collected examples of green libraries domestically

and in foreign countries. It included 29 Korean, 39 American, 5 Canadian, 2 European, and 5 Asian green libraries. All examples were analyzed to determine elements of the green library.

Second, previous research papers and books related to the green library and environment were collected. Green elements were determined according to the researchers' analysis of the preceding literature.

Third, all of the green elements that were determined by the processes above were listed to group the green elements by similar characteristics; each group was distinctively named.

Next, the specific evaluation items of green library buildings were finally determined along 11 evaluation areas: Land Use and Traffic, Energy and Prevention of Environmental Pollution, Materials and Resources, Water Circulation Management, Maintenance, Ecological Environment, Indoor Environment, Library Resources, Eco-friendly Education Programs and Campaigns, Employees and Operations, and Computerization. Regarding the number of evaluation indicators, the areas with the largest number of indicators were, in order: library resources with 31 indicators, energy and prevention of environmental pollution with 29 indicators, eco-friendly education programs and campaigns with 19 indicators, and the indoor environment with 17 indicators.

In deciding the specific evaluation items for certification of the library in this study, the architectural elements of the library were the same specific evaluation items of the certification system of other eco-friendly buildings. In addition, elements specific to the green library were identified and used.

3.2 Step 1.2: Verification of the green library evaluation indicators with survey

In developing the specific evaluation items for certifying green libraries in this study, specific evaluation items were finalized according to the results of a survey and the opinions of specialists. The importance of each specific evaluation item in the architectural area of library buildings was targeted to the employees and librarians of the certified green libraries for preparation of the survey. The reason for limiting the target was that the librarians and employees of domestic libraries had less awareness of the green library. The number of certified green domestic libraries was 20 from 2005 to 2015. Five copies of each questionnaire were distributed to these libraries, and five librarians and staff responded to the questionnaire. As a result, 88 questionnaires were returned from 20 libraries and the recovery rate is 25%.

This study initially developed 11 evaluation areas, 31 specific evaluation items, and 144 evaluation indicators by converging the employees' opinions of the libraries. As a result, 11 evaluation areas and 31 specific evaluation items scored over 3 points and only 9 items among 144 evaluation indicators scored under 3 points. Accordingly, excluding the items that scored under 3 points, it was composed of a total of 11 evaluation areas, 30 evaluation items, 69 sub-evaluation items, and 127 evaluation indicators. All of the specific evaluation items were awarded weighted values; in reflection of the weighted values, values of each full scale according to the standards were suggested.

Table 1. Verification of the green library evaluation indicators

Evaluation Area		Evaluation Items		Specific Evaluation Items		Evaluation Standard	
Content	Full Score	Content	Full Score	Content	Full Score	Content	Full Score
1. Land Use and Traffic	95	1.1 Ecological Value	17.5	1.1.1 Ecological Value of Existing Land	17.5	Scored according to ecological value of existing land, land usage, and land use zone	17.5
		1.2 Effect on Adjacent Land	17.5	1.2.1 Validity of Measures for Preventing Violation of a Right to Sunlight	17.5	Maximum angle of elevation in measuring height from the boundary line of the adjacent land due north to each side of the target building	17.5
		1.3 Reduction of Traffic Load	60	1.3.1 Proximity to Public Transportation	20	Walking distance to the public transportation facilities	20
				1.3.2 Facilities for Reducing Traffic	20	Built a bicycle shed	20
				1.3.3 Distance between the City Center and a Library	20	Constructed a library building close to residential and commercial areas	20
2. Energy and Prevention of Environmental Pollution	510	2.1 Energy Saving	377.5	2.1.1 Facilities Controlled by Sensors	17.5	Installed automatic switching system in the stack room for infrequent visits	17.5
						Utilized natural light with installation of lighting controlled by sensors	17.5
						Utilized natural light with installation of blinds controlled by sensors	17.5
				2.1.2 High-efficiency Air Conditioning/Heating Facilities and System	19.64	Installation of cooling/heating control system using reflection and influx of sunlight	20
						Installed high-efficient air conditioner	20
						Energy saving rate of using air conditioning/heating system with geothermal heat	20
						Provided solar energy for cooling/heating	20
						Used construction materials for effective cooling/heating	20
						Energy saving for air conditioning/heating system using influx and release of outside air	20
						Installation of electric flash heater	17.5
				2.1.3 Increased Efficiency of Cooling/Heating with green facilities	17.5	Reduced usage of energy for cooling/heating with green rooftop	17.5
				2.1.4 Facilities for Reducing Heat Island Effect	17.5	Created environment for reducing heat island effect	17.5
						Reduced heat island effect with green outdoor environment and landscaping	17.5
2.1.5 Utilization of Natural Light for Library Lighting	20	Utilized natural light energy with facilities using reflection and influx of natural light	20				
		Utilized natural light with appropriate arrangement of glass windows	20				
		Usage of facilities for influx of sunlight in the roof and ceiling	20				
2.1.6 Use of Artificial lighting with high energy efficiency	20	Used fluorescent light with high energy efficiency	20				
		Used steel halide lamp with low voltage	20				
2.1.7 Energy Saving for Landscape Management with Installation of Irrigation Facilities	17.5	Installed automatic irrigation facilities for landscape management and utilized rainwater for irrigation	17.5				
		Executed landscaping work for library buildings with native vegetation	17.5				
2.2 Use of Sustainable Energy Sources	82.5	2.2.1 Use of New & Renewable Energy	16.5	Utilized solar energy generation for electricity in library buildings	20		
				Utilized hydrogen fuel cell for electricity	15		
				Utilized wind energy for electricity	15		
				Utilized geothermal power generation for electricity	17.5		
				Utilized bio-energy for electricity	15		
2.3 Prevention of Global Warming	50	2.3.1 Reduced Emission of CO ₂	16.67	Reduced emission of CO ₂ in transportation using local materials	15		
				Applied a system for reducing the emission of CO ₂	17.5		
				Prohibited usage of a certain substance for protecting ozone layer	17.5		

Evaluation Area		Evaluation Items		Specific Evaluation Items		Evaluation Standard					
Content	Full Score	Content	Full Score	Content	Full Score	Content	Full Score				
3. Materials and Resources	125	3.1 Resource Conservation	15	3.1.1 Reducing use of Bathroom Consumer Goods	15	Dry method of washing hands and face in bathrooms	15				
				3.2 Utilization of Sustainable Resources	110	3.2.1 Usage of Certified Eco-friendly Products for Effective Resource Recycling	17.5	Used certified eco-labelling products or GR-certified products	17.5		
						3.2.2 Sustainable Construction Materials	15	Used recycled materials in construction Provided construction waste	15 15		
						3.2.3 Separate Collection of Recyclable Resources	16.25	Installed storage facilities for recycled waste and evaluated according to product types for separation Installation of collection box for used batteries	17.5 17.5		
						3.2.4 Indoor Facilities of Libraries	15	Usage of materials obtained from library land site for the indoor facilities	15		
						3.2.5 Display of CO ₂ Emissions Score	15	Evaluated certification of displaying CO ₂ score for used materials	15		
						4.1.1 Validity of Measures for Reducing Rainwater Load	17.5	Utilized soil of green roof to prevent losses from rainwater Installation of drain for rainwater	17.5 17.5		
4. Water Circulation Management	140	4.1 Establishment of Water Circulation System	52.5	4.1.1 Validity of Measures for Reducing Rainwater Load	17.5	Selected a site with trees and forests	17.5				
						4.2 Water Conservation	87.5	4.2.1 Validity of Measures for Reducing Water for Daily Life	17.5	Evaluated application of certified eco-labelling products	17.5
						4.2.2 Usage of Rainwater	17.5	Installed facilities utilizing rainwater for sprinkler system and landscaping according to standards of facilities using rainwater and of water quality in water reuse system Utilized rainfall on the roof of library buildings as irrigation water for landscaping	17.5 17.5		
						4.2.3 Installation of Water Reuse system	17.5	Established water reuse system for treating used tap water to use the treated water for sprinkler system and landscaping	17.5		
						5.1.1 Rationality of Field Management Plan in Consideration of Environment	17.5	Acquisition of ISO14001 by construction company and level of acceptance for environment-first policies in establishing guidelines for field management	17.5		
						5.2 Effective Building Management	35	5.2.1 Validity of Management Documents for Operation/Maintenance and Guidelines	17.5	Provided manual and guidelines for effective operation/maintenance of equipment/facility to the manager of building	17.5
						5.2.2 Performance of TAB and Commissioning	17.5	Performance of TAB and commissioning	17.5		
6. Ecological Environment	102.5	6.1 Construction of Green Area in the Land Site	17.5	6.1.1 Green Area Ratio of Natural Ground	17.5	Green area ratio of natural ground across the land site (Excluding artificial ground and green area on the top of building)	17.5				
		6.2 Acquiring Ecological Functions of Outside Area and Building Envelope	17.5	6.2.1 Ecological Area Ratio	17.5	Divided area types according to ecological values; sum of converted area after multiplying weighted values for each type of area and ratio of the total land site	17.5				
		6.3 Construction of Living Space for Plants	67.5	6.3.1 Construction of Biotope	16.88	Use of drought-resistant palaeovegetation in designing library buildings and cultivation of native plants in the green roof Applied greening method for artificial environment (Green rooftop and green wall) Linkage between the indoor library and ecological park	15 17.5 17.5				
7. Indoor Environment	320	7.1 Air Environment	142.5	7.1.1 Application of Products with Low-emission of Pollutants to Indoor Air	17.5	Utilized a variety of landscaping on site covered by asphalt for greening Strict application of standards for VOC (Volatile Organic Compounds) and usage of materials with low diffusion rate of VOC Usage of machines and filters with high efficiency for preventing emissions of pollutants	17.5 17.5				

Evaluation Area		Evaluation Items		Specific Evaluation Items		Evaluation Standard			
Content	Full Score	Content	Full Score	Content	Full Score	Content	Full Score		
8. Library Resources	415	8.1 Collection Management	65	7.1.2 Acquisition of Natural Air Ventilation	18.33	Construction of arch-shaped structure for good ventilation	17.5		
				Installation of automatic air circulation system	20				
				Adjustment of glass windows using computer control system	17.5				
				7.1.3 Performance of Ventilation for Unit Household	17.5	Installation of high-tech ventilation system	17.5		
				Influx of outside air through CO ₂ monitoring	17.5				
				Installation of heat recovery ventilation system in the ceiling (Air circulation system)	17.5				
				7.2 Sound Environment	17.5	7.2.1 Indoor Noise Level with Traffic Noise (Road and Railroad)	17.5	Determination of indoor noise level according to predicting and measuring methods with compliance to Standards for Measuring the Noise Level in Apartment Houses (Notification of Ministry of Land, Transport and Maritime Affairs) (Unit: dB(A))	17.5
				7.3 Light Environment	40	7.3.1 Acquisition Rate of Daylight	20	Construction of library buildings with a southern exposure	20
				Installed shade control system in the windows of library	20				
				7.4 Construction of Pleasant Indoor Environment	120	7.4.1 Construction of Resting and Refreshing Space	20	Construction of rest spaces for user resting and refreshment	20
				7.4.2 Construction of Clean Indoor Environment	20	Installed indoor air purification system to reduce CO ₂ and ozone emissions and disinfect the air	20		
				Compliance to no-smoking policy for environmental preservation	20				
				7.4.3 Pleasantness of Indoor Environment in Construction and Remodeling of Library Buildings	20	Perfect block of ventilation opening before completion and cleaning before opening the library	20		
				Ventilating before opening the library	20				
				Processes of bake-out	20				
8.1.1 Effective Preservation of Collection	15	Minimum preservation of the library collection	15						
8.1.2 Proper Disposal of Materials	17.5	Proper disposal of materials	17.5						
8.1.3 Active Use of Electronic Resources	16.25	Provision of library service by remote connection	17.5						
Natural resource saving in utilization of e-book	15								
8.2 Library Supplies	90	8.2.1 Eco-friendliness of Supplies Management	17.5	Isolation of chemicals and storage in ventilated room	17.5				
8.2.2 Electronic Equipment	17.5	Preservation of natural resource using RFID and NFC chips	17.5						
8.2.3 Use of Eco-friendly Fixtures	18.33	Use of certified green detergent and eco-friendly cleaner	17.5						
Use of recyclable fixtures	20								
Use of pencil made of recycled paper	17.5								
8.3 Resource Conservation	225	8.3.1 Introduction of Resource Conservation System and Development of Eco-friendly Management	15	Reduction of the total number of printers in library	15				
Introduction of copy management system based on internet network	15								
8.3.2 Recycling Paper Resources	17.5	Use of recycled paper	17.5						
Use of scrap paper and printing on both sides of paper	17.5								
8.3.3 Recycling Library Furniture	15	Reuse of shelves of the existing building	15						
Recycling of library furniture	15								
8.3.4 Recycling Content-containing Media	16.25	Sending used non-book materials to recycling company	17.5						
Recycling and donation of e-waste	15								
8.3.5 Recycling Library Consumables	16.25	Recycling of packaging materials	17.5						
Recycling of media consumables and recreation as a piece of art	15								

Evaluation Area		Evaluation Items		Specific Evaluation Items		Evaluation Standard					
Content	Full Score	Content	Full Score	Content	Full Score	Content	Full Score				
9. Eco-friendly Education Program and Campaign	230	9.1 Environmental Education for Users and the Public	110	8.3.6 Recycling Library Materials	15	Recycling waste books as supplies and fixtures for use in library or recreation as a piece of art	15				
				8.3.7 Resource Conservation by Library Cooperation	17.5	Distributed conservation by mutual cooperation	17.5				
				8.4 Use of Space	35	8.4.1 Use of Space	15	Minimization of resource use by interlibrary loan with other libraries	17.5		
				8.4.2 Effective Use of Total Space	20	8.4.1 Use of Space	15	Flexible use of library spaces using partition	15		
				9.1.1 Educational program for Eco-friendliness	16.25	9.1.1 Educational program for Eco-friendliness	16.25	8.4.2 Effective Use of Total Space	20	Effective space arrangement in consideration of user movement flow	20
								Performed eco-friendly education (lecture) for users	17.5	Provided educational program for eco-friendliness online	15
								Offered classes preparing for certificate of Green Eco Environmental Sharing	17.5	Operated environmental reading club	15
				9.1.2 Environmental Education with Library Tour and Provision of Materials	15	9.1.2 Environmental Education with Library Tour and Provision of Materials	15	9.1.1 Educational program for Eco-friendliness	16.25	Offered green library tour	15
								Arranged eco-friendly collections	15	Offered green library tour	15
								Ecological experience education at eco-experience center	15	Arranged eco-friendly collections	15
				9.1.3 Environmental Education with Ecological Experience Activities	15	9.1.3 Environmental Education with Ecological Experience Activities	15	9.1.2 Environmental Education with Library Tour and Provision of Materials	15	Offered green library tour	15
								Offered green library tour	15	Offered green library tour	15
								Arranged eco-friendly collections	15	Offered green library tour	15
				9.2 Green Culture Program	45	9.2 Green Culture Program	45	9.1.3 Environmental Education with Ecological Experience Activities	15	Ecological experience education at eco-experience center	15
								9.2.1 Promotional Program of Eco-friendly Products	15	Offered promotional program of eco-friendly products	15
9.2.2 Green Program in Cooperation with Local Communities	15	MOU with local Green Korea United	15								
9.3 Campaign	75	9.3 Campaign	75	9.2.1 Promotional Program of Eco-friendly Products	15	One Book – One Community program with focus on ‘sustainable environment’	15				
				9.2.2 Green Program in Cooperation with Local Communities	15	One Book – One Community program with focus on ‘sustainable environment’	15				
				9.3.1 Award	15	Awarded Year Award for obtaining high level of indicators such as environmental organizations	15				
				9.3.2 Operation of Green Market	15	Awards of GreenPrize for sustainable literature	15				
				9.3.3 Event for Environmental Day	15	Awards to libraries or librarians for achievement in establishing green libraries	15				
				9.3.1 Award	15	Awards of GreenPrize for sustainable literature	15				
10. Employees and Operations	75	10.1 Employees and Operations	75	9.3.2 Operation of Green Market	15	Operated green thrift book market	15				
				9.3.3 Event for Environmental Day	15	Operated green thrift book market	15				
				10.1.1 Structure of Eco-friendly Organization	15	Provided all kinds of eco-friendly events, programs, educations, and practices on ‘Environmental Day’	15				
				10.1.2 Eco-friendliness of Duties and Employees’ Activities	15	Provided all kinds of eco-friendly events, programs, educations, and practices on ‘Environmental Day’	15				
11. Computerization	112.5	11.1 Green Content	47.5	10.1.1 Structure of Eco-friendly Organization	15	Changed library organization to the structure based on star model	15				
				10.1.2 Eco-friendliness of Duties and Employees’ Activities	15	Changed library organization to the structure based on star model	15				
				11.1.1 Use of Web2.0 Tools	15	Performed employee education on the subject of eco-friendliness	15				
				11.1.2 OPAC Services	17.5	Preferred purchasing for books, academic journals, and newspapers using recycled paper	15				
		11.2 Eco-friendly Library Service	15	11.2 Eco-friendly Library Service	15	11.1.3 Provision of website with Rich Content	15	Purchasing from publishing company using soy ink or vegetable ink	15		
						11.2.1 Provision of e-materials	15	Purchasing from publishing company using soy ink or vegetable ink	15		
						11.3.1 Green IT Solution such as Search System	17.5	Recommended use of personal dish or equipment in employee meetings	15		
						11.3.2 Digitization of Printed Materials	15	Recommended use of personal dish or equipment in employee meetings	15		
11.3 Automation	50	11.3 Automation	50	11.1.1 Use of Web2.0 Tools	15	Provision of environmental contents using Web2.0 tools	15				
				11.1.2 OPAC Services	17.5	Use of OPAC	17.5				
				11.1.3 Provision of website with Rich Content	15	Provided website containing rich contents to users	15				
				11.2.1 Provision of e-materials	15	Provided website containing rich contents to users	15				
11.3.1 Green IT Solution such as Search System	17.5	11.3.1 Green IT Solution such as Search System	17.5	11.2.1 Provision of e-materials	15	Purchase rate of digital materials	15				
				11.2.1 Provision of e-materials	15	Purchase rate of digital materials	15				
11.3.2 Digitization of Printed Materials	15	11.3.2 Digitization of Printed Materials	15	11.3.1 Green IT Solution such as Search System	17.5	Establishment of ‘Automated Storage and Retrieval System (ASRS)’ in the stack room	17.5				
				11.3.1 Green IT Solution such as Search System	17.5	Establishment of ‘Automated Storage and Retrieval System (ASRS)’ in the stack room	17.5				
11.3.2 Digitization of Printed Materials	15	11.3.2 Digitization of Printed Materials	15	11.3.2 Digitization of Printed Materials	15	Development of a new system in searching books for users	17.5				
				11.3.2 Digitization of Printed Materials	15	Development of a new system in searching books for users	17.5				
11.3.2 Digitization of Printed Materials	15	11.3.2 Digitization of Printed Materials	15	11.3.2 Digitization of Printed Materials	15	Use of storage for printed materials according to digitization of printed material	15				
				11.3.2 Digitization of Printed Materials	15	Use of storage for printed materials according to digitization of printed material	15				

3.3 Step 2: Evaluation of the Level of Eco-Friendliness in Libraries

In the second step, trial evaluation was performed for actual libraries based on the developed and verified evaluation indicators in the first step.

First, currently certified green libraries were the subject of evaluation according to 11 evaluation areas, 30 evaluation items, and 127 evaluation indicators. While a total of 20 libraries were certified as green libraries in Korea, 13 libraries among the 20 green libraries participated in the evaluation. Thus the participation rate for the evaluation of green libraries was 65%.

Second, five evaluation grades were developed to grade each library based on the evaluation scores of green libraries: Certified, Silver, Gold, Platinum, and Diamond. Regarding the distribution of the participating libraries, the differences between grades was in increments of 10%.

Third, based on the evaluation indicators for green libraries, the levels for the target libraries were analyzed along various aspects, and calculations were performed to determine the ratio of each item to the full scores of green libraries and scores of each library specifying its level of eco-friendliness.

Fourth, based on the scores of green libraries, each library was graded and the result was announced. Each library was notified of its evaluation grade and awarded a certificate.

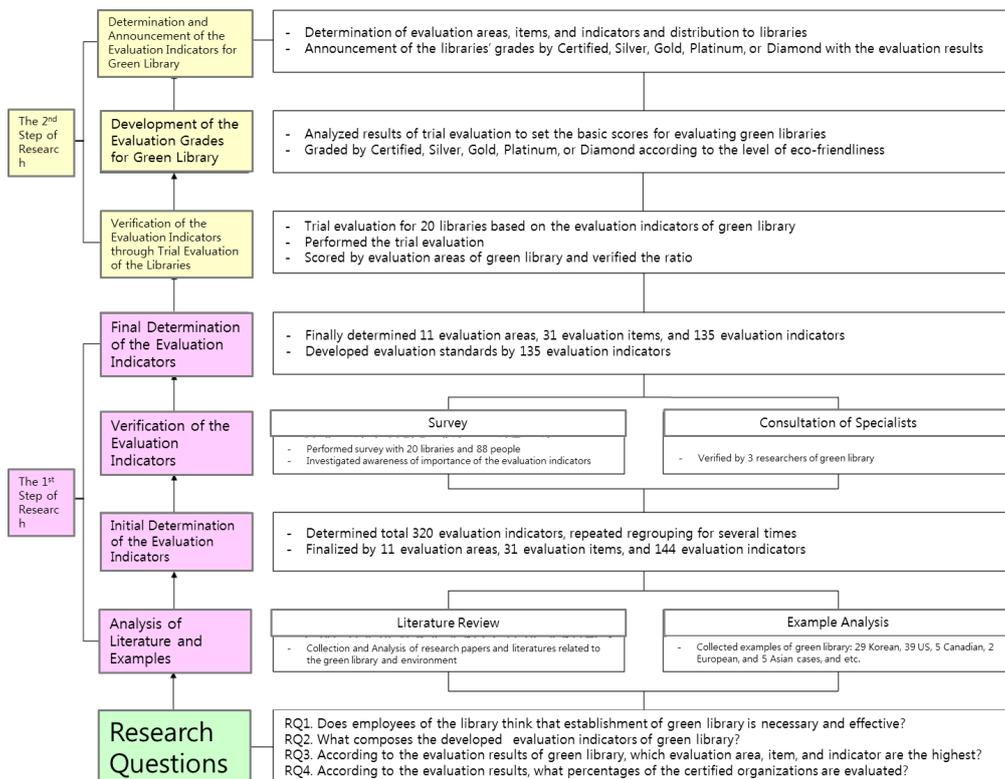


Fig. 1. Research Stages and Contents for Developing and Assessing Evaluation Indicators for Green Libraries

3.4 Distribution of Scores According to the Evaluation Areas and Ratio

Based on the results of the research above regarding the distribution of scores and the ratios of the items according to the categories the highest areas were in order of the energy and prevention of environmental pollution with 23.42%, library resources with 19.06%, and indoor environment with 14.70%. The ratio in distribution of scores was the lowest in the area of maintenance with 2.41%.

Furthermore, the existing architectural items of eco-friendly buildings constituted 61.77% with seven items and items that reflected more of the library features constituted 38.23% with four items. Of course, the items of architectural elements contained specific evaluation items that reflected the features of the library environment. All areas together scored 2,177.5.

Table 2. Items in the Category of Evaluation Indicators for Green Library and Distribution of Scores by Each Item

Category of Evaluation Indicators	Distribution of Scores	Ratio
1. Land Use and Traffic	95	4.36%
2. Energy and Prevention of Environmental Pollution	510	23.42%
3. Materials and Resources	125	5.74%
4. Water Circulation Management	140	6.43%
5. Maintenance	52.5	2.41%
6. Ecological Environment	102.5	4.71%
7. Indoor Environment	320	14.70%
8. Library Resources	415	19.06%
9. Eco-friendly Education Program and Campaign	230	10.56%
10. Employees and Operations	75	3.44%
11. Computerization	112.5	5.17%
Sum	2,177.5	100%

4. Results

4.1 Evaluation of All Items for Level of Eco-Friendliness in Libraries

To evaluate the level of eco-friendliness in the libraries, 11 areas were categorized for evaluation and the averages were calculated. Based on the full scores, the areas with highest scores of eco-friendliness were, in order: energy and prevention of environmental pollution with 510, library resources with 415, and the indoor environment with 320. In evaluating the level of eco-friendliness, the greenest areas were in order: library resources with a score of 176.92, energy and prevention of environmental pollution with a score of 172.69, and the indoor environment with a score of 150.88; the least green area was employees and operations with 16.38.

Additionally, the biggest gap with the full score was observed in the area of the eco-friendly education program and campaign by approximately 7 times, and the smallest gap was measured as approximately 1.5 times.

In addition, regarding the scores by the libraries, the highest scores of the libraries were 179.77 for A10 library, 120.57 for A08 library, and 97.09 for A02 library; the lowest score was 28.82 for A09 library, registering an approximately 6 times difference in comparison to the highest score.

Table 3. Level of Eco-friendliness in Evaluated Libraries

Evaluation Area	Full Score	A01	A02	A03	A04	A05	A06	A07	A08	A09	A10	A11	A12	A13	Sum	Mean	Std.
1. Land Use and Traffic	95	44	60	40	55.5	95	87.5	63	72.5	37.5	74	95	77	52	853	65.62	19.776
2. Energy and Prevention of Environmental Pollution	510	85.25	271	184.75	83.5	59.25	176	62.5	317.75	82.5	489	169	163.5	101	2245	172.69	124.130
3. Materials and Resources	125	15	83	3	23.5	38.5	21	18	69.5	15	97.5	38.5	25.5	25	473	36.38	28.913
4. Water Circulation Management	140	101.5	94.5	24.5	17.5	21	52.5	17.5	98	3.5	140	24.5	94.5	98	787.5	60.58	44.990
5. Maintenance	52.5	10.5	28	10.5	14	0	21	10.5	38.5	7	52.5	17.5	21	14	245	18.85	14.039
6. Ecological Environment	102.5	17.5	42	3.5	21	20	10.5	10.5	44	10.5	85	10.5	34.5	16.5	326	25.08	22.009
7. Indoor Environment	320	115	167	132	97.5	112	146	104.5	243.5	97.5	320	137.5	142	147	1961.5	150.88	63.733
8. Library Resources	415	82.5	214	107	162	159	259	218	271.5	54	365	165	154	89	2300	176.92	87.547
9. Eco-friendly Education Program and Campaign	230	3	22.5	15	0	24	19.5	21.5	76.5	0	215	9	24	6	436	33.54	57.956
10. Employees and Operations	75	0	36	0	12	9	45	9	27	3	45	3	6	18	213	16.38	16.505
11. Computerization	112.5	0	50	59	17.5	17.5	85.5	17.5	67.5	17.5	94.5	23.5	47	47	544	41.85	29.167
Sum	2177.50	474.25	1068.00	579.25	504.00	555.25	923.50	552.50	1326.25	328.00	1977.50	693.00	789.00	613.50	10384.00		
Mean	197.95	43.114	97.091	52.659	45.818	50.477	83.955	50.227	120.568	29.818	179.773	63.000	71.727	55.773	944.000		

4.2 Evaluation of the Level of Eco-friendliness by Evaluation Items

The evaluation areas that were defined by 11 items contained 1-4 evaluation items for each area. The levels of eco-friendliness in each were summed, averaged, and compared with the full scores of each evaluation item to calculate the ratio of the average of each evaluation item to the full scores. As a result, first, those scoring the highest ratio of average scores to the full score in the area of land use and traffic were determined to be reduction of traffic load, which scored 81.53%, ecological value, which scored 49.26%, and effect of adjacent land, which scored 46.17%.

Second, the area of energy and prevention of environmental pollution showed the lowest ratio of average scores to the full score. In this area, the highest ratio of average scores was obtained by energy conservation, which scored 37.40%.

Third, in the area of materials and resources, the highest ratio of average scores among the evaluation items was 70.80%, but utilization of sustainable resources scored considerably lower with 23.43%.

Fourth, in the area of water circulation management, establishment of water circulation system scored 52.30% and water resource conservation scored 37.85%.

Fifth, the area of maintenance also scored lower; effective building management scored around 40% but systematic field management scored much lower with 27.71%.

Sixth, the area of ecological environment scored on average around 25%; scoring the highest was construction of green areas in the land site with 35.37% and lowest construction of living space for plants with 21.60%.

Seventh, the area of indoor environment showed a much higher level than other areas; in particular, light environment scored 60.00% and construction of pleasant indoor environment scored 62.57% respectively.

Eighth, the area of library resources scored similarly with 61.54% in the use of space, 54.91% in library supplies, and 51.66% in collection management

Ninth, the area of eco-friendly education program and campaign scored the lowest among the 11 areas; all evaluation items scored more than or around 10% as compared to the full scores. In particular, green cultural programs scored the lowest among all of the evaluation items with 10.27%.

Tenth, the area of employees and operations included one evaluation item with a score of 21.84%.

Eleventh, in the computerization area, green content scored the highest with 39.12%, followed in order by automation, which scored 38.70%, and eco-friendly library service, which scored 26.13%.

Among 31 evaluation items, the highest ratio of average scores to the full scores was obtained by the item of reduction of traffic load which scored 81.53% against the full scores. This item scored substantially higher than items such as building a bicycle shed, shortening the distance to the public transportation facilities, and constructing libraries near residential areas. On the other hand, among 31 evaluation items, the lowest ratio of average scores to the full scores was obtained by the item of green cultural programs which scored 10.27%, implying that this was the least green area of domestic libraries. In other words, promotional programs for eco-friendly products were largely unknown and local organizations such as Green Korea United rarely cooperated.

According to the evaluation results, most of the areas had significant differences from green libraries, leading to the conclusion that the individual libraries should increase the level of eco-friendliness with a focus on the evaluated areas in which the lowest scores were received.

Table 4. Level of Eco-friendliness in Libraries by Evaluation Items

Evaluation Area	Evaluation Items	Sum	Mean	Std.	Full Score	Ratio of average scores to the full scores
1. Land Use and Traffic	1.1 Ecological Value	112	8.62	7.906	17.5	49.26
	1.2 Effect of Adjacent Land	105	8.08	8.256	17.5	46.17
	1.3 Reduction of Traffic Load	636	48.92	0.693	60	81.53
2. Energy and Prevention of Environmental Pollution	2.1 Energy Conservation	1835.5	141.19	1.899	377.5	37.40
	2.2 Use of Sustainable Energy Sources	251	19.31	1.703	82.5	23.41
	2.3 Prevention of Global Warming	158.5	12.19	0.590	50	24.38

Evaluation Area	Evaluation Items	Sum	Mean	Std.	Full Score	Ratio of average scores to the full scores
3. Materials and Resources	3.1 Resource Conservation	138	10.62	6.076	15	70.80
	3.2 Utilization of Sustainable Resources	335	25.77	2.011	110	23.43
4. Water Circulation Management	4.1 Establishment of Water Circulation System	357	27.46	0.420	52.5	52.30
	4.2 Water Conservation	430.5	33.12	0.593	87.5	37.85
5. Maintenance	5.1 Systematical Field Management	63	4.85	6.476	17.5	27.71
	5.2 Effective Building Management	182	14.00	1.667	35	40.00
6. Ecological Environment	6.1 Construction of Green Area in the Land Site	80.5	6.19	5.743	17.5	35.37
	6.2 Acquiring Ecological Functions of Outside Area and Building Envelope	56	4.31	5.182	17.5	24.63
	6.3 Construction of Living Space for Plants	189.5	14.58	1.723	67.5	21.60
7. Indoor Environment	7.1 Air Environment	586	45.08	1.484	142.5	31.64
	7.2 Sound Environment	87.5	6.73	7.886	17.5	38.46
	7.3 Light Environment	312	24.00	0.288	40	60.00
	7.4 Construction of Pleasant Indoor Environment	976	75.08	2.039	120	62.57
8. Library Resources	8.1 Collection Management	436.5	33.58	1.551	65	51.66
	8.2 Library Supplies	642.5	49.42	1.530	90	54.91
	8.3 Resource Saving	941	72.38	1.320	225	32.17
	8.4 Use of Space	280	21.54	0.760	35	61.54
9. Eco-friendly Education Program and Campaign	9.1 Environmental Education for Users and the Public	238	18.31	0.629	110	16.65
	9.2 Green Culture Program	60	4.62	1.695	45	10.27
	9.3 Campaign	138	10.62	1.297	75	14.16
10. Employees and Operations	10.1 Employees and Operations	213	16.38	1.601	75	21.84
11. Computerization	11.1 Green Content	241.5	18.58	2.144	47.5	39.12
	11.2 Eco-friendly Library Service	51	3.92	4.481	15	26.13
	11.3 Automation	251.5	19.35	3.190	50	38.70

4.3 Evaluation of the Level of Eco-friendliness by Specific Evaluation Items and Indicators

4.3.1 Land Use and Traffic

In evaluating the level of eco-friendliness in the area of land use and traffic, a total of five items were identified. As a result, the highest averages were scored 18.15 for facilities for reducing the traffic, 15.69 for the distance between the city center and a library, and 15.0 for the proximity to public transportation.

In comparison with the full scores, the biggest difference was observed in the validity of measures for preventing violation of a right to sunlight by approximately 2.2 times, and the smallest difference was observed in the facilities for reducing traffic by approximately 1.1 times.

Table 5. Level of eco-friendliness by Specific Evaluation Items in the Area of Land Use and Traffic

Evaluation Area	Specific Evaluation Items	Sum	Mean	Std.	Full Score
1. Land Use and Traffic	1.1.1 Ecological Value of Existing Land	112	8.62	7.906	17.5
	1.2.1 Validity of Measures for Preventing Violation of a Right to Sunlight	105	8.08	8.256	17.5
	1.3.1 Proximity to the Public Transportation	196	15.08	5.693	20
	1.3.2 Facilities for Reducing the Traffic	236	18.15	5.565	20
	1.3.3 Distance between the City Center and a Library	204	15.69	6.824	20

4.3.2 Energy and Prevention of Environmental Pollution

When the level of eco-friendliness in the area of energy and prevention of environmental pollution was evaluated by a total of nine items, the highest averages were scored for the use of artificial lighting with high energy efficiency, followed by increased efficiency of the cooling/heating system, and facilities for reducing heat island effect. The lowest average was for facilities controlled by sensors.

In comparing the full scores, the greatest difference was shown in facilities controlled by sensors by approximately 5.1 times, and the least difference was shown in increased efficiency of cooling/heating system by two times.

Table 6. Level of Eco-friendliness by Specific Evaluation Items in the Area of Energy and Prevention of Environmental Pollution

Evaluation Area	Specific Evaluation Items	Sum	Mean	Std.	Full Score
2. Energy and Prevention of Environmental Pollution	2.1.1 Facilities Controlled by Sensors	133	3.41	0.535	17.5
	2.1.2 High-efficiency Air Conditioning/Heating Facilities and System	640	7.03	3.088	19.64
	2.1.3 Increased Efficiency of Cooling/Heating with Work for Eco-friendliness	115.5	8.88	8.284	17.5
	2.1.4 Facilities for Reducing Heat Island Effect	217	8.35	1.221	17.5
	2.1.5 Utilization of Natural Light for Library Lighting	296	7.59	0.881	20
	2.1.6 Use of Artificial lighting with high energy efficiency	252	9.69	1.005	20
	2.1.7 Energy Conservation for Landscape Management with Installation of Irrigation Facilities	182	7.00	0.252	17.5
	2.2.1 Use of New & Renewable Energy	251	3.86	1.703	16.5
	2.3.1 Reduced Emission of CO ₂	158.5	4.06	0.590	16.67
	Sum	2245	6.65	2.520	

4.3.3 Materials and Resources

The level of eco-friendliness in the area of materials and resources was evaluated by six items. The highest averages were scored for conservation of consumer goods in bathrooms, separate collection of recyclable resources, and using certified eco-friendly products for effective resource recycling. The lowest average was for indoor library facilities, showing more than 7 times the difference in comparison to the highest average score.

In comparison with the full scores, the greatest difference was shown in indoor library facilities by approximately 11 times, and the least difference was shown in conservation of consumer goods in bathrooms by approximately 1.4 times.

Table 7. Level of Eco-friendliness by Specific Evaluation Items in the Area of Materials and Resources

Evaluation Area	Specific Evaluation Items	Sum	Mean	Std.	Full Score
3. Materials and Resources	3.1.1 Conservation of Consumer Goods in Bathroom	138	10.62	6.076	15
	3.2.1 Usage of Certified Eco-friendly Products for Effective Resource Recycling	56	4.31	6.253	17.5
	3.2.2 Sustainable Construction Materials	57	2.19	0.030	15
	3.2.3 Separate Collection of Recyclable Resource	165	6.35	3.735	16.25
	3.2.4 Indoor Library Facilities	18	1.38	3.380	15
	3.2.5 Display of CO ₂ Emissions of Material	39	3.00	5.874	15
	Sum	473	4.64	2.401	

4.3.4 Water Circulation Management

When the level of eco-friendliness in the area of water circulation management was evaluated using four items, the highest averages were scored 9.15 for validity of measures for reducing rainwater load, 7.27 for using rainwater, and 6.73 for validity of measures for reducing water for daily life.

In comparison to the full scores, the greatest difference was shown in installation of water reuse systems by 3.8 times and the least difference was shown in the validity of measures for reducing rainwater load by 1.9 times.

Table 8. Level of Eco-Friendliness by Specific Evaluation Items in the Area of Water Circulation Management

Evaluation Area	Specific Evaluation Items	Sum	Mean	Std.	Full Score
4. Water Circulation Management	4.1.1 Validity of Measures for Reducing Rainwater Load	357	9.15	0.420	17.5
	4.2.1 Validity of Measures for reducing water use	87.5	6.73	7.350	17.5
	4.2.2 Usage of Rainwater	283.5	7.27	0.460	17.5
	4.2.3 Installation of Water Reuse system	59.5	4.58	6.760	17.5
	Sum	787.5	6.93	3.827	

4.3.5 Maintenance

The level of eco-friendliness in the area of maintenance was evaluated by three items. The averages were scored 7.54 for validity of management documents for operation/maintenance and guidelines, 6.46 for performance of TAB and commissioning, and 4.85 for rationality of a field management plan in consideration of the environment.

In comparison with the full scores, the greatest difference was shown in rationality of a field management plan in consideration of the environment by 3.6 times, and the least difference was shown in the validity of management documents for operation/maintenance and guidelines by 2.3 times.

Table 9. Level of eco-friendliness by Specific Evaluation Items in the Area of Maintenance

Evaluation Area	Specific Evaluation Items	Sum	Mean	Std.	Full Score
5. Maintenance	5.1.1 Rationality of Field Management Plan in Consideration of Environment	63	4.85	6.476	17.5
	5.2.1 Validity of Management Documents for Operation/Maintenance and Guidelines	98	7.54	5.317	17.5
	5.2.2 Performance of TAB and Commissioning	84	6.46	7.674	17.5
	Sum	245	6.28	1.179	

4.3.6 Ecological Environment

The level of eco-friendliness in the area of ecological environment was evaluated by three items. The highest averages were scored at 6.19 for green area ratio of natural ground, 4.31 for ecological area ratio, and 3.64 for construction of biotopes.

In comparison with the full scores, the greatest difference was shown in construction of biotopes by 4.6 times, and the least difference was shown in green area ratio of natural ground by 2.8 times.

Table 10. Level of eco-friendliness by Specific Evaluation Items in the Area of Ecological Environment

Evaluation Area	Specific Evaluation Items	Sum	Mean	Std.	Full Score
6. Ecological Environment	6.1.1 Green Area Ratio of Natural Ground	80.5	6.19	5.743	17.5
	6.2.1 Ecological Area Ratio	56	4.31	5.182	17.5
	6.3.1 Construction of Biotope	189.5	3.64	2.068	16.88
	Sum	326	4.71	1.980	

4.3.7 Indoor Environment

The level of eco-friendliness in the area of indoor environment was evaluated by eight items. The highest averages were scored for construction of restful and refreshing spaces, pleasantness of indoor environment in construction and remodeling of library buildings, and daylight acquisition rate. The lowest average was scored for application of products with low-emission of pollutants to indoor air, showing approximately 4 times the difference in comparison to the highest average score.

In comparison with the full scores, the greatest difference was shown in the application of products with low-emission of pollutants to indoor air by 4.2 times, and the least difference was shown in the construction of restful and refreshing space by 1.2 times.

Table II. Level of eco-friendliness by Specific Evaluation Items in the Area of Indoor Environment

Evaluation Area	Specific Evaluation Items	Sum	Mean	Std.	Full Score
7. Indoor Environment	7.1.1 Application of Products with Low-emission of Pollutants to Indoor Air	108.5	4.17	0.780	17.5
	7.1.2 Acquisition of Natural Air Ventilation	250	6.41	2.391	18.33
	7.1.3 Performance of Ventilation for Unit Household	227.5	5.83	0.703	17.5
	7.2.1 Indoor Noise Level with Traffic Noise (Road and Railroad)	87.5	6.73	7.886	17.5
	7.3.1 Daylight Acquisition Rate	312	12.00	0.288	20
	7.4.1 Construction of Restful and Refreshing Space	212	16.31	4.151	20
	7.4.2 Construction of Clean Indoor Environment	264	10.15	1.191	20
	7.4.3 Pleasantness of Indoor Environment in Construction and Remodeling of Library Buildings	500	12.82	1.056	20
	Sum	1961.5	9.30	2.573	

4.3.8 Library Resources

When the level of eco-friendliness in the area of library resources was evaluated by 15 items, the highest averages were scored for effective use of total space, electronic equipment, and use of eco-friendly fixtures. The lowest average was scored for recycling library materials, showing approximately 7 times of difference in comparison to the highest average score.

In comparison with the full scores, the greatest difference was shown in recycling library materials by 6.2 times, and the least difference was shown in effective use of total space by approximately 1.2 times.

Table 12. Level of eco-friendliness by Specific Evaluation Items in the Area of Library Resources

Evaluation Area	Specific Evaluation Items	Sum	Mean	Std.	Full Score
8. Library Resources	8.1.1 Effective Preservation of Collection	117	9.00	5.050	15
	8.1.2 Proper Disposal of Materials	63	4.85	5.257	17.5
	8.1.3 Active Use of Electronic Resources	256.5	9.87	1.232	16.25
	8.2.1 Eco-friendliness of Supplies Management	122.5	9.42	9.080	17.5
	8.2.2 Electronic Equipment	133	10.23	6.619	17.5
	8.2.3 Use of Eco-friendly Fixtures	387	9.92	0.733	18.33
	8.3.1 Introduction of Resource Saving System and Development of Eco-friendly Management	117	4.50	2.553	15
	8.3.2 Recycling Paper Resources	189	7.27	0.268	17.5
	8.3.3 Recycling Library Furniture	105	4.04	1.547	15
	8.3.4 Recycling Content-containing Media	142.5	5.48	0.896	16.25
	8.3.5 Recycling Library Consumables	132	5.08	0.960	16.25
	8.3.6 Recycling Library Materials	63	2.42	0.472	15
	8.3.7 Resource Conservation by Library Cooperation	192.5	7.40	0.240	17.5
	8.4.1 Use of Space	60	4.62	6.436	15
	8.4.2 Effective Use of Total Space	220	16.92	7.511	20
		Sum	2300	7.40	3.061

4.3.9 Eco-friendly Education Programs and Campaigns

The level of eco-friendliness in the area of eco-friendly education programs and campaigns was evaluated by eight items. The highest averages were scored for environmental education with library tours and providing materials, educational programs for eco-friendliness, and awards. The lowest average was scored for promotional programs of eco-friendly products, showing approximately a 4 times of difference in comparison to the highest average score.

In comparison with the full scores, the greatest difference was shown in promotional programs of eco-friendly products by 16.3 times, and the least difference was shown in environmental education with library tours and providing materials by 4.3 times. This area showed the greatest gap in the averages in comparison to the full scores among other evaluation areas for greening.

Table 13. Level of eco-friendliness by Specific Evaluation Items in the Area of Eco-friendly Education Program and Campaign

Evaluation Area	Specific Evaluation Items	Sum	Mean	Std.	Full Score	
9. Eco-friendly Education Program and Campaign	9.1.1 Educational program for Eco-friendliness	133	2.56	0.627	16.25	
	9.1.2 Environmental Education with Library Tour and Provision of Materials	90	3.46	0.635	15	
	9.1.3 Environmental Education with Ecological Experience Activities	15	1.15	4.160	15	
	9.2.1 Promotional Program of Eco-friendly Products	12	0.92	2.253	15	
	9.2.2 Green Program in Cooperation with Local Communities	48	1.85	1.032	15	
	9.3.1 Awards	90	2.31	1.218	15	
	9.3.2 Operation of Green Market	27	2.08	4.132	15	
	9.3.3 Event for Environmental Day	21	1.62	3.380	15	
		Sum	436	1.99	1.522	

4.3.10 Employees and Operations

The level of eco-friendliness in the area of employees and operations was evaluated by two items. In comparison to the full score of 15 points, the eco-friendliness of duties and employees' activities showed 4.3 times difference with a 3.23 score, and the structure of eco-friendly organizations showed 4.6 times difference with a 3.46 score.

Table 14. Level of eco-friendliness by Specific Evaluation Items in the Area of Employees and Operations

Evaluation Area	Specific Evaluation Items	Sum	Mean	Std.	Full Score
10. Employees and Operations	10.1.1 Structure of Eco-friendly Organization	45	3.46	6.578	15
	10.1.2 Eco-friendliness of Duties and Employees' Activities	168	3.23	1.341	15
	Sum	213	3.35	3.703	

4.3.11 Computerization

The level of eco-friendliness in the area of computerization was evaluated by six items, with the highest averages being scored for using OPAC service, green IT solutions such as search systems, and providing websites with rich content. The lowest average was scored for using Web 2.0 tools, showing more than 10 times difference in comparison to the highest average score.

In comparison to the full scores, the greatest difference was shown in using Web 2.0 tools by 13 times, and the least difference was shown in using OPAC services by approximately 1.4 times. Regarding the OPAC services, it was expected that all libraries would obtain full scores, but actually few libraries even owned their websites.

Table 15. Level of eco-friendliness by Specific Evaluation Items in the Area of Computerization

Evaluation Area	Specific Evaluation Items	Sum	Mean	Std.	Full Score
11. Computerization	11.1.1 Use of Web 2.0 Tool	15	1.15	4.160	15
	11.1.2 OPAC Service	157.5	12.12	8.407	17.5
	11.1.3 Provision of website with Rich Content	69	5.31	5.765	15
	11.2.1 Provision of e-materials	51	3.92	4.481	15
	11.3.1 Green IT Solution such as Search System	227.5	8.75	0.000	17.5
	11.3.2 Digitization of Printed Materials	24	1.85	2.882	15
	Sum	544	5.52	2.813	

4.4 Level of eco-friendliness and the Evaluation Result

This study aimed to measure the level of eco-friendliness in libraries, and grade libraries based on actual data. USGBC (U.S. Green Building Council, 2014) developed an evaluation system for certifying eco-friendly buildings (LEED; Leadership in Energy and Environmental Design, Green

Building Rating System) in 2000. It was composed of 6 categories and 34 specific items to apply the green building rating system in evaluating the libraries in the US according to the level of eco-friendliness. The basic evaluation score was a total of 69 points, ranked by the level of eco-friendliness: 26 points for Certified, 33 points for Silver, 39 points for Gold, and over 52 points for Platinum. This study determined the libraries' levels of evaluation by 5 grades, and the scores were rated by over 60 % for Diamond, 50%-60% for Platinum, 40% - 50% for Gold, 30% - 40% for Silver, 20% -30% for Certified, and less than 20% for Non-certified. The score ranges according to the grades and the evaluation results of the libraries were as follows:

Table 16. Score Ranges According to the Grades and the Grade of Each Library

Grade	Evaluation and distribution	Libraries	Ratio
Diamond	More than 60 %	A10, A08	15.39%
Platinum	More than 50% -Less than 60%	-	0%
Gold	More than 40% -Less than 50%	A02, A06	15.39%
Silver	More than 30% -Less than 40%	A11, A12	15.39%
Certified	More than 20% -Less than 30%	A01, A03, A04, A05, A07, A13	38.46%
Non-certified	Less than 20%	A09	7.7%

5. Conclusion & Future Research

5.1 Conclusion

5.1.1 Development Study for Evaluation Indicators

In the past, the world accomplished rapid industrial growth to comprehensively improve the quality of human life. However, the natural environment, which establishes the foundation of human life, has been almost as quickly destroyed. Recently growth has been curtailed due to the great expense incurred from damage to the environment.

As a result, discussions of sustainable development began in various fields of society with a concentration of efforts to identify ways to conserve the environment and develop the economy in a more balanced way. The term "green growth" became important through a series of conscious and practical developments. It started with a critical look at environmental problems and progressed to seeking ways to encourage sustainable development, taking a greater interest in improving the quality of life, and promoting an exploration of a green society. Green growth supported eco-efficient policies for economic growth which would cause the least damage to the environment while still improving the economy.

Libraries, too, should pursue these same goals. Accordingly, libraries should achieve their goal to provide information to users in an eco-friendly way. However, the knowledge of how to best act as eco-friendly libraries needed to be identified in a systematic manner. Therefore, this study aimed to develop and propose specific evaluation items and evaluation indicators for eco-friendly

libraries to suggest directions for development and growth. Up to now, the indicators for certifying green libraries were applied by evaluation items according to the types of commercial buildings and other institutional buildings, not reflecting the features of libraries but only general architectural aspects. To certify as green libraries, a variety of aspects should be considered, such as materials, services, and library interior. In reviewing the literature, eco-friendly green libraries were certified in the US, the UK, Canada, and in Korea as well, but as stated above, the basis concentrated on the physical standards only. Thus, examples of green movement libraries were collected from all around the world to find the green factors of libraries and to develop the evaluation indicators accordingly. To do so, a survey was conducted of employees of libraries with regard to specific evaluation items as determined to examine and recognize the importance of other criteria and to propose that these evaluation indicators be used to certify green libraries.

Based on the research questions, the evaluation results that were found in this study were discussed as follows: First, regarding the question of “Do employees of the library think that establishment of green libraries is necessary?”, the employees of the libraries responded yes by 65.52%, with only 4.6% responding that it would not be necessary; the average was significantly high with a result of 3.793. Regarding the effect of the establishment of green libraries, 68.97% responded that it would be helpful, and only 4.6% responded that it would have no effect; in particular, they indicated that the effect would enhance the best use of energy resources and save energy with a proper indoor environment (design).

Second, regarding the need for developing specific evaluation items for green libraries based on the libraries’ characteristics, 60% responded yes, and 54.03% were not aware that the certification of green libraries was being done by using the same standards as those for commercial and other institutional buildings; thus, 40.23% responded that certification organization for green libraries, based on the libraries’ characteristics, was necessary, and it should be performed by the G-SEED organization. However, 29.89% thought that cooperation between the certification organization and the G-SEED organization would be effective; the latter method could be better for improving the status of green libraries.

Third, the most important evaluation areas of green libraries, according to the opinions of the libraries’ employees, were ranked in order: the indoor environment, energy and prevention of environmental pollution, and materials and resources areas. As the subjects of the survey were the employees of the libraries, it was expected that they would give relatively high scores for eco-friendliness to the use of resources and to the duties and operations of the libraries, but they actually considered other factors as having more significance. Furthermore, the area of computerization scored relatively lower than other areas, indicating little consensus for eco-friendliness in computerization. It implied the need for education for this aspect of green libraries.

5.1.2 Evaluation Results for Green Libraries

This study aimed at 20 libraries in Korea that were currently certified as green libraries based solely on their architectural aspects. It evaluated the libraries using the evaluation indicators developed in this study to grade the levels of these factors in the libraries. The results were as follows:

First, 11 areas were determined to evaluate the level of eco-friendliness in the libraries; the highest averages were scored for the area of energy and prevention of environmental pollution (510), library resources (415), and indoor environment (320).

Second, according to the specific evaluation items in the area of land use and traffic, the highest averages for eco-friendliness were scored for facilities for the reduction of traffic (18.15), distance between the city center and a library (15.69), and proximity to public transportation (15.0). In comparison to the full score, the item of building a bicycle shed was the closest to the full score.

Third, the level of eco-friendliness in the area of energy and prevention of environmental pollution was evaluated by a total of nine items, and the highest averages were scored 9.69 for using artificial lighting with high energy efficiency, 8.88 for increased efficiency of cooling/heating systems, and 8.35 for facilities for reducing the heat island effect. In comparison to the full score, the item of increased efficiency of cooling/heating systems was the closest to the full score.

Fourth, the level of eco-friendliness in the area of materials and resources was evaluated by six items, and the highest averages were scored for conserving consumer goods in bathrooms (10.62), separate collection of recyclable resources (6.35), and using certified eco-friendly products for effective resource recycling (4.31).

Fifth, the level of eco-friendliness in the area of water circulation management was evaluated by four items, and the highest averages were scored for validity of measures for reducing rainwater load (9.15), using rainwater (7.27), and validity of measures for reducing water for daily life (6.73). In comparison to the full score, the item of validity of measures for reducing rainwater load was the closest to the full score.

Sixth, the level of eco-friendliness in the area of maintenance was evaluated by three items, and the highest averages were scored for validity of management documents for operation/maintenance and guidelines (7.54), performance of TAB commissioning (6.46), and rationality of the field management plan in consideration of the environment (4.85). In comparison to the full score, the item of validity of management documents for operation/maintenance and guidelines was the closest to the full score.

Seventh, the level of eco-friendliness in the area of ecological environment was evaluated by three items, and the highest averages were scored for green area ratio of natural ground (6.19), ecological area ratio (4.31), and construction of biotopes (3.64). In comparison to the full score, the item of green area ratio of natural ground was the closest to the full score.

Eighth, the level of eco-friendliness in the area of indoor environment was evaluated by eight items, and the highest averages were scored for construction of restful and refreshing space (16.31), pleasantness of indoor environment in construction and remodeling of library buildings (12.82), and acquisition rate of daylight (12.00). In comparison to the full score, the item of construction of restful and refreshing space was the closest to the full score.

Ninth, the level of eco-friendliness in the area of library resources was evaluated by 15 items; the highest averages were scored for effective use of total space (16.92), electronic equipment (10.23), and use of eco-friendly fixtures (9.92). In comparison to the full score, the item of effective use of total space was the closest to the full score.

Tenth, the level of eco-friendliness in the area of eco-friendly education programs and campaigns

was evaluated by eight items, and the highest averages were scored for environmental education with library tour and provision of materials (3.46), educational programs on eco-friendliness (2.56), and awards (2.31). In comparison to the full score, the item of environmental education with library tours and the provision of materials was the closest to the full score.

Eleventh, the level of eco-friendliness in the area of employees and operations was evaluated by two items; in comparison to the full score of 15 points, the eco-friendliness of duties and employee activities showed 4.3 times the difference with a score of 3.23, and the structure of eco-friendly organization showed 4.6 times the difference with a score of 3.46.

Twelfth, the level of eco-friendliness in the area of computerization was evaluated by six items, and the highest averages were scored for using OPAC service (12.12), green IT solutions such as a search systems (8.75), and providing a website with rich content (5.31). In comparison to the full score, the item of using OPAC service was the closest.

Last, the libraries were graded based on actual data according to the results to measure the level of eco-friendliness, two libraries were graded as Diamond, the highest grade, accounting for 15.39% of all libraries; Gold and Silver grades accounted for another 15.39%, together five Certified graded libraries accounted for 38.46%, which was the highest rate among the libraries. Any library scoring less than 20% when compared to the full score was graded as Non-certified, and one library, which scored 15.06% fell into this category.

This study assessed the certified libraries as green libraries in compliance with the current standards of construction and examined the differences in comparison to the evaluation standards for green libraries when other characteristics of the libraries were taken into consideration. As a result, one library was found to be non-certified.

5.2 Future Research

The results of this study set up to serve as basic data for the direction of development for green libraries in our country, as well as a reference for the employees of libraries in constructing or remodeling library buildings, establishing service infrastructure, providing information service, and planning library duties in an eco-friendly way. Furthermore, while recently a number of libraries were eco-friendly certified, the previous evaluations only reflected the architectural aspects without taking into consideration the other characteristics of the libraries. The evaluation indicators for eco-friendly green libraries that were developed in this study based on the features of libraries should evaluate the eco-friendliness of the libraries with more accuracy.

However, the weighted values for the evaluation indicators or specific evaluation guidelines according to each evaluation indicator have not been developed yet. Therefore, first, a future study should assign weighted values to the 135 evaluation indicators that scored more than three points. Also, specific guidelines for scoring according to each item of the evaluation indicators must be developed.

Second, after completion of the evaluation indicators, weighted values according to the evaluation indicators, and the evaluation guidelines, future studies should actually evaluate libraries. In actually evaluating libraries, new problems may be found, and the evaluation indicators should be modified and supplemented accordingly. A national approach would be more effective to evaluate the level

of eco-friendliness of the libraries in our country with more accuracy.

Third, this research was a basic study performed through personal research using the results of several years. Therefore, a future study should be performed on a national level with a wider scope. In other words, the evaluation indicators for green libraries should be developed on a national level.

Fourth, as this study was performed on a personal level, covering the libraries in the entire country was not practical. Thus, all of the libraries nationwide should be evaluated based on the evaluation indicators for green libraries that were developed on a national level.

Fifth, the libraries in this study scored relatively low in grading, but the number of subjects were small in the evaluation. In the US, Certified received grades of 37.68%; Silver scored 48.83%; Gold scored 56.52%; and Platinum scored 75.36%. If the distribution of the libraries were nationwide in Korea, the results would be different. Therefore, the scope of research should be expanded and the grades of evaluation should then be upgraded.

This study developed evaluation indicators for green libraries in reflection of the features of the libraries for the first time. During the time that critical environmental problems such as global warming were on the rise, examples of constructing eco-friendly green libraries have been found more often in the library field. While, certification of green libraries was performed to measure the level of eco-friendliness of the libraries, the standards were concerned only with the architectural aspects, so that resources inside and outside of the libraries, library programs, eco-friendliness of library organization and employees, etc. could not be evaluated. With this in mind, this study sought to develop evaluation indicators for green libraries reflecting those characteristics. It is expected that researchers in the future will add more ideas to develop advanced evaluation indicators to refine and enhance green libraries going forward.

The evaluation indicators for green libraries should be the guidelines for government and library employees for directing the construction of green libraries.

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