

A Comparative Study on Office Building Criteria between G-SEED and LEED

Mok, Seon-Soo*

Cho, Dong-Woo**

Park, Ah-Reum***

Abstract

G-SEED aims for establishing green environmental building with energy saving and has started for evaluating with multi-residential complex in 2002 by the Ministry of Land, Infrastructure & Transport (MOLIT) and the Ministry of Environment to develop the current 10 building types and new & existing building types to be applied. Since G-SEED has been developed for more than 10 years, the strategy of globalization is needed with constant review itself and comparison between other assessments to understand current situation from the global perspectives.

This study draws similarities and differences of G-SEED and LEED criteria by the comparison from re-constructed LEED criteria based on G-SEED. "Energy & Pollution" is the most concerned category in both assessments as the result of analysis on category rates. Next concerns are "Material & Resources", "Indoor Environment" and "Water Management". The unique categories in both criteria are "Ecological Environment" in G-SEED and "Innovation & Design Process" in LEED. The conclusion of this research is that two assessments are organized at different locations and with different strategies for developing green building but there are common concerns such as energy saving, material use, indoor environment. As a result, it is expected to use fundamental data for developing G-SEED for global standard.

Keywords : G-SEED, LEED, Office Building Certification Criteria

1. Introduction

1.1 Background and Purpose of Study

G-SEED (Green Standard For Energy and Environmental Design) certification criteria were developed to evaluate the current 10 building types and new & existing buildings by expanding the certification criteria to be applied to office buildings and school facilities, etc., after the certification criteria for multi-residential housing started in 2002 for the purpose of constructing environmental-friendly and energy saving buildings. In addition, as only the environmental-friendly building performance evaluation system in Korea, the name in English, 'G-SEED (Green Standard for Energy and Environmental Design)' was developed and is being utilized. As the status of G-SEED certification (as of September, 2013) issued by the Ministry of Land, Infrastructure & Transport is considered, multi-residential housing takes

30.7%, 34.75% for school and 12.94% for office buildings, it was found that the certification for office building is increasing continuously to the enlargement of the responsibility for green building certification and the accompanied incentives.

LEED (Leadership in Energy and Environmental Design) is expanding its certification works in Canada and other countries in addition to the environmental-friendly building certification works in the USA. In a comparative study on the evaluation items of G-SEED and LEED focusing on the office facilities (by Hyeon-woo Lee), it was argued that a careful review is needed in order for a domestic building to obtain a LEED certificate through the comparison between the certification criteria of both countries and the certification criteria of each country are different according to the regional and cultural backgrounds. However, LEED certificates for office buildings owned by global companies are increasing currently in Korea and also even cases obtaining both G-SEED and LEED certificates for an office building in Songdo New City are increasing, too. In addition, in a study on the correlation between the certification systems for environmental-friendly buildings of the domestic and foreign countries through the certification cases (by Chul-young Park), it was argued that some quantitative

* Main & Corresponding Author, Korea Institute of Construction Technology (mss@kict.re.kr)

** Korea Institute of Construction Technology (dwcho@kict.re.kr)

*** Korea Institute of Construction Technology (arpark01@kict.re.kr)

evaluation methods should be sought based on the performance criteria rather than on the specification criteria by comparing the certification criteria on which office building with a LEED certificate can obtain a G-SEED certificate.

In this study, it is intended to suggest the direction of the revision of certification criteria in order for G-SEED to respond to the global standard criteria in future after grasping the importance of the certification criteria of both countries by deducing some similarities and differences of the evaluation criteria in details through the reclassification of the structural systems and the evaluation criteria for office buildings of both countries.

1.2 Selection of Objects and Method

In this study, G-SEED 2010 version and LEED V2.2 as the versions at similar period were operated in order to compare the certification criteria for office buildings between G-SEED and LEED and the certification criteria were reclassified to find similarities and differences in details were analyzed.

2, Theoretical Review

2.1 G-SEED

G-SEED was introduced targeting multi-residential buildings to be co-supervised by the Ministry of Land, Infrastructure & Transport and the Ministry of Environment in 2002. It is a domestic certification system evaluating the environmental-friendly buildings which are currently being constructed including house and multi-residential housing as residential buildings and office buildings, residential complex building, school, retail, hotel and other buildings as non-residential buildings. And the evaluation is implemented targeting multi-residential housing and office buildings to the existing buildings. G-SEED certification system is divided into 7 categories, that are Land Use & Transport, Energy & Environment Pollution, Materials & Resources, Water Management, Management, Ecological Environment and Indoor Environment. The total point, 100 is obtained by multiplying the obtained score from each category with a weighting factor and the final scores obtained are divided into 4 grades.

2.2 LEED

As a green building certification system centered on the Northern America that is operated after it was founded by a private organization of the USA, 'US Green Building

Council', in 1993, LEED evaluates by dividing the areas into newly constructed buildings, existing buildings, residential buildings, shopping malls, interiors of commercial facilities, structures, outer surfaces, air conditioning area, school facilities, medical facilities and urban planning.

And in case of LEED NC(New Construction) certification criteria, it is divided into the following 6 broad areas, that is, SS(Sustainable Sites), WE(Water Efficiency), EA (Energy & Atmosphere), MR(Materials & Resources), IEQ (Indoor Environmental Quality) and ID(Innovation & Design Process). LEED makes it a rule to secure the minimum performance criteria by satisfying the prerequisites. And an average grade is decided by totalling the evaluated scores from each item and the final scores are divided into 4 grades.

2.3 Comparative Analysis of Constructive System between G-SEED and LEED

Compared the classified categories of the evaluation objects of G-SEED and LEED, G-SEED has the feature that the classified categories of building types are the same based on the building permission and the linking to incentives. On the other hand, LEED has the feature that the evaluation objects can be divided according to the spatial structure of buildings and the benefits after a certificate is obtained are operated through the market, so the evaluation objects can be designated by being divided into sub-areas.

G-SEED is composed of 7 categories and LEED consists of 6. And "and Use & Transport", "Energy & Environmental Pollution", "Materials & Resources", "Water Management", "Management" and "Indoor Environment" are the component areas of both systems. And as a difference, G-SEED has its unique area, "Ecological Environment" and LEED does the one, "Innovative Design Process" respectively.

Both certification systems divide the evaluation grades into 4. But G-SEED has the score ranges that the total scores including a weighting factor for office buildings have an interval of 10 from 50 points and the scores over 80 points belong to Green1, Superior grade. But LEED has the score ranges that the total scores obtained from adding scores to have an interval of 7 from 26 points and the scores over 52 belong to the Platinum grade. G-SEED evaluates whether an office building obtained the minimum scores from 6 mandatory criteria, but LEED evaluation can be initiated only after the prerequisites of each criteria are obtained. The comparative tables of the structural systems of G-SEED and LEED are as follows.

Table 1. Contents of G-SEED and LEED

	G-SEED	LEED NC v.2.2
Objective	<ul style="list-style-type: none"> ● New Building: Multi-residential housing, Residential complex, Office, School, Retail, Hotel, Home, and the other Building ● Existing Building: Multi-residential building, Office building in pilot 	<ul style="list-style-type: none"> ● New Buildings
Assessment	<ul style="list-style-type: none"> ● 7 Categories(23~43 criteria) 	<ul style="list-style-type: none"> ● 6 Categories(34 criteria)
Categories	<ul style="list-style-type: none"> ● Land Use and Transport ● Energy and Pollution ● Materials and Resources ● Water Management ● Management ● Ecological Environment ● Indoor Environment 	<ul style="list-style-type: none"> ● Sustainable Sites ● Water Efficiency ● Energy & Atmosphere ● Materials & Resources ● Indoor Environmental Quality ● Innovation & Design Process
Rating	<ul style="list-style-type: none"> ● Green1 (above 80 points) ● Green2 (above 70 points) ● Green3 (above 60 points) ● Green4 (above 50 points) 	<ul style="list-style-type: none"> ● Platinum(above 52 points) ● Gold (39~51 points) ● Silver (33~38 points) ● Certified (26~32 points)
Significant	<ul style="list-style-type: none"> ● request mandatory criteria ● weighting factor for total 100 points 	<ul style="list-style-type: none"> ● request prerequisites in each category ● 1 point each criteria for 69 points

3. Comparison of Certification Criteria between G-SEED and LEED

The evaluation criteria of LEED were reclassified and similarities and differences were compared and analyzed based on the detailed certification criteria of each among 7 categories of G-SEED certification criteria in order to compare the certification criteria of G-SEED 2010 version with those of LEED V2.2.

3.1 Reclassification for Comparing the Certification Criteria between G-SEED and LEED

1) Land Use and Transport

As a difference, the “Ecological Values of Site” of G-SEED are evaluated based on the purpose of minimizing the damages within a site, but LEED evaluates the relevant site and the surrounding conditions comprehensively.

Although the purpose of G-SEED evaluation regarding to the “Feasibility of the measure to prevent interference of daylight right” is the same as that of LEED evaluation, G-SEED evaluates by calculating an elevation of the true north direction but LEED evaluates based on the interior daylight illumination of a target building. As another difference, the grades of “Accessibility to public transport” of G-SEED are classified according to the distance from a public transport facility but LEED evaluates by suggesting a certain distance criterium for each public transport facility.

G-SEED evaluates by deciding whether a bicycle storage or a shower facility should be established or not in accordance with the provisions of the relevant law regarding to the item, “whether a bicycle storage should be established within a site or not”, but LEED can evaluate only after both of a bicycle storage and a shower facility are established. In addition, LEED evaluates the establishment of environmental-friendly automobile facilities, the evaluation of parking lot facilities and the maximization of open space.

Table 2. Land Use and Transport

	G-SEED (Office Building)	C	LEED NC v.2.2	C
1. Land Use and Transport	Ecological Value of Site	2	SS P1: Construction Activity Pollution Prevention SS C1 : Site Selection SS C3: Brownfield SS C5.1 : Site Development - Protect or Restore Habitat(partial)	M 1 1 1
	Feasibility of the measure to prevent interference of daylight right	2	EQ C8.1: daylight and view-daylight, 75% EQ C8.2: daylight and view-daylight, 90%	1 1
	Accessibility to public transport	2	SS C4.1 :Alternative Transportation - Public Transportation Access	1
	bicycle storage on site	2	SS C4.2 :Alternative Transportation - Bicycle Storage and Changing Rooms	1
	-		SS C2: Development Density & Community connectivity SS C4.3: Alternative Transportation -low-emitting & fuel-efficient vehicles SS C4.4:Alternative Transportation -Parking capacity SS C5.2:Maximize Open Space	1 1 1 1
	Total Credits	8	Total Credits	11
No. of criteria	4	No. of criteria	12	

C:Credit, M:Mandatory

2) Energy and Pollution

As another difference, regarding to the criteria, the “Energy Performance”, G-SEED evaluates it by linking the Energy Performance Index which is calculated based on the primary energy consumption volume or the obtained scores of energy certification grade, but LEED evaluates by calculating the energy saving rate as an energy cost in accordance with ASHRAE. The criteria, “Installation of Meter” of G-SEED is evaluated based on whether a meter is established or not, but the evaluation criteria of LEED are strengthened by establishing a meter, monitoring the energy consumption volume and submitting the validation plan. The criteria, “Saving of Lighting Energy” of G-SEED is evaluated according to the average crude density of a ceiling and that of LEED is evaluated based on the establishment of each individual lighting control by each resident or each

group. The criteria, "Use of renewable energy" of G-SEED is evaluated according to the establishment rate of renewable energy facilities, but that of LEED is evaluated by calculating the reduction rate of energy costs from the use of renewable energy within a site and the scores are evaluated by being supplied with renewable energy resources for 35% of electrical energy, so it is judged that this is an evaluation criterium considering the efficient operation as well as the establishment of renewable energy facility.

Table 3. Energy and Pollution

	G-SEED (Office Building)	C	LEED NC v.2.2	C
2 Energy and pollution	Energy performance	12 (M)	EA P1: Fundamental commissioning of the building energy system EA P2: min Energy performance EA C1.1~C1.10: Optimize Energy Performance	M M 10
	Installation of Meter	2	EA C5 :Measurement and Verification	1
	Saving of Lighting energy	4	EQ C6.1 :Controllability of Systems - Lighting	1
	Use of renewable energy	3	EA C2.1 :Renewable Energy, 2.5% EA C2.2 :Renewable Energy, 7.5% EA C2.3: Renewable Energy, 12.5% EA C6 : Green Power	1 1 1 1
	Reducing of CO ₂ emissions	3	-	
	Preventing use of Ozone depletion materials	3	EA P3 : Fundamental Refrigerant Management EA C4 : Enhanced Refrigerant Management	M 1
	-		SS C7.1: Heat Island Effect, Non-roof SS C7.2: Heat Island Effect, Roof SS C8:Lighting Pollution Reduction	1 1 1
	Total Credits	27	Total Credits	20
	No. of criteria	6	No. of criteria	23

C:Credit, M:Mandatory

The criteria, "Reduction of CO₂ Emissions" of G-SEED is evaluated according to the kinds of combined heat and power generation within a building and it is possible to obtain double scores based on two criteria according to the proportion of renewable energy facilities. The criteria, "Perverting use of Ozone depletion materials" of G-SEED is evaluated according to whether some refrigerants, insulating materials and fire extinguishers conform with ODP or GWP criteria or not, but that of LEED is evaluated only with refrigerants and fire extinguishers and the prerequisites are checked by using refrigerants for which CFC is not used. Some additional items, such as heat island phenomenon and reduction of lighting pollution that are related to environmental pollution are included to LEED.

3) Materials and Resources

Table 4. Materials and Resources

	G-SEED (Office Building)	C	LEED NC v.2.2	C	
3. Material and Resources	Saving consumption goods in toilet	1	-		
	Use of environmental-friendly products	3 (M)	MR C3.1 : Materials Reuse, 5% MR C3.2 : Materials Reuse, 10% MR C4.1a : Recycled Content,10% MR C4.1b : Recycled Content,20% MR C6 : Rapidly Renewable Materials	1 1 1 1 1	
	Recycling	2 (M)	MR P1 : Storage and Collection of Recyclebles	M	
	Displaying carbon emissions of material	2	MR C7 : Certified Wood MR C5.1: Regional Materials -10% Extracted, Processed &manufactured Regionally MR C5.2: Regional Materials -20% Extracted, Processed &manufactured Regionally	1 1 1	
	refurbishment only	Saving resource by reusing structure of existing building	7	MR C1.1 : Building Reuse - Maintain 75% of Existing Walls, Floors and Roof MR C1.2 : Building Reuse - Maintain 95% of Existing Walls, Floors and Roof	1 1
		Saving resource by reusing non-bearing walls of existing building	2	MR C1.3 : Building Reuse - Maintain 50% of Interior Nonstructural Elements	1
				MR C2.1: Construction Waste Management, Divert 50% from Disposal MR C2.2: Construction Waste Management, Divert 75% from Disposal	1 1
	Total Credits	17	Total Credits	13	
	No. of criteria	6	No. of criteria	14	

C:Credit, M:Mandatory

The criteria, "Saving consumption goods in toilet" of G-SEED is evaluated according to whether a hand dryer or a rolling towel is installed or not for the purpose of inducing the saving of consumer goods used in a restroom and of seeking clean living environment. but, LEED has no evaluation criteria. The criteria, "Use environmental-friendly certification products" of G-SEED is evaluated according to the use of Environment Labeled or GR Marked products, but that of LEED is evaluated based on the reduction rate of costs to the use of reused or recycled materials. The criteria, "Recycling" of G-SEED has the minimum evaluation criteria which are the same as those of LEED. Since the types of recycling collection increased for the criteria of G-SEED, the criteria for recycling of G-SEED is strengthened compared to LEED.

The criteria, "Displaying carbon emissions of material" is evaluated by each kind of materials under the carbon

footprint labeling system, but that of LEED is evaluated based on the use rate of materials within a region and of wood materials which are certified by FSC (Forest Stewardship Council).

The criteria, "Saving Resources by reusing structure of Existing Buildings" of G-SEED is evaluated based on the reuse rate of major structural components and the criteria, "Saving Resources by reusing the non-bearing walls of the existing buildings" is evaluated based on the reuse rate of non-bearing walls. The waste management is generated during construction period due to the evaluation related to the criteria.

4) Water Management

Table 5. Water Management

	G-SEED (Office Building)	C	LEED NC v.2.2	C
4. Water Management	Feasibility of measure to reduce rainwater load	3	SS C6.1 : Storm water Design - Quantity Control SS C6.2 : Storm water Design - Quality Control 90%, 80%	1 1
	Feasibility of measure to reduce water consumption	4 (M)	WE C3.1 : Water Use Reduction(20) WE C3.2 : Water Use Reduction(30)	1 1
	Rainwater harvesting	3	WE C2 : Innovative Wastewater Technologies	1
	Grey Water	3	WE C1.1 : Water Efficient Landscaping reduce by 50% WE C1.2 : Water Efficient Landscaping no portable water use or no irrigation	1 1
	Total Credits	13	Total Credits	7
	No. of criteria	4	No. of criteria	7

C:Credit, M:Mandatory

The criteria, "Feasibility of measure to reduce rainwater load" of G-SEED is evaluated based on the rate of establishment area of rainwater catchment surface, but that of LEED is evaluated based on a design drawing for rainwater management and a management plan. The criteria, "Feasibility of measure to reduce water consumption" of G-SEED is evaluated based on the application of products, but that of LEED is evaluated based on the application of products and the reduction rate of water consumption. The criteria, "Rainwater harvesting" of G-SEED is evaluated based on the capacity of a rainwater tank, but that of LEED is evaluated based on the reduction rate of tap water through the application of products. The criteria, "Gray water" is evaluated based on the usage rate of a rainwater tank, but that of LEED is done based on the reduction rate of tap water. As a difference, that of G-SEED is evaluated

based on the establishment rate of the rainwater facilities, but that of LEED is done based on the reduction rate of water consumption.

5) Management

Management as a category of G-SEED is evaluated based on whether an environment management plan is established or not, but LEED accepts the overall requirements through commissioning. As a difference, the criteria, "Modifiability of space and system plan for users" of G-SEED is evaluated as the separated criteria into Management, but that of LEED is evaluated by separating the criteria into 'Energy and pollution' and 'Indoor Environment' categories.

Table 6. Management

	G-SEED (Office Building)	C	LEED NC v.2.2	C	
5. Management	Reasonableness of site management plan	1	EA C3: Enhanced Commissioning	1	
	Appropriateness of provision of operation / management	2 (M)			
	TAB & Commissioning	2			
	Modifiability of space and system plan for users	4	-		
	Total Credits	9	Total Credits		1
	No. of criteria	4	No. of criteria		1

C:Credit, M:Mandatory

6) Ecological Environment

The detailed criteria of the category, 'Ecological Environment' of G-SEED are evaluated based on Providing green axis, Ratio of natural ground and the number of biotope creation methods. But the criteria, 'Maximization of SS Credit 5.2, Open Space' as the land use criteria of LEED is evaluated based on the landscape design.

Table 7. Ecological Environment

	G-SEED (Office Building)	C	LEED NC v.2.2	C
6. Ecological Env.	Providing green axis	2	-	-
	Ratio of natural ground	6	-	-
	Biotope	4	-	-
	Total Credits	12	Total Credits	0
	No. of criteria	3	No. of criteria	0

C:Credit

7) Indoor Environment

The criteria, "Using low VOC emitting product" of G-SEED is evaluated by applying the products emitting harmful chemicals at a low level influencing the health

of residents, but that of LEED strengthened by evaluating all of the material finishes.

The criteria, “natural ventilation” of G-SEED is evaluated based on whether the vent is installed or not, but that of LEED is evaluated based on the IAQ (Indoor Air Quality) and the conditions of buildings for preventing pollution by tobacco smoke in accordance with ASHRAE. The criteria, “Ventilation performance of unit residence” of G-SEED is evaluated based on the installation of air inlets/outlets and the air volume and that of LEED is evaluated based on the air volume by monitoring the air conditioning system as an evaluation reference similar to that of G-SEED. The criteria, “Indoor chemical and pollutant source control” of G-SEED is evaluated based on whether any asbestos is used as a construction material or not, but that of LEED is evaluated comprehensively based on the management of chemicals and contamination materials indoor. The

Table 8. Indoor Environment

G-SEED (Office Building)	C	LEED NC v.2.2	C
Using low VOC emitting product	3 (M)	EQ C4.1 : Low-Emitting Materials - Adhesives & Sealants	1
		EQ C4.2 : Low-Emitting Materials - Paints & Coatings	1
		EQ C4.3 : Low-Emitting Materials - Flooring Systems	1
		EQ C4.4 : Low-Emitting Materials - Composite Wood & Agrifiber Products	1
		Natural ventilation	3
Ventilation performance of unit residence	3	EQ C1: Outdoor Air Delivery Monitoring EQ C2: Increased Ventilation	1 1
Indoor chemical & Pollutant source control from materials	1	EQ C5 Indoor Chemical & Pollutant Source Control	1
Auto temperature adjusting device for indoor space	2	EQ C6.2 : Controllability of Systems - Thermal Comfort	1
		EQ C7.1 : Thermal Comfort - Design	1
		EQ C7.2 : Thermal Comfort - Verification	1
Indoor sound impact from transports	2	-	
rest areas for users	3	-	
comfortable Indoor environment for users	4	-	
-		EQ C3. 1 Construction IAQ Management Plan -During Construction	1
		EQ C3.2 Construction IAQ Management Plan-before occupancy	1
Total Credits	21	Total Credits	12
No. of criteria	8	No. of criteria	14

C:Credit M:Mandatory

criteria, “Auto temperature adjusting device for indoor space” of G-SEED is evaluated based on the installation rate of the indoor automatic temperature controllers, but that of LEED is done by checking the satisfaction level of residents as well as the suggestions for designing. In G-SEED only “Indoor sound impact from transport Rest area for users” and “comfortable indoor environment for users” are evaluated. It is judged that those evaluation criteria are for evaluating the regional characteristics focusing on cities with high density of population. In LEED, IAQ management plan is required to be submitted during the construction period and before moving in order to manage the indoor air quality.

8) Innovation & Design Process

“Innovation & Design Process” is an evaluation category used only by LEED. The scores are given by making a higher level of suggestion than a standard evaluation criteria and by suggesting and evaluating some innovative designs which still are not suggested based on the current criteria and also through the participation of LEED AP (Accredited Professional).

Table 9. Innovation & Design Process

	G-SEED (Office Building)	C	LEED NC v.2.2	C
8 Innovation & Design Process	-		Innovation in Design	1
	-		Innovation in Design	1
	-		Innovation in Design	1
	-		Innovation in Design	1
	-		-LEED AP	1
	Total Credits	0	Total Credits	5
	No. of criteria	0	No. of criteria	5

C:Credit

3.2 Analysis of Distribution of Scores through Reclassification of Certification Criteria between G-SEED and LEED

1) A Comparative Analysis of Number of Evaluation Criteria between G-SEED and LEED

The distribution rate of the number of criteria for each category through the reclassification from G-SEED and LEED was compared and analyzed. It was found that the order of adopted category of G-SEED is Indoor Environment (22.9%) followed by Energy & Pollution and Materials & Resources (17.1% respectively), Land Use & Transport, Water Management and Management (11.4% respectively) and Ecological Environment (8.6%). And it was found that the order of adopted category of LEED is Energy & Pollution (29.3%) followed by Materials &

Resources and Indoor Environment (18.7%), Land Use & Transport (16.0%), Water Management (9.3%) and Innovation and Design Process (6.7%).

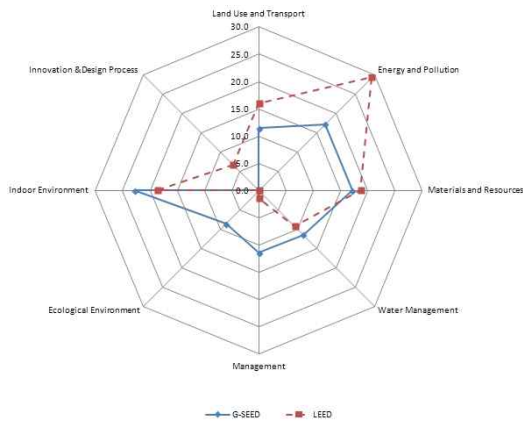


Fig. 1. Credit Rate of G-SEED and LEED

2) A Comparative Analysis of Weighting rate of Each category between G-SEED and LEED

The weighting rate of categories of the certification criteria of G-SEED and the reclassified weighting rate of categories of LEED were compared and analyzed. It was found that the order of the adopted category of G-SEED is Energy & Pollution (30%) followed by Indoor Environment (18%), Materials and Resources (15%), Land Use & Transport, Water Management and Ecological Environment (10% respectively) and the order of the adopted category of LEED by applying the reclassified weighting factor is Energy & Pollution (27.5%) followed by Land Use & Transport (15.9%), Materials & Resources, Indoor Environment (18.8% respectively), Water Management (10.1%), Innovative Design (7.2%) and Management (1.4%).

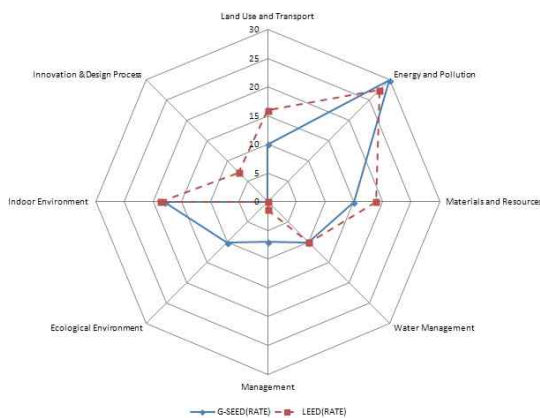


Fig. 2. Category Weighting Rate of G-SEED and LEED

4. Conclusion

In this study, the following points to be improved were induced by reclassify the criteria of LEED and by analyzing the distribution of scores from the detailed criterion in order to compare and analyze evaluation criteria of office building between G-SEED and LEED

- Land Use & Transport: As an item showing the topographical characteristics the most, LEED shows the characteristics with which the status of the outskirts of land is comprehensively evaluated as well as the land use within a site is evaluated. So, regarding to the category, "Land Use and Transport", a method for understanding and evaluating the surrounding environment without limiting the area within a site should be sought in the future.
- Energy & Pollution: Although there are some differences in the aspect of the calculation criteria of the categories, "Energy" and "Renewable Energy" between G-SEED and LEED, it is necessary to revise and develop the criteria and to strengthen the certification criteria step by step for evaluating the energy consumption volume quantitatively under the concept of the Life Cycle Assessment (LCA) since those categories are the specialty ones having the importance with the highest evaluation scores.
- Materials & Resources: G-SEED is highly recognized and has shown its high performance as the system for saving materials and resources by evaluating based on whether the facilities related to materials and resources are installed or not. It is necessary to introduce the evaluation criteria using the usage rate of materials and resources in the future.
- Management: The current criteria with which whether an environment control plan is established or not is evaluated during the design and construction stages should be revised in order to seek the operation and management of buildings which obtained a G-SEED certificate and to be evaluated based on the monitoring for managing continuously and the evaluation criteria for the existing buildings are needed to be expanded.
- Ecological Environment: As a category evaluated only by G-SEED, it reflected the difference of the importance according to the regional characteristics, but recently, some problems occur since the post-

management is difficult. So, it is judged that some revision is needed by submitting and evaluating a report and an ecological report by a specialist based on a landscaping plan and by enhancing the importance of the post-management.

- Indoor Environment: As a category showing similar purposes of both countries' certification criteria, the importance of the indoor environment among the living environments for domestic residents is increasing rapidly. So, the evaluation criteria suggesting the design & management methods considering the indoor environment from the design stage is needed rather than whether evaluating installation of air conditioning facilities.
- Innovative Design & Process: Under the LEED, additional scores are given to the innovative design & process exceeding the current evaluation criteria and the data is established in the pilot credit library. The evaluation scopes, such as designing various green buildings, materials and construction, etc., should be expanded by newly creating the criteria, "Innovation" of G-SEED which can be applied to the new category.
- G-SEED has the largest number of criteria for evaluating the "Indoor Environment" and for weighting factor, "Energy and Pollution" are the highest. But LEED has the largest number of items and the highest weighting factor for evaluating the criteria, "Energy and Pollution". It is judged that the institutional efforts for saving the global energy consumption since the certification criteria of G-SEED and LEED are considered similar importance. And it is implied that the response to the environmental change is important even though the system is operated in each country.

Through this study, it was recognized that other countries' green building certificates which are obtained by the domestic buildings has increased. So, a method for improving G-SEED was induced in order for the other countries' certificates not to be overemphasized. Therefore, G-SEED can become a global standard in the future and can be expanded for realizing green buildings when ordering the overseas works in the future.

Acknowledgements

This research was supported by a grant(11 High-tech

Urban G01, 12CHUD-C061818-02-000000) from High-tech Urban Development Program funded by Ministry of Land, Infrastructure and Transports of Korean government.

References

- [1] G-SEED Certification Criteria, MOLIT Notification No.2010-301
- [2] G-SEED Certification Data (late Sep. 2013), homepage: www.molit.go.kr
- [3] LEE, Hyun-Woo, A Comparative Study of the Evaluation Items of G-SEED environmental-friendly Building Certification System of Korea and LEED, A Paper of Journal of the Korean Solar Energy Society, Vol.31, No1., 2011
- [4] Park, Cheol-Yong, A study on Correlation between KGBC and LEED by examining the certification cases, A Paper Collection for Academic Symposium of AIK (Architectural Institute of Korea), Vol30, No1, Oct., 23, 2010
- [5] LEED V2.2, USGBC, www.usgbc.org

Received November 3, 2013;

Final revision received January 9, 2014;

Accepted January 13, 2014;