

Checklist and Design Recommendations for the Interiors of Korean, Eco-healthy Childcare Facilities

우리나라 영유아 보육시설의 친환경 실내를 위한 체크리스트와 디자인안 제안

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Abstract

As children are known to touch and chew everything, green cleaning procedures are an important step in preventing children from ingesting harmful toxins. The objectives of this study are to develop a new, self-evaluation checklist and to suggest design recommendations which comply with easy, adaptable, economical ways to improve the eco-friendly indoor environment of Korean childcare facilities. The information compiled during this study was collected through literature review and internet surveys¹⁾ from July, 2009 to February, 2010. The results of this study show that the current Korean childcare accreditation system and practices emphasize clean building interiors, policies for sanitation and cleanliness, and control of humidity and lighting. On the other hand, the information provided by green-building rating systems from GBCC, LEED, and GBTool offers additional and comparative details regarding indoor environment quality and standards regarding the IAQ performance and management plan, ventilation and thermal comfort systems, views from windows, acoustics, and lighting. In conclusion, this document provides an appropriate and easy-to-follow, self-evaluation checklist composed of eight criteria and 51 practical items. This study also provides the design recommendations composed of 27 practical ideas focusing on interior elements. Both the checklist and design recommendations I have suggested can be a post-occupancy tool for evaluating eco-healthy facility standards as well as tips for continuing to maintain eco-healthy childcare facilities.

Keywords : Eco-health, Childcare facility, IEQ, IAQ, Checklist, Design recommendations

키워드 : 친환경, 보육시설, IEQ, IAQ, 체크리스트, 디자인안

1. Introduction

As children are known to touch and chew everything, green cleaning procedures are an important step in preventing children from ingesting harmful toxins. In addition, as parental concern regarding the environment continues to grow, parents and childcare providers who want environments which are healthy and free of chemicals demand that daycare centers be carefully managed and are eco-friendly. Consequently, eco-healthy childcare is a national program in Korea designed to ensure that

childcare settings are as healthy, safe, and green as possible in order to reduce children's exposure to toxins.

The Korean accreditation program for childcare facilities, established in 2005, was created in order to provide information regarding the assessment of childcare centers and to suggest guidelines for parents who wish to choose a suitable childcare facility. As this program also provides high-quality services for children's education and development, the system has continued to expand nationally.²⁾ As seen in several states in the United States, green daycare is already accredited or is in the process of being accredited. In addition, integrated design collaboration has produced a healthy environment that nurtures young children with a reduced ecological impact. However, in Korea we do not have an adequate checklist or design guidelines which allow us to identify environmentally oriented facilities. Neither do we have a tool for

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1) <http://www.daum.net/>, <http://www.naver.com/>
<http://kr.yahoo.com/> for Korean sources,
<http://www.google.co.kr/>, <http://www.yahoo.com/> for Foreign sources

2) <https://www.KCAC21.Or.Kr>

post-occupancy evaluation. For these reasons, suggesting some ideas for effective changes in childcare facility interiors should be of great value.

The objectives of this study are to develop a new, self-evaluation checklist and to suggest design recommendations which comply with easy, adaptable, economical ways to improve the eco-friendly indoor environment of Korean childcare facilities.

2. Method

The information compiled during this study was collected through literature review and internet survey³⁾ from July, 2009 to February, 2010.

I first investigated both domestic and foreign accreditation programs⁴⁾ for childcare facilities. The health and physical environment sections of the childcare accreditation systems of both the Korean Ministry for Health, Welfare and Family Affairs (MIHWAF) and the American National Association for the Education of Young Children (NAEYC), were reviewed for this study.

Second, the certification criteria for achieving the credits of accreditation as part of the green building rating systems, including the Korean Green Building Certification Criteria (GBCC), Leadership in Energy and Environmental Design (LEED) 2009 for Commercial Interiors, and GBTool 2005 were summarized, and the practical ideas required to optimize indoor environmental quality in each rating system were compared. The above rating systems have been used to evaluate green buildings because of their relevance, applicability, availability, and general measurability.

Third, articles and guidelines dealing with indoor environmental issues regarding childcare facilities which would benefit the health and well-being of all children were summarized through literature review. This includes the Eco-healthy childcare checklist offered by the Oregon Environmental Council, the Childcare Center Design Guide by the U.S. General Services Administration, the Checklist for interior design of childcare facilities which I devised,⁵⁾ and

numerous other articles and research papers⁶⁾.

Finally, I defined the necessary criteria and standards which maximize indoor environmental quality in a childcare facility after collecting the necessary data, and I developed a checklist based on these practical ideas (Table 4). I also suggested design recommendations for spaces in each area such as the entrance, multipurpose room, staff office, classroom, toilet, kitchen as required for new construction or renovation of the indoor environment of childcare facilities through literature review, internet surveys, and former studies (Figure 1).

3. Accreditation, Rating System, and Guideline Issues for the Interiors of Childcare Facilities

3.1 Accreditation Program and Practices for Childcare Facilities

Korean childcare accreditation of the MIHWAF began with the goal of providing an accrediting system that would raise the level of overall issues regarding early childhood programs. At present, nearly 13,000 facilities are accredited according to the Korean Childcare Accreditation Council. The assessment program consists of three kinds⁷⁾ by building scales and types and is organized according to seven evaluation categories including: 1. Physical environment; 2. Administration and management; 3. Curriculum; 4. Children and teacher relationships; 5. Nutrition and health; 6. Safety; and 7. Family and community relationships in the case of an institution accommodating more than 40 people,⁸⁾ all practices regarding health and physical environment were selected from some of these seven sections.

Since 1985, NAEYC has offered a national, voluntary accreditation system in order to set professional standards for early childhood education programs and to help families identify high-quality programs. The assessment program was updated in 2006 and is organized according to 10 standards including: 1. Relationships; 2. Curriculum; 3. Teaching; 4. Assessment

3) <http://www.daum.net/>, <http://www.naver.com/>
<http://kr.yahoo.com/> for Korean sources,
<http://www.google.co.kr/>, <http://www.yahoo.com/> for Foreign sources
 4) MIHWAF, Childcare accreditation systems, Korea, 2009,
<https://www.KCAC21.Or.Kr>
 NAEYC, Program portfolio instructions for organization. USA,
 2006, pp1-18, www.naeyc.org
 5) Jinhie Chun. Evaluation of interior environmental characteristics
 on foreign childcare facilities. Journal of Korean Society of

Design and Science 2008; 21(3); pp267-278.
 6) Journal of Building and Environment, 2010
 Illinois Facilities Fund. The building blocks of design: A
 handbook for early childhood development facilities, USA, 2004,
 pp51-52, 66-67
 Elizabeth Wilhide, Eco-The essential source book for
 environmentally friendly design and decoration. London, U.K,
 2005
 Little Green Tree House Careers and Employment, 2010,
<http://www.indeed.com/cmp/Little-Green-Tree-House>
 7) The institution accommodating more than 40 children, less than
 39 children, or disabled children
 8) <https://www.KCAC21.Or.Kr>

Table 1. Practices regarding the health and physical environment from two childcare accreditation agencies

SE CTI ON	PRACTICES	CATEGORIES	
		MIH WAF *	NAE YC **
Hea lth & Phy sica l En viro nm ent	Protection from cold, heat, and sun injury	5-2	5.A.07
	Maintenance of heating and cooling systems	5-2	9.D.05
	Policies for protection from air pollution		9.D.03
	Policies for air exchange	5-2	
	Evidence that rooms are ventilated before use by children		9.C.13
	Policies for a smoke-free facility		9.C.11
	Service for fire extinguishers, alarms, and smoke detectors		9.C.11
	Policies for maintaining a clean indoor environment	5-1	
	Cleaning and sanitation frequency checklists		9.C.06
	Policies for changing diapers and cleaning toilets	4-3	
	Maintenance for clean toilets and washrooms	5-3	
	Cleaning toys contaminated by bodily secretions		5.C.03
	Maintaining a clean kitchen and food supply	5-4	
	Cleanliness of drinking water and drinking cups	5-5	9.D.02
	Controlling humidity	5-2	
	Controlling natural light and illumination	1-1	
	Building and facility inspection reports		9.D.01
	Evidence of remediation of hazards such as falling or dangerous material	6-2	9.D.01
	Policies for protection from hazards such as falling or dangerous material	6-2	9.C.08
Policies for equipping first-aid kits		9.C.10	
Compliance with ADA requirements		9.C.03	

* 1-1 through 6-2 of MIHWAF are number for classification of categories used in Korean Ministry for Health, Welfare and Family Affairs. (1-1: Physical environment-Indoor lighting)

** 5.A.07 through 9.D.05 of NAEYC are number for classification of categories used in American National Association for the Education of Young Children (5.A.07: Health-Promoting and protecting children's health and controlling infectious disease)

of child progress; 5. Health; 6. Teachers; 7. Families; 8. Community relationships; 9. Physical environment; and 10. Leadership and management.⁹⁾ Among these 10 standards, all practical items regarding both 9. Physical environment and 5. Health standards for children were reviewed for this study.

As summarized in Table 1, both MIHWAF and

NAEYC offer 21 practical ideas including the heating and cooling system, humidity, ventilation, lighting, protection from fire and other hazards, and universal design to increase both the quality of health and the physical environment. Sixteen of the 21 practical ideas are related to the interiors of eco-healthy childcare facilities (Shaded areas in Table 1). In addition, the current Korean childcare accreditation of MIHWAF compared with the NAEYC accreditation, emphasizes maintenance of clean building interiors, policies for sanitation and building cleanliness, and control of humidity and lighting, as suggested by specific practices as shown at Table 1. However, the Korean accreditation system has omitted very important policies regarding protection from air pollution, including ventilation before occupancy, as well as services for protection from fire related to indoor air quality.

3.2. Green Building Rating Systems and Criteria for IEQ

The Korean GBCC was developed in 2002 as a consensus-based, building rating system based on the use of the existing certification systems for green building. The GBCC, controlled by Korea Industry Technology Certificate Co., Ltd., is currently the predominant rating system for green building in the Korean market. The version of GBCC for office buildings applied to day-care facilities in Korea consists of nine categories including Site selection, Traffic, Energy, Materials and resources, Water resources, Air pollution, Maintenance, Ecological environment, and Indoor environment.¹⁰⁾ The Indoor environment category was summarized in order to compare it with foreign rating systems.

Leadership in Energy and Environmental Design (LEED) was developed and first used in the United States in 1998 as a consensus-based building rating system. It is the recognized system for certifying high-performance, green interiors that are healthy, functional and are less costly to operate and maintain. There are different versions of LEED-NC (for new construction and major renovations), Existing buildings, Commercial interiors, Building core and shell, Homes, and Neighborhood development.¹¹⁾ The version of LEED 2009 for Commercial Interiors, as used for daycare facilities in the U.S., consists of seven categories including Sustainable site, Water efficiency,

9) www.naeyc.org

10) <http://www.kier.re.kr>

11) <http://www.usgbc.org/DisplayPage.asp?CategoryID=19>

Energy and atmosphere, Materials and resources, Indoor environmental quality, Innovation and design process, and Regional priority credits.¹²⁾ I summarized the Indoor environmental quality for this study.

GBTool is the software implementation of the Green Building Challenge (GBC) assessment method that has been under development since 1996 by a group of more than a dozen countries. Currently, approximately 15 countries are involved in preparing the assessments which include criteria in categories such as Site selection, Project planning and development, Energy and resource consumption, Environmental loadings, Indoor environmental quality, Functionality and long-term performance, and Social and economic aspects. The indoor environmental quality was assessed by its HVAC, illumination, and acoustics.¹³⁾

Potentially useful techniques, according to the above 3 Green building rating systems for creating "Eco-healthy" childcare facility interiors, are summarized below Table 2.

Table 2. Certification criteria for enhancing the IEQ according to the Green building rating system

Practical ideas	Rating system (Certification criteria)		
	GBCC	LEED	GBTool
Facilitate the IEQ through good design, construction, and practices for occupants' health	<ul style="list-style-type: none"> Outdoor air delivery system design(3) Construction IAQ management plan(3) Comfortable indoor environment with source control(4) 	<ul style="list-style-type: none"> Minimum IAQ performance(Prereq.1) Outdoor air delivery monitoring(1) Construction IAQ management planning during construction(1) Construction IAQ management planning before occupancy(1) 	<ul style="list-style-type: none"> Indoor air quality-finishes, limited pollutant migration, maintenance, etc.
Provide areas for relaxation and refreshment aspects	<ul style="list-style-type: none"> Areas for relaxation and refreshment(4) 	<ul style="list-style-type: none"> Daylight and access to views(1) 	<ul style="list-style-type: none"> Social aspects-views, privacy
Provide thermal comfort	<ul style="list-style-type: none"> Controllability of the thermal comfort system(2) 	<ul style="list-style-type: none"> Controllability of systems for thermal comfort(1) Thermal comfort design(1) Thermal comfort verification(1) 	<ul style="list-style-type: none"> Air temperature and relative humidity
Supply adequate levels of ventilation	<ul style="list-style-type: none"> Increased ventilation(2) 	<ul style="list-style-type: none"> Increased ventilation(1) Indoor chemical & 	<ul style="list-style-type: none"> Ventilation

12) LEED 2009 for Commercial Interiors, Project Checklist, <http://www.usgbc.org/DisplayPage.aspx?CMSPageID=145>

13) Fowler, K.M. Rauch, K.M. Sustainable building rating systems summary, Pacific Northwest National Laboratory; 2006; pp1-27.

Indoor and outside air		pollutant source control(1)	
Prevent airborne bacteria, mold, etc.			<ul style="list-style-type: none"> Humidity and limited pollutant migration
Limit spread of pathogens	<ul style="list-style-type: none"> Limit the spread of tobacco smoke(3) 	<ul style="list-style-type: none"> Environmental tobacco smoke control(Prereq.2) 	<ul style="list-style-type: none"> Limited pollutant migration
Avoid the use of materials high in pollutants	<ul style="list-style-type: none"> Low VOCs building materials(6) Elimination of harmful building materials(1) 	<ul style="list-style-type: none"> Low-emitting materials - adhesives and sealants(1) Low-emitting materials - paint and coatings(1) Low-emitting materials - flooring systems(1) Low-emitting materials - composite wood and agri-fiber products(1) Low-emitting materials -furniture and seating(1) 	<ul style="list-style-type: none"> Selection of interior finishes, building materials
Assure acoustic privacy and comfort	<ul style="list-style-type: none"> Limit noise by adequate acoustics(2) 		<ul style="list-style-type: none"> Noise and acoustics
Create a highly illuminated environment		<ul style="list-style-type: none"> Controllability of systems - lighting(1) 	<ul style="list-style-type: none"> Daytime lighting and illumination
Design for the elderly and disabled persons	<ul style="list-style-type: none"> Consideration of children, the elderly, and disabled persons(1) 		

Number inside () is point for certification. The possible total scores for IEQ of GBCC system are 31, and those for IEQ of LEED system are 17.

The information provided in Table 2 offers comparative details regarding indoor environmental quality. The certification criteria for green building rating systems compared with those for childcare accreditation, have more design considerations regarding interior finishes, building materials, views of the outdoors, acoustics, lighting, IAQ performance and management plan, and ventilation and thermal comfort system than those regarding protection from physical hazards and an unsanitary environment. The current Korean GBCC, compared with foreign rating systems, does not stress preventing airborne bacteria, mold, etc. as well as creating a highly illuminated environment.

3.3 Guideline Issues and Practices for Eco-healthy, Indoor Environments of Childcare Facilities

The following eight criteria and the guidelines dealing with indoor environment issues of childcare facilities were taken from Table 1 and 2 above, and from other articles and research papers. These detailed, sustainable issues were incorporated into the self-evaluation checklist (Table 4) and design recommendations (Figure 1).

1) IAQ/ Ventilation

Pollutants are certain to become airborne and to create symptoms in even the healthiest children and to aggravate the symptoms of children suffering from chronic allergies and asthma. It is essential to reduce children's exposure to lead, mercury, any other harmful toxins, and tobacco smoke. One method for improving indoor air quality is to maintain adequate ventilation and air flow. Natural ventilation through windows and doors can offer a much higher ventilation rate than mechanical ventilation and in a more energy-efficient manner. The measurements conducted by Hua showed that natural ventilation can achieve high ventilation rates especially when both windows and doors are open. When all of these are closed and exhaust fans are turned on, a substantial degree of negative pressure is created.¹⁴⁾ Besides, when left on, high-efficiency, particle-arresting, air purifiers are effective and economical for continually removing harmful pollutants such as bacteria and viruses from the air. In addition, there should be enough time between the installation of interior components and building material which need to "off-gas" and occupancy of a center's new facilities. The maximum, feasible time to "off gas" is one month, but never less than one week after completion of any renovation.¹⁵⁾

2) IAQ/ Finishes and Materials

A healthful environment should be the primary component of any "spaces for children" design. The solution entails complete dedication to biodegradable, non-toxic, recycled finishes and material. The surface covering applied on building materials is as important as the substrate itself, when considering the bioreceptivity of this material to potential fungal infestation. Biodegradable paint, varnish, and wallpaper

treated with a biocide offer partial resistance to fungal growth. For non-toxic materials, linoleum and rubber floor finishes are available in tile or sheet form. They are preferable to vinyl products and can be used instead of vinyl. Eco-friendly paint for interior walls must include less than 10grams of VOCs per liter. If furniture is made of particle board rather than solid wood, formaldehyde emissions from the particle board should be less than .01ppm.¹⁶⁾ Ceramic tile consisting of at least some pre-and/or post-consumer recycled content and ceiling tile with a high, recycled content are recommended.

Upholstered furniture should be in good condition and without exposed foam or inside stuffing, and natural organic fiber or recycled fiber are preferable for its composition. Carefully selected furnishings and toys should be made primarily from sustainably harvested wood. In addition, rugs, curtains, comforters, and cushions made from recycled fiber or natural organic fiber are preferable.

3) Fire Protection and Safety

For a children's facility, flame spread ratings and smoke development requirements according to Korean standards for public buildings, should be adhered by builders and architects. Every facility should have at least two emergency exits, automatic sprinklers, and a fire alarm system with both audio and visual alarms. Smoke detectors should also be installed throughout. No dead-end corridor should exceed 6.1 meters in length¹⁷⁾ And all doors and door frames should be precisely fire-rated.

4) Heating and Cooling Systems

As children spend a great deal of time on the floor, a thermal environment that causes discomfort may adversely affect their physiology, perceptions, and mental alertness. Therefore, both temperature control and avoidance of drafts are very important. Maximum floor insulation and an air diffuser are desirable in order to minimize drafts, although greater energy use does not necessarily improve the well-being of a room's occupants.

Regarding the room temperature, 18°C ~ 23°C in winter, 20°C ~ 26°C in summer, 23°C ~ 26°C for infants and toddlers, and 18°C ~ 23°C for preschoolers are recommended. Regarding the humidity, 35 percent minimum relative humidity in winter and 50 percent

14) Hua Qiana et.al, Natural ventilation for reducing airborne infection in hospitals. *Building and Environment* 2010; 45(3); pp559-565.

15) U.S. General Services Administration. *Childcare center design guide*. 2004, p9-1

16) www.jswdarch.com/pdfs/bp2006_berkeley_Web.pdf

17) U.S. General Services Administration., op.cit., p10-1

maximum relative humidity in summer are minimally recommended¹⁸⁾ Conditions should also be avoided which lead to excess moisture which contributes to the growth of mold and mildew.

5) Cleaning and Sanitation

For the kitchen, toilets, washrooms, and diapering stations, recommended finishes include impervious flooring and millwork, counter tops, and wall covering. Floors that are not padded should be covered with tile, linoleum or wood so they can be mopped and sanitized daily. Wall surfaces adjacent to a diaper-changing table should have impervious finishes.

Furniture and equipment should be provided with consideration given to its cleaning, durability, and sanitation for children as well as its environmental impact. A kitchen with stainless steel counter tops is preferred. The items used daily, including mattresses, toys, serving bowls, cups, and cot covers, must be easily cleaned and cleaned often. The floor mats for wiping footwear before entering an area as well as each child's blankets must be washed in hot water at least once a week.

6) Natural Light and Illumination

Natural lighting is essential in childcare facilities. The use of natural light benefits daycare centers by reducing the total energy use as well as promoting the children's activity level. Therefore, the amount and orientation of natural light should be considered as part of the design of childcare centers. Children's rooms for reading, eating, and playing must have a total window area of at least 8 percent of the floor area if the windows face south and directly outdoors, 10 percent of the floor area if the windows face east or west, 15 percent of the floor area if the windows face north, and 20 percent of the floor area if windows are not on an exterior wall.¹⁹⁾

If there are no windows, the absence of natural light during the day has negative results. To solve this problem and to provide sufficient daylight in interior spaces, it might be necessary to install some additional lighting systems. Both a mirror sun lighting system and a light pipe system, which are simple, inexpensive, and easily constructed, are very useful in dark interiors of childcare facilities.²⁰⁾ In addition, all classroom

windows should be equipped with either window blinds or shades so that the room can be fully darkened during nap times. Venetian blinds are a commonly used type of shading device and are increasingly becoming operated automatically to overcome the limitations of manual operation. These automated blinds can be installed in order to maximize the benefits of daylight for occupants' comfort and to reduce energy consumption.

When using fluorescent lights, bulbs that provide the most natural color mix are recommended. A variety of full-spectrum bulbs are currently available, although they may be more expensive, 500lx on children's work surfaces for reading and close work and 250lx ambient light for classroom and play areas are desirable. Light fixtures in classrooms and nap rooms should be able to be dimmed in the range of 500lx to 50lx. All ceiling tiles should have a high (80% min) light reflection capability so as to enhance the amount of light in interior spaces.²¹⁾

7) Noise and Acoustics

Wall and floor finish choices affect the appearance of each room and can also reduce noise levels. Acoustic ceiling material can control the transfer of interior noise. Exposed structural ceiling elements can require additional acoustical treatment such as the addition of acoustical baffles, banners or fabric. And not only sound-absorbing flooring including cork, linoleum or carpet, but also sound-attenuating wall finishes should be provided for noisy areas. For multiple-purpose and exercise areas, the materials covering movable partitions and raised drama stage areas may be treated acoustically in order to reduce noise levels. Doors opening onto noisy areas should have solid cores.

8) Design Flexibility

Flexible design that is easily reconfigured for future expansion, should be encouraged as it decreases cost and conserves resources by specifying some percentage of the building interior components to be easily reconfigurable. Each classroom must have an open, unrestricted activity area which does not contain any walls or furniture. This can be achieved through the use of elements such as movable panels and demountable walls. Complete classroom enclosure is not recommended because it decreases the space flexibility. In addition, movable or stackable furniture

18) http://www.sehn.org/pdf/EHCC_ChecklistFINAL.pdf.

U.S. General Services Administration. op.cit., p10-9

19) U.S. General Services Administration. op.cit., p5-3

20) Jeong Tai Kim and Gon Kim. Overview and new developments in optical daylighting systems for building a healthy indoor

environment. Building and Environment 2010;45(3); pp559-565

21) U.S. General Services Administration. op.cit., p10-10

Table 3. Practices for Eco-healthy, Indoor Environments of Childcare Facilities

CRITERIA	PRACTICES
IAQ/ Ventilation	<ul style="list-style-type: none"> • Reduce children's exposure to pollutants. • Improve the indoor air quality with ventilation. • Provide enough time between the installation and occupancy for off gas.
IAQ/ Finishes and Materials	<ul style="list-style-type: none"> • Select the biodegradable, eco-friendly paint and wallpaper. • Use the non-toxic, materials, linoleum and rubber floor finishes. • Use the finishing materials made from pre-and/or post-consumer recycled content. • Choose the furnishings and toys made from organic fiber or sustainable harvested wood.
Fire Protection and Safety	<ul style="list-style-type: none"> • Assure the Korean standards regarding flame and smoke spread. • Provide at least two emergency exits. • Install the sprinkler, fire alarm system, and smoke detector. • Exceed 6.1 meters for no dead-end corridor. • Provide fire-rated doors.
Heating and Cooling Systems	<ul style="list-style-type: none"> • Provide the comfort thermal environment. • Control the humidity in winter and summer
Cleaning and Sanitation	<ul style="list-style-type: none"> • Select the impervious and sanitized interior finishes for the kitchen, toilets, washrooms, and diapering stations. • Provide the clean and durable furniture and equipment. • Supply the clean and washable daily items.
Natural Light and Illumination	<ul style="list-style-type: none"> • Consider the amount and orientation of natural light. • Provide the adequate window area. • If there are no windows, install some additional lighting systems. • Install either window blinds or shades for all classroom. • When using fluorescent lights, provide the variety of full-spectrum bulbs. • Provide the desirable amount of light for classroom and play areas. • Install the dimming light fixtures in classrooms and nap rooms. • Select the highly reflecting ceiling tiles.
Noise and Acoustics	<ul style="list-style-type: none"> • Choose the partitions, wall, and floor finish reducing noise levels. • Choose the acoustic ceiling material. • Provide the additional acoustical treatment. • Select the solid cores' doors for noisy areas.
Design Flexibility	<ul style="list-style-type: none"> • Install the movable panels and demountable walls instead of solid walls. • Choose the movable or stackable furniture and equipment. • Place the windows at children's viewing heights.

and equipment is preferable so that a room can be changed to accommodate other activities.

For optimal social interaction, windows should be placed at children's viewing heights above the floor.

Maximum window sill heights for children are from 450mm to 750mm above the finished floor; the recommended heights are 450mm for infants, 600mm for toddlers, and 750mm for pre-school children.²²⁾

4. Eco-healthy Checklist and Design Recommendations

4.1 Eco-healthy Checklist

To develop an eco-healthy childcare facility, a suitable and easy-to-follow checklist should be provided. The following self-evaluation checklist was developed from the information compiled during this study. Eight major categories were key words taken from three Green building rating systems (Table 2). However, 51 practical guidelines were pieced together and modified from Tables 1 and 2 and the above 3.3. guideline issues and practices.

4.2 Design Recommendations

The following design recommendations were developed from the same information compiled during this study. However, Figure 1 was designed to be adapted by children's ages including infants, toddlers, and pre-school children for each area in a Korean childcare facility. Furthermore, the design recommendations on furniture, furnishings, and equipments which were not presented at Table 4 were emphasized in this plan. Therefore, combining checklist with design recommendations is preferable for evaluating eco-healthy facility standards.

1. Washable, walk-off mat to prevent dirt and unwanted materials from being tracked into the center;
2. Washable and durable wallpaper finishes with zero- or low-VOCs adhesives, or low-VOCs latex paint;
3. For all infants, cribs with organic mattresses and which are free of formaldehyde and all other chemicals;
4. Maximum insulation of floors, hard-surface floors for wheeled cribs, easily cleaned and non-porous floor finishes, and sound-absorbing ceiling tiles;
5. Partial- or full-height, insulated partitions to divide spaces and to absorb noise;
6. Clean diaper-changing area with a changing table, sink, waste bin, and upper cabinets;
7. Maximum insulation of floors, easily cleaned, non-porous floor finishes, and sound-absorbing ceiling tiles;
8. Adaptable/flexible/movable table for meals and snacks;

22) Ibid., p10-7

Table 4. Checklist for creating an eco-healthy childcare facility

○	△	X	N/A	
IAQ/ Ventilation				
				We maintain adequate ventilation and air flow.
				We do not permit smoking anywhere on the premises.
				We use plants to improve the indoor air quality by filtering pollutants from the air.
				We avoid children's potential exposure to lead, mercury or any other harmful toxins.
				We provide ventilation for off-gassing materials for one week to 30 days before use for children
IAQ/ Finishes and Materials				
				We select non-toxic and washable wall finishes (vinyl not recommended).
				We use zero- or low-VOCs adhesives and sealants.
				We use low-emitting and sustainable flooring systems and finishes.
				We use low-emitting furniture upholstered with recycled fibers or natural organic fibers.
				We maintain furniture in good condition and without foam or the inside stuffing exposed.
				We choose rugs, curtains, and cushions made with recycled fibers or natural organic fibers.
				We do not use fluffy rugs or cushions which may create or exacerbate chronic allergies and/or asthma.
				We use only low-VOCs latex paints and do not paint when children are present (less than 10grams of VOCs per liter).
				We use furniture made of solid wood or low-emitting particle board (less than .01ppm).
Fire Protection and Safety				
				Doors and door frames are correctly fire-rated.
				The facility has at least two exits.
				Emergency lighting is installed in all hallways.
				Automatic sprinklers are installed throughout the facility.
				There is an automatic fire alarm system throughout the facility.
				Fire alarm systems have both audio and visual alarms.
				Automatic smoke detectors are installed throughout the facility.
				No dead-end corridor should exceed 6.1 meters in length.
Heating and Cooling Systems				
				We maintain heating and cooling systems.
				We have installed highly insulated floors.
				We control the room temperature in order to promote children's health and mobility (18°C ~23°C in winter, 20°C ~26°C in summer, 23°C ~26°C for infants and toddlers, and 18°C ~23°C for preschoolers).
				We control the humidity so as to prevent airborne bacteria, mold, and other fungi (35 % minimum relative humidity in winter and 50 % maximum relative humidity in summer).
Cleaning and Sanitation				
				We have cleaning and sanitation frequency checklists.
				We supply a rough mat to wipe shoes before entering the facility.
				We have a kitchen with an easily cleaned floor finish and washable ceiling finish.
				We have a kitchen with stainless steel countertops and washable wall surfaces.
				We use toxin-free, stainless steel, reusable bowls, plates, and cups to help reduce waste.
				We supply clean drinking water and drinking cups.
				We have sufficient toilets and washrooms.
				We maintain clean toilets, diapering station, and washroom.
				We use only low-toxicity cleaning products and laundry supplies.
				We use washable organic mats, blankets, and cot covers.
				We clean toys contaminated by any bodily secretion.
Natural Light and Illumination				
				We are able to control the amounts of both natural light and electric illumination.
				All classroom windows have either window blinds or shades.
				Classrooms without windows have full spectrum, indirect lighting (500lx on children's work surfaces for reading and close work and 250lx ambient light for classroom and play areas).
				All rooms have windows to enhance the lighting quality (at least 8 % of the floor area if the windows face south and outdoors, 10 % if the windows face east or west, 15 % if the windows face north, and 20 % if windows are not on an exterior wall).
				Light fixtures in classrooms and nap rooms are dimmable in the range of 500lx to 50lx.
				Ceiling tiles have a high light reflectability (more than 80%).
Noise and Acoustics				
				We provide acoustic ceilings to control the interior noise.
				We provide a sound-attenuating wall finish for noisy areas.
				Doors opening onto noisy areas have a solid core.
				We provide baffles, banners or fabrics to absorb any high sound level.
Flexibility of Design				
				Each classroom has an open, unrestricted activity area.
				We use movable panels and walls which can be moved according to the space required for various activities.
				We use movable/storable chairs and tables which can be moved if necessary in order to make room for various activities.
				Every classroom has a view window at child level (window sill heights: 450mm for infants, 600mm for toddlers, and 750mm for pre-school children).

Key description

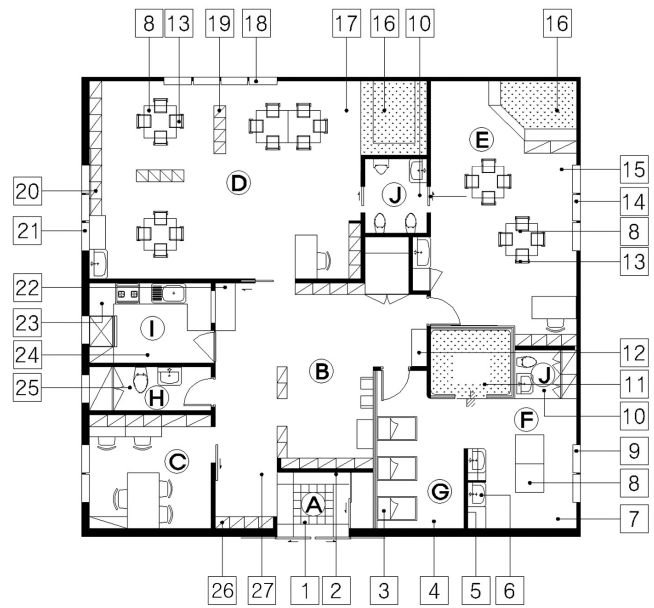
○ : Does meet recommendation

× : Does not meet recommendation

△ : Meet recommendation with exception(s)

N/A : Not Applicable

9. Windows and window treatments which can control direct sunlight and maximum windowsill height of 450mm for rooms where there are infants;
10. Child-height sinks, durable/non-porous/very cleanable ceramic tile floors and non-toxic cleaning supplies;
11. Infant crawl space with an easily removable, cushioned space for easy regular cleaning;
12. Very cleanable drinking fountain in the corridor or lobby;
13. If possible, stackable/hangable/removable chairs to accommodate various activities;
14. Windows and window treatments to control direct sunlight and with maximum windowsill heights 600mm above the finished floor for toddlers;
15. Hard/durable/washable floors and wall finishes, ceiling tiles with good light reflection to enhance the lighting quality of all areas;
16. Quiet reading or cuddling area with protective resilient surfaces, acoustic treatment, and easily cleaned materials;
17. Open and unrestricted space plan, hard/durable/washable floors, acoustic treatment on walls and ceilings, ceiling tiles with good light reflection;
18. Windows providing natural light with window shades or blinds;
19. Modular shelving or display racks made from post-industrial, recycled, wood fiber, and which can be easily cleaned and have a non-porous finish;
20. Modular, particle-board cabinets made from post-industrial, recycled wood fiber and which can be easily cleaned and have a non-porous finish;
21. Windows and window treatments to control direct sunlight, maximum windowsill heights of 750mm above the finished floor for preschoolers;
22. Completely washable and non-porous foods cart or low cupboards;
23. Kitchen with stainless steel countertops and completely washable, seamless wall surfaces;
24. Slip-resistant/impervious/durable/very cleanable ceramic tile floors, washable ceiling finish, and automatic sprinkler/fire alarm system/smoke detector;
25. Washable, slip resistant/impervious flooring, and washable wall finish above impervious wainscoting;
26. Personal storage cabinets and areas which are easily cleaned and have a non-porous finish;
27. Entry lobby and waiting area with a durable floor such as linoleum or rubber, formaldehyde-free medium-density fiberboard wall at wainscot height, and acoustic and adequate light-reflecting ceiling;



A Entrance
 B Multipurpose Room
 C Staff Office
 D Preschooler Classroom
 E Toddler Classroom
 F Young Toddler Room
 G Sleeping Areas for Infants
 H Staff Toilet
 I Kitchen
 J Children's Toilet

Fig. 1 Floor plan accommodating 30 children (136m²)²³⁾

5. Conclusion

The results of this study show that the current Korean childcare accreditation system and practices emphasize clean building interiors, policies for sanitation and cleanliness, and control of humidity and lighting. However, they do not yet have appropriate policies and services for protection from air pollution, including ventilation before occupancy, and services for protection from fire. On the other hand, the information provided by green-building rating systems from GBCC, LEED, and GBTool offers additional and comparative details regarding indoor environment quality and standards regarding the IAQ performance and management plan, ventilation and thermal comfort systems, views from windows, acoustics, and lighting. However, the current Korean GBCC compared with foreign rating systems has omitted certification criteria for preventing airborne bacteria, mold, etc. as well as creating a highly illuminated environment, some additional reinforcements in order to supply adequate levels of ventilation, avoid the use of materials high in pollutants, provide thermal comfort, assure acoustic comfort, facilitate IEQ through

²³⁾ The floor plan was one of results accomplished by this researcher's former study. Jinhie Chun, *op.cit.*, pp267-278. The plan and lay-out was used to suggest design recommendations conducted by this study.

flexible design in the Korean childcare accreditation system, will be required in order to make these facilities safer and more eco-friendly.

In conclusion, this document provides an appropriate and easy-to-follow, self-evaluation checklist composed of eight criteria and 51 practical items related to IAQ/Ventilation, IAQ/Finishes and materials, Fire protection and safety, Heating and cooling systems, Cleaning and sanitation, Natural light and illumination, Noise and acoustics, and Flexibility of design based on the domestic and foreign accreditation programs, the certification criteria for achieving the credits of green-building rating systems, and articles and guidelines dealing with indoor environmental issues regarding childcare facilities. This study also provides the design recommendations composed of 27 practical ideas focusing on interior elements such as floors, walls, ceilings, doors and windows, furniture, and equipment for each area of an eco-healthy childcare facility, which could be used for building providers, staff, and parents not only to eliminate these dangerous aspects but also to enhance the quality of the indoor, childcare facility environment. Both the checklist and design recommendations I have suggested can be a post-occupancy tool for evaluating eco-healthy facility standards as well as tips for continuing to maintain eco-healthy childcare facilities. However, the qualitative and quantitative measuring tools which occur based on the experiences gained through its use should be made in order to evaluate sustainable design achievements and expected building performance.

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