

# The Application of Green Ecological Concept in the Architectural Design of Kindergartens in Coastal Cities of Korea - Busan as an Example

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**Abstract.** Korea has accelerated its economic development with advanced science and technology and has been ranked among the developed countries. However, resource scarcity and environmental pollution problems in the country are becoming increasingly stressful, and energy conservation and environmental protection have become important issues in Korea. The development of green building design in most kindergarten buildings is lagging, and most kindergartens do not have the green design. In this paper, we take the representative green kindergarten buildings in Korea and Japan as examples and explore and study the green ecological design of kindergarten buildings in Busan, a city surrounded by the sea on three sides of Korea. This paper proposes improvement strategies and gives guidance for the future design of kindergartens in coastal areas.

## 1 Introduction

Due to the limited land area in Korea, kindergartens are often small in size and feature a high floor area ratio and low building density. The developmental characteristics of young children require a high indoor environment and a high demand for outdoor activity space. However, the reality is that there are problems of limited land use, poor indoor and outdoor space design, and comfort design, resulting in poor space applicability and richness and soft indoor comfort. Especially in the humid, sultry, windy, and rainy coastal climate, how to summarize the original architectural experience of coastal cities and form a modern green design strategy for kindergartens, deal with the architectural layout, space, and architectural details needed by children, and rationalize natural resources has become an urgent problem to solve. This paper uses field research, literature research, interview research, and other research methods. For the overall kindergarten environment, outdoor activity space, classroom interiors, building roofs, other field observation research, and statistical analysis of data to increase the accuracy of the research results.

## 2 Theoretical Research

### 2.1 Current situation and development trend of kindergartens in Korea

The number of kindergartens and the enrollment rate have been increasing year by year throughout Korea, as shown in the figure. The number of kindergartens nationwide is 8705, and the enrollment rate is 49.5%, which is an increasing trend compared to 8494 kindergartens and 26.2% enrollment rate in 2000<sup>[1]</sup>. Due to the limited land area in Korea, kindergartens are often small in size and feature a high floor area ratio and low building density. The developmental characteristics of young children require a high indoor environment and a high demand for outdoor activity space. However, the reality is that there are problems of limited land use, poor indoor and outdoor space design, and comfort design, resulting in poor space applicability and richness and soft indoor comfort. Especially in the humid, sultry, windy, and rainy coastal climate, how to summarize the original architectural experience of coastal cities and form a modern green design strategy for kindergartens, deal with the architectural layout, space, and architectural details needed by children, and rationalize natural resources has become an urgent problem to solve<sup>[2]</sup>. This paper uses field research, literature research, interview research, and other research methods. For the overall kindergarten environment, outdoor activity space, classroom interiors, building roofs, other field

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observation research, and statistical analysis of data to increase the accuracy of the research results. (see Table.1.)

**Table 1.** Kindergarten-related data for Korea 2000-2020

Year	Enrollment Rate	Number of kindergartens	Number of students	Number of faculty members
2000	26.2	8,494	545,263	28,012
2005	30.9	8,275	541,603	31,033
2010	40.2	8,388	538,587	36,461
2014	47.3	8,826	652,546	48,530
2015	49.4	8,930	682,553	50,998
2016	50.7	8,987	704,138	52,923
2017	50.7	9,029	694,631	53,808
2018	50.6	9,021	675,998	54,892
2019	50.2	8,837	634,314	51,583
2020	49.5	8,705	613,512	49,681

According to the statistics, there are 403 kindergartens in Busan in 2020, with 40,765 children. There are 116 public kindergartens and 287 private kindergartens, and from the data, private kindergartens are the main ones. (see Table.2.)

**Table 2.** Busan 2020 Kindergarten Related Data

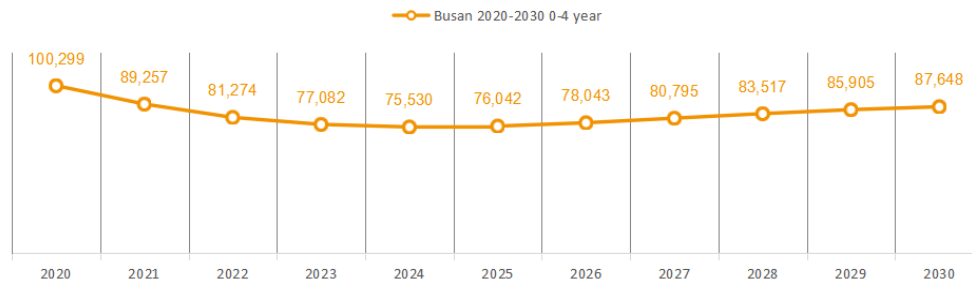
Region	2020 year	State	Public	Private	Total number
Busan	Number of kindergartens	-	116	287	403
	Number of Classes	-	454	1,691	2,145
	Number of children	-	8,201	32,564	40,765
	Number of teaching staff	-	669	2,798	3,467
	Number of new enrollment	-	4,173	13,232	17,405
	Number of graduated students	-	3,167	12,393	15,560

The birth rate of the population has an enormous impact on educational construction. Data from the National Statistical Center of Korea shows an overall downward trend in the national birth rate this year. In Busan Metropolitan City, the estimated population by the age of 0-4 years old is predicted to decrease from 100,299 to 87,648 in 2020-2030. (see Table.3.) As the population rate decreases, parents' demands for

kindergartens will also increase, which will lead to fierce competition among kindergartens. Then the construction of green kindergartens guarantees children's physical health and a particular expression of kindergarten education from the design level to improve children's psychological sense of use and the architectural design in terms of environmental education.

**Table 3.** Busan 2020-2030 Population Projection Data

Busan 2020-2030 (0-4 years old) Population Projection



## 2.2 Green Ecological Concept

A Green building is an ecological building and sustainable building. Green buildings can provide a more comfortable living environment is determined by their nature. Its content includes the building itself and the building interior and the building exterior environmental, ecological function system, and the construction of community safety, health, and stable ecological service and maintenance function system. Green building through the overall scientific design, integrated green configuration, natural ventilation, natural lighting, low energy consumption envelope structure, new energy use, water reuse, green building materials, and intelligent control and other high-tech, with reasonable site planning, efficient use of resources, energy-saving measures integrated and practical,


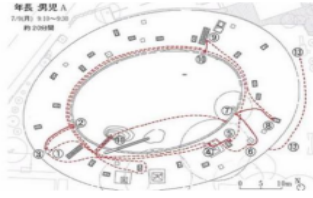
healthy and comfortable building environment, waste emission reduction and harmless, flexible and appropriate building functions and other characteristics.

## 3 Case Study

### 3.1 Fuji Kindergarten

Fuji Kindergarten in Tokyo, Japan, is like a school on the roof. In order to create a free space for activities without dead space, the designers deformed the whole building into an oval shape and did not install any playground facilities but turned the roof into a playground to enhance children's interest. Fuji Kindergarten completely breaks the boundaries between indoors and outdoors, and the significant plant coverage allows children to walk freely through and get in touch with nature. (see Table.4.)

**Table 4.** Fuji Kindergarten Green Building Analysis


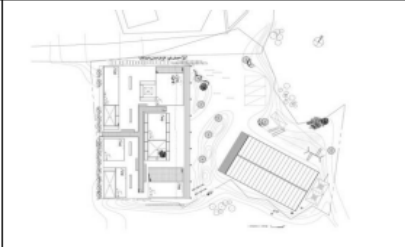
Name	Fuji Kindergarten	Country	Japan Tokyo	Establishment time:	2007
Basic information	Fuji Kindergarten, located in Tachikawa, Tokyo, Japan, was established in 2007 and selected by the Organization for Economic Cooperation (OECD) as the best educational building in the world. The kindergarten is oval-shaped, with an area of 4791.69 square meters. The project is a single-story elliptical structure that breaks down the physical boundaries of traditional early childhood buildings and encourages children to play and interact in an open and accessible environment. Giant sliding doors divide the interior and exterior spaces of the circular building and are open year-round, ensuring that children can move freely between indoors and outdoors and develop independence and social skills. The roof is the main playground for the kindergarten, providing ample space for students to run, jump and play.				
Image					
Rating	Weak : ○                      Medium : ◐                      Strong: ●				
Green Space	Continuity	Exposure	Facilities		
	●	●	◐		
Naturalness	Plant cover	Sunlight	watert		
	◐	●	○		

### 3.2 Amesol Kindergarten

The results of a field visit to investigate and analyze its facilities and surroundings show that Amisore Kindergarten is an early childhood education facility far from the city center. Hills surround the facility, a garden in front and a garden on the roof of the building, and many garden areas for hands-on experience. Natural

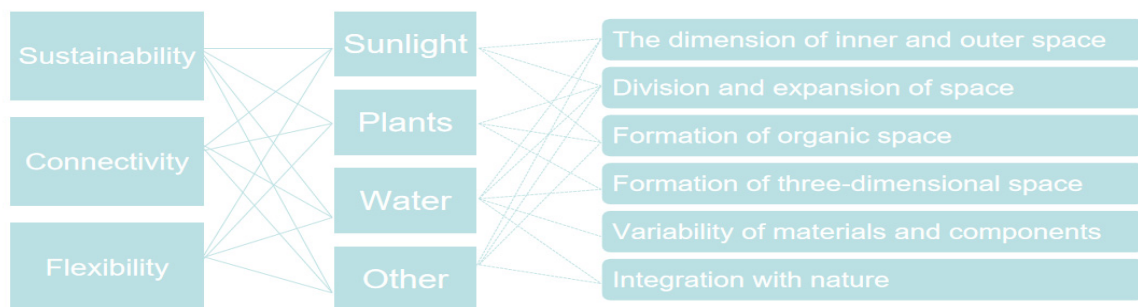
affinity factors-light, plants, water, dirt, and stones are everywhere. Such a spatial concept is continuous, and it is naturally easy to touch nature, feel it, learn it, and enjoy all kinds of forest games. More than the city center, the variety of experiences, both direct and indirect, has a significant impact on the development of young children. (see Table.5.)

**Table 5.** Amesol Kindergarten Analysis

Name	Areumsol Kindergarten	Country	Yangju City, Korea	Establishment time:2008
Basic information	2008 Korea Architects Association Award, with a floor area of 723.0 m <sup>2</sup> , where children live and learn and experience nature. They create a space for children to sing and dance in their bodies and learn the virtues of our society based on sharing and sharing. Founded by traditional musician and theater actor Kim Jong-ye, this place has a large outdoor playground of lawns and a rooftop garden of herbs and wildflowers where children can run and play in the forest, enjoy a nature-friendly experience, and nurture their creativity. There are a variety of fun and educational programs.			
Image				
Rating	Weak : ○                      Medium : ◐                      Strong: ●			
Green Space	Continuity	Exposure	Facilities	
	●	●	◐	
Naturalness	Plant cover	Sunlight	watert	
	●	●	◐	

Nevertheless, because some green building design kindergartens are far from the city center, many children in the city center can not receive education together. Then through the analysis of natural affinity factors and early childhood development, common spatial concept

characteristics from the principle of continuity, contact, and flexibility, the respective space applicable program through early childhood education facilities case study results of the analysis are as follows:(see Figure.1.)



**Figure 1.** Naturalistic association in space

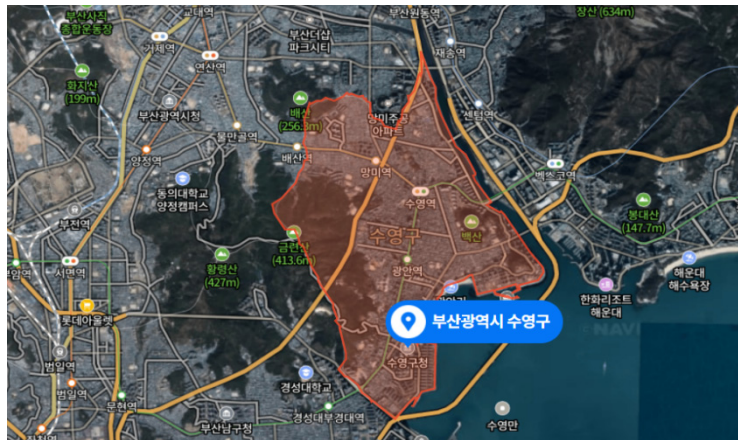
### 4 Design Practice

In kindergarten green design practice, we need to talk about energy conservation, ecological harmony, and design science. Children's educational facilities seek a comfortable, nature-friendly environment to achieve

family home-like comfort and physical and mental stability. Therefore, in this plan, the site was chosen in an area where the city center also has easy access to nature, and the building profile is as follows. We selected a vacant site in Suyeong-gu, Busan Metropolitan City, as the subject of our project. (see Figure.2.) The project center is well-equipped with facilities and convenient

transportation. The educational environment of the early childhood education facility utilizes nature-friendly factors, giving nature as a gift to children and planning the space for various early childhood education facilities that complement nature. The design concept of "sunshine,

air, rain, playground" is proposed through lengthy and detailed observation of young children's lifestyle and psychological characteristics, providing them with sunshine, rain, fresh air, and a safe and healthy play and living space.



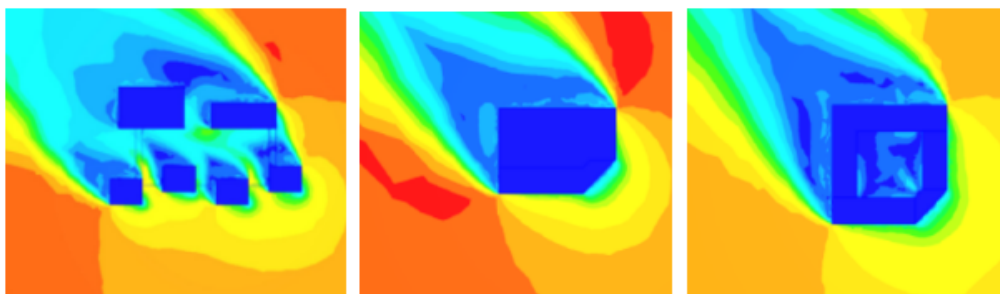
**Figure 2.**Busan Suyeong Program Address

#### 4.1 Building space design

In spatial planning, we thoroughly considered the children's needs in terms of lighting and activity space. Combining the local coastal climate conditions, making full use of the natural resources, and advocating energy conservation, the kindergarten decided to design a rainwater recycling system in the garden. Through rainwater collection, filtration, and storage techniques, water resources are recycled. After utilizing the rainwater collection system, improves the utilization rate of the kindergarten's water resources and dramatically reduces

the kindergarten's heat island effect. This design makes the whole kindergarten green, ecological, and environmentally friendly.

In order to see more clearly the difference of ventilation in different layout forms under coastal climate conditions, we used software to conduct a qualitative simulation of the layout ventilation. With the same north-south orientation and the same wind environment, the decentralized ventilation effect is the best in Image 1, the centralized effect is the worst in Image 2, and if conditions are limited, the courtyard type is also a good choice in Image 3. (see Figure.3.)



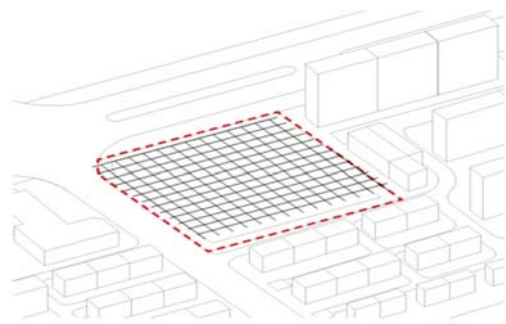
**Figure3.**Simulation of wind environment

#### 4.2 Renderings

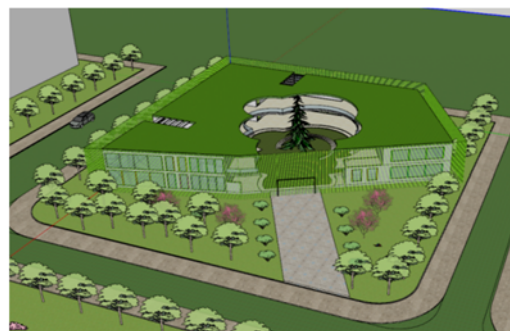
According to the actual situation, we chose the effect of

courtyard-type architectural design is shown in the figure..(see Figure.4.5)





**Figure4.** Sketch



**Figure5.** Renderings

## 5 Conclusion

Applying the green ecological concept to kindergarten architectural design is in line with the world's sustainable development concept and the concept of energy-saving and environmental protection green, which is the future development trend of education buildings. In the design process, we need to pay attention to the site selection of kindergartens, energy-saving, design integrity and safety, integration with nature, and other factors to provide a more green and ecological living environment for young children.

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\*These authors contribute equally to this paper and should be considered as co-first author

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