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Green Design for the Comfort Environment of Kindergarten Building in Malaysia: A review

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Abstract. Public buildings such as kindergarten can be used as a potential educational spot in promoting environmental sustainability for the children. Most of the public kindergartens in Malaysia are facing uncomfortable issues, such as due to the poor air ventilation and inefficient design at the respective building and facilities. By promoting green design and sustainability, this paper presents the synthesis of other studies, which consist of the factors and aspect approaches towards the application of green design in developing development of kindergarten building. This paper will review different articles and studies, which have published within 2009 until recently from the selected online database. Through green design at kindergarten, it is hoped to be able to promote sustainability for the children and foster designers to design more friendly buildings for them.

1. Introduction

A comfortable kindergarten building is important for the development of learning process for children in preschool environment. Since, children spend their time and play mostly within the building, therefore the building needs to be designed based on the specification of children's needs in order for them to feel the comfort while learning. In Malaysia, most kindergarten buildings not originally built as a function of kindergarten and need to renovate to fit the purpose of learning space for children [1]. Therefore, the buildings are facing several problems such as sick building syndrome, poor air quality [1] and inefficient physical design [2] due to the renovating activity. This may result uncomfortable environment, limited space for children to move around, to receive stack air within building and have potential to expose to poor air quality that lead to bad health [3].

Moving towards green and sustainability invention, the development of kindergarten building also need to be involved with the specification of green designs in order to achieve the best convenient level and become more children friendly. Since the awareness and application of green design in kindergarten have become attention for most developed country [4]. This paper tends to overlook the aspect of green design that influencing the development of comfortable environment kindergarten from the current literature review. The specific concerns of this paper are: (1) to identify the kindergarten development in context of Malaysia (2) to review the comfort factors and green design applications worldwide as a guideline for green and sustainable kindergarten buildings in Malaysia.



2. Methods

Literatures were selected based on different disciplines including green design, building design, environmental education, children's developments, and health. The combination of the keywords were used to guide the computerized search from online database consists of different articles and studies. The papers were selected from the literatures that have been published within a ten years period, starting from 2009 until 2018 including theoretical review and empirical article that consists of qualitative and quantitative of research. The aspects that consider include the factors, criteria, preferences, and importance of green designs in influencing the comfort environment of kindergarten buildings. As results, this paper will review and discuss the aspects of kindergarten development and green design applications for comfort environment of kindergarten buildings.

3. Kindergarten Developments

The development of kindergarten building and its facilities is important to ensure the quality of learning for the children. According to the Education Act 1996, Act 550 [5], kindergarten is defined as any places where pre-school education (children with age 4 years to 6 years old) is provided to ten or more pupils. This can be understood that kindergarten become as a place that is set up in order to facilitate the preschool education in Malaysia.

In developing kindergarten building and its facilities, *Jabatan Perancangan Bandar dan Desa Semananjung* Malaysia has introduce specific outline in order to starting set up of the kindergarten. According to *Garis Panduan Penubuhan Taska dan Tadika* [6] several criteria has been outlined which are site planning, building design, establishment process of kindergarten, implementation and payment rate for establishment of kindergarten.

A good environment of kindergarten were designed based on four important environmental stimuli, which are movement, comfort, competence, and control [7]. Research in early childhood environment found that, children require comfort environment, facilities and space to foster their quality of learning [2]. This shows that, the fulfillment of comfort parameter is crucial in developing physical-sensory, socio-emotional and mental development of children toward progress of adulthood [8]. This becomes focus for this study.

4. Comfort Environments for Children in Kindergarten

Comfort defines as a reaction to the environment that is strongly influenced by cognitive and behavioral processes that is controlled by habit and sensation of human [9]. Since children spend most of their time inside buildings, it is very important to maintain the comfort level during learning activity. Therefore, the design and planning of the building and educational facilities need to be considered in the aspect of comfort in order to achieve the conducive and effective learning for students. Since kindergarten becomes a place for children to explore and learn, the comfort environment of kindergarten is served when the children feel comfortable with their physical surrounding through its convenient setting [7]. The consideration of comfortable setting can be felt in variation of architecture elements such as scale, height, lighting, and finishes material that involve systematic manipulation of space to achieve comfort environment [2].

4.1. Factors Influencing Comfort Environment

There are several comfort parameters in creating appropriate space for children to feel comfort during stay in kindergarten building. The identified comfort parameters are air comfort, space comfort, light comfort, and aesthetic comfort specifically for indoor environment of the building [8-10].

4.1.1. Air and thermal comfort

The indoor and outdoor air quality of kindergarten is important for children's health and development. Children require good indoor air quality to influence their growth and wellbeing development [3]. Therefore, the implementation of good and natural ventilation system is important for children. In order to enhance the comfort, the quality of fresh air regulates the air humidity, removes odor, lower

dust content and keep the thermal comfort of the buildings [8]. Special attentions are needed when selecting proper finishing materials for interior surfaces such as floors, walls, ceilings, and other surfaces of kindergarten [11].

It might be harmful for the children health and performance if the selected material contain unsafe ingredient. Thus, the use variety type of natural and man-made materials such as wood, brick, concrete, steel, and plastic such as polycarbonate board can become more eco-friendly for the children [4]. The materials used to construct the kindergarten need to have pleasant texture in order to keep the comfort temperature of the kindergarten building, although without the use of any mechanical cooler. Besides that, the use of natural elements such as deciduous trees and indoor plants can keep the environmental quality of the kindergarten. Plants act as filter from direct sun, keep room temperature, and promote sustainability solution for the building.

4.1.2. Space comfort

The space and size of surrounding kindergarten may different based on design guideline of the country. As for context of Malaysia, the provided overall space for kindergarten is divided based on the guideline from *Jabatan Perancangan Bandar dan Desa Semenanjung* Malaysia. The space for the kindergarten is divided by two types of space which are floor space and open space (total space =166m²). As example from other developed countries the floor area or space of kindergarten depending on the capacity of the building (number of children) and based on the aged of the children [4]. The space of the kindergarten building is divided into three main spaces which are child area, staff area, and service area (total space = 162m²).

To ensure the comfortable spaces, the organization, circulation, and shape of the space need to take into consideration so that children can move around and do activities [8]. The daily activities of children (such as reading, writing, listening, playing, and etc.) require optimization of space and function by providing subdividing zone to improve the comfort of the children movement. Although most of kindergarten space is controlled by the standard, designers need to be smart in arranging the space by promoting innovative solutions to make the space more children-friendly. It is to ensure the safety and comfortable environment for the children.

Since, most kindergartens in Malaysia are developed in the existing built up dwelling type of building [2]. The provided spaces are limited and the arrangements of children's space need to be designed in minimize area. Therefore, the important of circulation in helping children to move around and become separate area between children activity area and others spaces [4]. Moreover, the selection of furniture and facilities such as toilet needs to be in proportion and have suitable height for children for easy access without assistance from teacher [7].

4.1.3. Light Comfort

Light comfort associates with the existing daylight and artificial lighting, which are built in the building. As for kindergarten building, the specific parameter such as window position, window area, glazing type, intensity of color and type of artificial light can influence the light comfort of kindergarten [8]. In supporting the idea of sustainability, the use of efficient window and skylight can increase the application on natural daylight in school [12]. As a result, the sufficient light comfort is important to achieve more pleasant environment and visual comfort effect of kindergarten.

In term of color and lighting, most of the walls are painted and decorated with appropriate color and displayed mural to attract children's interest in learning. The sufficient of natural sunlight is encouraged for most kindergarten designs to encourage children movement. However, most of kindergarten in Malaysia facing limited daylight effecting from existing building designs such ad dwelling and commercial building [2]. Due to that reason, children need to use mechanical lighting during learning session, as a result children is exposed to the excessive artificial light and limit children's sensory motor [13].

4.1.4. Visual and aesthetic comfort

The visual appearance and aesthetic comfort also can become aid for children in developing their physical and mental development [2]. Therefore, the places where children spend their time need to be aesthetically pleasant and beautiful to attract children attention. The interior space elements, texture, shapes, colors and size play significant roles in creating aesthetic comfort of kindergarten buildings. Somehow, aesthetic comfort may be affected by arrangement of space that utilize the senses such as eye contact, feel to touch, and experience for interaction [8].

4.1.5. Acoustic comfort

The noise can affect children's academic performance for two reasons, which are noise distraction and make them unable to understand the teacher due to the inappropriate level of signal-to-noise ratio and articulation loss of consonants [14]. Children that chronically exposed to the noise distraction will affect in lower reading scores rather than those that live in quieter surrounding [15]. This shows that, the acoustic conditions of a classroom are particularly important for children as younger learners [16]. The distraction of noise usually come from the noise from traffic, building system, exterior and adjacent space sound transmission, noise from HVAC, and plumbing system [17].

5. Green design applications for comfort environment of kindergarten building

The use of green application is one of strategies in modern sustainable architecture. Green design involves a holistic approach in designing, which include the green material that contributes to the need of the user to promote the sustainability [18]. In the context of school, the green application can involve in various aspects such as improvements is additional daylight, improved indoor air quality, enhanced classroom acoustics, and comfortable and consistent indoor temperatures [19]. Previous researchers, particularly from Malaysia and other countries have proven that, the application of natural elements such as vegetation, integrated design and technology can become a solution to maintain the comfortable environment of the building. Table 1 indicates the implementation of green design can be applied in influencing comfort environment of kindergarten building in Malaysia.

Since Malaysia is still looking towards the development of green design in the country, the establishment of green design is more focusing towards the non-residential building [35], residential building, the township [36], and the lack consideration of school building [17]. Unlike, other western and developed countries, the green design specifically introduces for school building including kindergarten [37]. As Malaysia is situated in the tropics and hot climate region, the application of green design aspect needs to be considered in the design of the building with the respond towards the climate and culture to maintain the comfortable environment of kindergarten.

Table 1. Implementation of green design based on comfort factors

Comfort factors	Green design application	References
Air and thermal	Natural elements - Vegetation influenced microclimate surrounding - Green structure: covering vegetation, isolated trees, groves and lines of trees - Indoor plants - Passive design: natural ventilation, courtyard	[20] [21] [22] [23] [24] [25] [26]
	Integrated design and technology Rooftop garden and living wall	[27] [28]
Light	Natural elements - Matured tree: shading and solar filtration	[29]
	Integrated design and technology - Solar energy system - Skylight	[30] [4]
Space, visual and aesthetic	Natural elements - Landscape design: plants arrangement - Biophilic design	[31] [32] [33]
	Integrated design and technology Eco building material : timber, double glass façade solar, light steel structure	[34]
Acoustic	Natural elements Plants: reduce pollution and become barrier for noise	[21]

6. Conclusion

Literature reviews indicated that there are four important comfort factors influence the development of kindergarten buildings which are thermal, light, space, aesthetic and acoustic comfort in Malaysia and other countries. Through consideration of green design, several examples and study of existing kindergarten have been developed in most developed country, which resulted in several ecological and integrated approaches in the implementation of green design for kindergarten building. Thus, the diverse solution through green design can change the formal physical kindergarten building in Malaysia toward more sustainable buildings in the future.

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