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ABSTRACT

The application of green building principles in school buildings is a crucial component for improving the environmental quality of education-based, participatory and sustainable. Therefore, this study was focused on evaluating the fulfillment of green building criteria at Adiwiyata Mandiri Elementary School in Malang City. Descriptive qualitative research method analyzes conducted in this study by taking the object of study in Tunjungsekar 1 Public Elementary School and Insan Amanah Elementary School Malang. The results showed that the fulfillment of the green building criteria at the Adiwiyata Mandiri Elementary School in Malang City has not been optimal to fulfill the principles of green buildings, including site management, energy and water efficiency, materials utilization, improvement of the quality of health and comfort in indoor spaces, and environmental management of buildings.

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INTRODUCTION

Generally, school buildings have high energy consumption due to high occupancy rates and unique building user patterns (Elmasry, S. K. & Haggag, M. A. 2011). One of the strategies to increase energy efficiency is through optimization of green building design planning, both passively and actively.

The Green School Festival (GSF) activity program has been initiated by the Malang City Education Office with an emphasis on environmental quality improvement activities on a micro-scale, starting from the school environment. This is an innovative and creative program for Malang City Government, agencies, schools, media, and stakeholders to instill awareness of environmental care from an early age in elementary schools particularly.

On the other hand, there is also the Adiwiyata program promoted by the Ministry of Environment by giving the National Adiwiyata Award to selected schools, as well as the Adiwiyata Mandiri award. The emphasis of Adiwiyata principles prioritizes educational values, the character development of environment care, and sustainable development in elementary school level education curriculum units. This is the basis for the author's consideration to determine the object of

the research study at the Adiwiyata Mandiri National for Elementary School, namely SDN Tunjungsekar 1 and SD Insan Amanah Malang City.

Adiwiyata school program implements a character education program, where Adiwiyata means green. the Green school program is expected to be a strategy for environmental quality improvement to waste reduction such as plastic, energy, and water conservation, by promoting a healthy lifestyle, also developing active partnerships with society (Desfandi, M. 2015). Therefore, the values of environmental care will be obtained by students and they can become the development agents towards green sustainability (Prasetiyo, W. H., et al. 2020).

Green building principles play an important role in sustainable planning and development. The green building concept works within the framework of the sustainability concept (Wonorahardjo, S., & Sutjahja, I. M. 2018). The green building concept has three (3) main foundations, namely environmentally-friendly (air, water, and land), energy-friendly, and human friendly.

This study is focused on evaluating the fulfillment of green building criteria in the design of Adiwiyata Mandiri Elementary School buildings as an effort to realize sustainable architecture. This research is expected to be useful in developing knowledge related to the optimization of passive and active systems strategies for green buildings in elementary school buildings.

Green Building Council Indonesia (2016) describes the criteria for green building, including:

a. The accuracy of site development.
b. Conservation and energy efficiency of buildings.
c. Water conservation.
d. Source and material cycle.
e. Indoor comfort and health.
f. Building environment management.

One of the passive design planning for green buildings is through passive lighting optimization. This can be done through optimization of the shape of the building, orientation of the building facade, spatial design, thermal insulation on the roof, and thermal insulation on external walls of the building (Ragheb, A., El-Shimy, H., & Ghada, R. 2016).

Ramli, N. H, et al (2012) explained that green schools are facilities or school buildings that can create a healthy environment, conducive learning, conserve energy, resources, and costs. Gordon, D. E. (2010) states that green schools are the physical results of planning, design, and construction processes in the entire building life cycle for 50-60 years by maximizing resource efficiency, minimizing pollution, and teaching students about the importance of innovation in the built environment.

General characteristics of green schools, namely (United States Green Building Council, 2008):

a. Conservation of energy and natural resources.
b. Indoor air quality improvement.
c. Toxic-free from children's playground and learning.
d. Optimization of natural lighting strategies and classroom acoustics.
e. Reduction of sewage and wastewater in municipal waterways.
f. Waste management and recycling.
g. Drinking water saving and rainwater reuse.
h. Promotion of habitat protection.
i. Local landfills reduction.

METHODS

The descriptive research method of qualitative analysis in this research is carried out through field observation techniques, interviews, and filling out questionnaires as primary data collection, as well as secondary data collection through the study of scientific articles, literature, books, SNI, government regulations, and so on. The development analysis method is described descriptively from the primary and secondary data sets. The research variables studied were related to the fulfillment of green building criteria, namely site management efficiency, energy, water, materials, improvement of indoor health and comfort quality, and environmental management of Adiwiyata elementary schools in Malang. The research instrument uses digital meters, cameras, cellphones, drawing paper and writing instruments. The research location was conducted at the National Level Mandiri Adiwiyata Elementary School, namely Tunjungsekar 1 Public Elementary School and Insan

Amanah Elementary School, Malang City. Tunjungsekar 1 Public Elementary School was also the only elementary school from Indonesia that succeeded as the ASEAN Eco-School category.

(a) (b)

Figure 1. Location and Object of Research Study; (a) Tunjungsekar 1 Public Elementary School, Malang City; (b) Insan Amanah Elementary School Malang City. Source: Google maps, 2020.

RESULT AND DISCUSSION

Analysis and discussion of the evaluation of the fulfillment of green building principles of the object study can be seen in Table 1-6.

Table 1. Site Development Efficiency of Green Building Criteria

NO	GREEN BUILDING CRITERIA	AVAILABILITY	
		Available	Not Available
1	Site management policy	√	
2	Motor vehicle reduction policy	√	
3	Pedestrian accessibility – *the disabled user friendly*		√
4	Site landscaping - green space optimation	√	
5	Stormwater management		√
6	Environment quality improvement	√	
7	Heat island reduction	√	

Source: Author's analysis, 2020.

Table 1 explains that the site management strategy at Adiwiyata Elementary School has implemented site quality maintenance, landscaping by providing green open space, in the form of parks, ceremonial fields, sports fields, and vertical gardens with local vegetation types covering 40% of the total site area. Use of organic fertilizers, as well as the use of sloping roofs (gable and shields), is certainly very useful for reducing the impact of local heat islands, management of ground and surface water management, utilization of bio pores for composting, biopore maintenance, improvement of biopores, making biopore maps, also biopore training, as well as a compact site development pattern to optimize green open space as active open space. Utilization of this biopore hole is optimally carried out on Insan Amanah Public Elementary School. The construction of elementary schools can also minimize long-term impacts, as well as provide facilities for pedestrians that are comfortable, safe for children and adults alike. The provision of parking spaces for private vehicles, both four and two-wheeled is also provided in limited outdoor spaces. Efforts are also made to improve the quality of the environment for the surrounding community through the development

of child-friendly based programs and programs for caring the environment in the form of greening activities and creating technological innovation works.

The volume of rainwater runoff from the site is flowed directly into the city drainage channel as in Tunjungsekar 1 Public Elementary School because there is no rainwater storage tank on the school grounds, which should be optimized so that it can be used as a source of irrigation for the school landscape. The pedestrian facilities for the disabled people are also not found in the building of the object of study because there is no special admission of the disabled students.

Table 2. Energy Conservation and Efficiency of Green Building Criteria

NO	GREEN BUILDING CRITERIA	AVAILABILITY	
		Available	Not Available
1	Energy management and plan policy	√	
2	Building energy performance		
	a. Opening to wall ratio	√	
	b. Shading device	√	
3	Building Energy Performance Optimation		
	a. Periodic electricity consumption		√
	b. Lighting effectiveness		√
	c. Gas consumption efficiency	√	
	d. Use of Air Conditioning		√
	e. Vertical transportation (lift)		√
4	Using electronic equipment		
	a. Energy-efficient label for the electronic device		√
	b. Use of lighting automation features in public and service areas		√
5	Energy monitoring and control		√
6	Operation and maintenance building energy		√
7	On-site renewable energy - energy alternative source	√	
8	Less energy emission		√

Source: Author's analysis, 2020.

Table 2 shows the energy-saving strategy in elementary school buildings, which can be seen from the installation of posters of the environment cares through efficient use of lights according to the needs of the toilet area and classroom; use of shading elements in the form of canopy and shade vegetation in outdoor spaces; there is a wide opening in the classroom window; use of special gases for kitchen purposes in the school canteen; There is no air conditioning and elevator in the school building considering the number of building floors is only two (2) floors so that the use of stairs as a means of vertical transportation is sufficient.

On the other hand, the energy efficiency system in the building of the study object has not fully met the criteria for green buildings, including the use of electronic devices labeled energy saving and automation of artificial lighting in each room; there are still classrooms and school corridor areas that require lights during the day; there is no control system and data monitoring of energy use from kWh meter, both the lighting system and the periodic air system; there is no energy display in the public space; there are no guidelines regarding the operation and maintenance of all electronic devices and alternative sources of electric energy; as well as all energy sources obtained from the use of PLN electricity, not from the use of other renewable energy sources with lower emissions, such as gas or solar power. The use of solar panels at Insan Amanah Elementary School is currently being used as a prototype model for supporting garden lighting also school teaching and learning media, and it should also be optimized in the future as an alternative energy source in optimizing the energy efficiency of school buildings.

Table 3. Water Efficiency (Conservation) of Green Building Criteria

NO	GREEN BUILDING CRITERIA	AVAILABILITY	
		Available	Not Available
1	Water management policy	√	
2	Water sub-metering in a public area and building utility		√
3	Water monitoring control		√
4	Freshwater efficiency	√	
5	Water quality control	√	
6	Recycled water		√

NO	GREEN BUILDING CRITERIA	AVAILABILITY	
		Available	Not Available
7	Water portable	√	
8	Deep well reduction	√	
9	Water tap efficiency - use of the auto stop feature in public areas		√

Source: Author's analysis, 2020.

Table 3 shows that the water efficiency system of the study object has been carried out through the installation of writing on water use efficiency according to the needs of the toilet, saving on consumption of ready-to-drink and ready-to-use water, recording routine consumption of water use every month, using portable water station in the form of a "Zona Air Minum" (ZAM) PDAM, which is a ready-to-drink water device, as well as reducing clean water consumption through the use of deepwater wells.

However, the overall water efficiency system can be stated that it is not optimal because of the water management monitoring system; the system of use, inspection, and maintenance of the plumbing system has not been carried out regularly; there is no sub-meter of water consumption in public areas and building utilities; clean water source quality control system; rainwater generally directly seeps into the soil and is not optimized as an alternative water source or landscape irrigation source; the use of used water is also not optimized as recycled water that can be used for garden irrigation or toilet flushing; the portable water use and maintenance system also does not have regular monitoring so that when the ready-to-drink water equipment leaks or breaks, it does not immediately receive a repair; and there is no use of the auto stop feature on water taps in public areas.

Table 4. Material Efficiency (Resource and Cycle) of Green Building Criteria

NO	GREEN BUILDING CRITERIA	AVAILABILITY	
		Available	Not Available
1	Use of AC non-CFC refrigerants		√
2	Use of environmentally friendly materials policy		
	a. Local or regional production	√	
	b. ISO/ SNI/ Ecolabel material certificate		√
	c. Pre-fabrication materials		√
	d. Use of "reduce, reuse, and recycle" materials	√	
3	Waste management practice	√	
4	Hazardous waste management		√
5	Used good management	√	

Source: Author's analysis, 2020.

Table 4 shows that the material efficiency use in the object study is carried out through the absence of non-CFC refrigerant AC facilities; use of environmentally friendly materials in the form of locally or regionally produced materials; reuse and recycle materials in the form of using plastic materials, used cans and bottles, cloth scraps, etc. to become handicraft products, such as purses, bags, t-shirts, etc. by involving teachers, students, and their parents; reduction of packaging waste from plastic and/ or styrofoam; sorting organic and non-organic waste bins; as well as processing organic waste with the 3R principle (reduce, reuse, and recycle), such as at Tunjungsekar 1 Elementary School by making eco-print batik works using coloring materials from leaves, utilizing organic waste from star fruit through the composting system to become an innovative plant liquid fertilizer product.

On the other hand, the use of materials labeled ISO/ SNI/ ecolabel and pre-fabrication has not been applied to the building of the study object, and there is no standard operating procedure for waste management or hazardous waste management, such as lamps, batteries, printer ink, and other hazardous wastes for disposal of B3 waste is safe for the environment.

Table 5. Indoor Health and Comfort of Green Building Criteria

NO	GREEN BUILDING CRITERIA	AVAILABILITY	
		Available	Not Available
1	No smoking campaign	√	
2	Low emission interior materials & VOC (*Volatile Organic Compounds*)		√
3	Indoor air quality measurement		√
4	CO and CO2 indoor monitoring		√

NO	GREEN BUILDING CRITERIA	AVAILABILITY	
		Available	Not Available
5	Measurement of indoor air pollutant		√
6	Thermal comfort	√	
7	Visual comfort		√
8	Acoustic level		√
9	Building user survey; thermal comfort, acoustic comfort, lighting, building cleanliness, building health		√

Source: Author's analysis, 2020.

Table 5 relates to the application of green school criteria to the indoor health and comfort aspects of the study object. The existence of a smoking ban in the school environment and there are no special smoking rooms, as well as the wide openings with flowing circulation in classrooms that are in a row, certainly have a positive impact on indoor health and comfort quality. However, the type and design of passive openings, as well as active lighting and ventilation strategies in classrooms at the corner and corridors between classes need to be designed properly to fulfill green building criteria.

Periodic air quality measurements, the use of low-emission materials and Volatile Organic Compounds (VOC) in the room, CO and CO_2 gas control systems, thermal comfort measurements, visual comfort seen from the lighting level of each room, and room acoustics have also not been found in the study object. In addition, surveys of building user comfort related to aspects of thermal comfort, lighting, acoustics, cleanliness, and building health have not been conducted periodically.

Table 6. Building Environmental Management of Green Building Criteria

NO	GREEN BUILDING CRITERIA	AVAILABILITY	
		Available	Not Available
1	Operation and maintenance policy of building utility		
	a. Wastewater system		√
	b. Drainage system		√
	c. Fire protection system		√
	d. Mechanical Electrical Engineering system		√
	e. Waste management system	√	
2	Building innovation		
	a. A "healthy and energy-efficient" user behavior management approach	√	
	b. Green school program	√	
	c. Environmentally school program	√	
3	Building design and green technology		√
4	Operation and maintenance training of green building	√	

Source: Author's analysis, 2020.

Environmental management of green school buildings in table 6 is applied through an innovative approach to user behavior management and implementation of green school programs to be more energy-efficient, child friendly, and environmentally caring, such as active participation in the annual Green School Festival (GSF) which involves all school employees, students, and parents; school greenery program; the habit of scattered garbage picking up; utilization of organic waste into commercial products; children's reading corner facilities for literacy culture; traditional playground; poster of the environment care; as well as creative innovation of green technology works through simple technology such as solar panels as a garden lighting. Training on green school operation and maintenance systems on-site management, energy, water, materials, and air quality has also been carried out every year by becoming a pilot school as the National Adiwiyata School, where the application of participatory, educational, and sustainable principles has been integrated into the school curriculum program.

Meanwhile, the building design and the application of green technology have not been fully implemented, where the corridors between classes still need artificial lighting during the day, the design of classroom modules and classroom openings in the corner are insufficient for daylight and ventilation. The operational and maintenance management systems for building utility systems based on green design, both distribution and plumbing systems for clean water, dirty and wastewater, drainage, fire protection, and mechanical electrical engineering have not been optimally implemented, while the waste management system has begun to be implemented until product processing innovations have emerged from organic waste into a commercial product.

CONCLUSION

The implementation of green buildings in the buildings of the National Adiwiyata Elementary School in Malang City has not fully implemented the management of land efficiency, energy, water, materials, indoor comfort, and health quality, as well as building environmental management. Generally, the optimization of green building principles at Adiwiyata Mandiri Elementary School in Malang can be seen from the availability of a Green Open Space of at least 40% on the site, sorting organic and inorganic waste, utilization of biopores, organic waste processing into a commercial product, plastic and/ or styrofoam packaging waste reducing, use of used goods with the 3R principle (reduce, reuse, recycle), creation of innovative solar panel technology products, as well as energy conscious and environmental-care school activity program by involving the active participation of all school users and parents. Meanwhile, energy management systems, such as the use of electronic appliance automation features and energy-saving labels, the use of renewable energy sources as alternative energy sources; water management systems, such as using autostop features on water taps, rainwater management, wastewater management; utilization of environmentally friendly materials, hazardous waste (B3) management; strategies to improve air quality, lighting, and indoor acoustics; user comfort surveys; Green technology innovation as well as operating systems and maintenance of building utility systems which need to be gradually optimized at the National Adiwiyata Elementary School so it can become the sustainable program for green schools.

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