

Green Building Implementation at Schools in North Sulawesi, Indonesia

D A J Harimu*

Universitas Negeri Manado, Tondano 95618, Sulawesi Utara, Indonesia

*dr_debbie_harimu@unima.ac.id

Abstract. This research aims at investigating the green building implementation at schools in North Sulawesi, Indonesia; and to analysis the relationship between implementation of green building concept at school with students' green behaviour. This research is Survey Research with quantitative descriptive method. The analysis unit is taken purposively, that is school that had been implemented the green building concept, Manado's 3rd Public Vocational High School, Lokon High School at Tomohon, Manado Independent School at North Minahasa, and Tondano's 3rd Public Vocational High School. Data collecting is acquired by observation and questionnaire. The Assessment Criteria of green building on Analysis Unit, is taken from Greenship Existing Building ver 1. There are 4 main points that being assessed, which are Energy Conservation and Efficiency; Water Conservation; Indoor Health and Comfort; Waste Managerial. The Analysis technique used in this research is the simple regression analysis. The result of the research shows that there is a significant relation between green building implementation at school and students' green behavior. The result is accordance with the Gesalts Psychologist theories, that architecture can change the user's behaviour.

1. Introduction

Global warming is not only a story comes from a land far away; about gas pollution, huge factory disposal, melting ice, polar bear in the verge of extinction, and descending agricultural land in Africa are truly real. On the other side, most of people assume that the effect of global warming will only happen in tens year ahead. Unaware that the horrible effect from the global warming is coming closer to visit our lives. The impact can be felt now, likes the disorderly seasons, flood and drought happens at the same time, disaster often occurs related to the climate. In Indonesia, since 2003, has occurred 4 times escalation of disaster. In 2003 to 2005, there were 1.429 disasters and approximately about 53.3% among them, related to the climate, hydrology, such as flood, drought, forest fires and typhoon. In North Sulawesi, in recent years has occurred a wretched disaster [1].





Figure 1. In 2014 and 2015, a great flood happened in Manado



Figure 2. In 2015 forest fires, including the forest in the valley near Mount Lokon

In 2014 and 2015, a great flood happened (**Figure 1**), caused many people lost their lives, damaged home, and landslide followed by a long drought that caused forest fires in 2015 (see **Figure 2**), including the forest in the valley near Mount Lokon [2]. In truth, every of our choices and habits, like in choosing transportation, building, up to the habits of saving energy, water and not to carelessly littering, contributes importantly in the deteriorating global warming, or we can be the solution [3][4][5].

Based on the experiences from the disasters occurred in recent years, seems that the schools, especially in Manado, in Minahasa, and North Sulawesi in general, has started to introduce students about the go green act, and trying to implement the green building concept into their infrastructures at school. Such act can be seen through the slogans hang on the wall and school's magazine board (*madding*), also the availability of trash can, separating the organic and non-organic waste, and etc. This is interesting and urgent to be investigated and discussed, about the application of the concept of green building at school in Minahasa affecting the go green habits of theirs students. According to the explanation in the background, the research questions of these researches are; what are the green building concepts that have been implemented at schools in Minahasa? And how is the effect of implemented green building concept toward students' go green habits at schools in Minahasa?

2. Research Methods

The analysis techniques used in this research are the simple regression analysis and descriptive analysis. In order to get a representative picture, thus the research location was held in Manado, Tomohon, North Minahasa and Minahasa. The objects of the research from schools can see in **Figure 3**.



UNIT OF ANALYSIS 1	SMKN 3 Manado JL. POMOROUW Taas Kec. Tikala Kota Manado Prop. Sulawesi Utara.
UNIT OF ANALYSIS 2	Persekolahan Lokon Santa Nikolaus Tomohon, JL. PERLOMBAAN NO. 99, KAKASKASEN DUA, Kakaskasen Dua Kec. Tomohon Utara
UNIT OF ANALYSIS 3	Persekolahan Manado Independent School MIS JL. WALANDA MARAMIS, Kolongan Tetempangan Kec. Kalawat, Kab. Minahasa Utara Prop. Sulawesi Utara
UNIT OF ANALYSIS 4	Persekolahan SMKN 3 Tondano, JL. GUNUNG AGUNG Rinegetan Kec. Tondano Barat Kab. Minahasa Prop. Sulawesi Utara

Figure 3. The object of the research location in Manado, Minahasa, North Minahasa, North Sulawesi, Indonesia.

3. Results and Discussion

3.1. Implementation of “Green building” concept

Criteria assessment of the implementation of green building concept at analysis unit, conclude from green ship rating tools for established building, version 01. There were 4 main points that was assessed, which were; 1) energy efficiency and conservation; 2) water conservation; 3) indoor health and comfort; 4) waste managerial [6] [7].

The field observation result of the energy efficiency and conservation shows in **Table 1**. There are four unit of analysis schooling in North Sulawesi only applied given electric meter for every building (**Figure 5**), only some of them regularly do the evaluation to calculate the use of energy, and three unit of analysis prioritizing natural lighting (**Figure 4**) and the management of room temperature by air ventilation of each room. Four unit of analysis schooling in North Sulawesi didn't apply OTTV circulation, on site renewable energy, and anticipate climate change impact.

Table 1. Implementation of the energy efficiency and conservation

No	Green Building Criteria	Unit of Analysis			
		1	2	3	4
1	Electrical Sub Metering	•	•	•	•
2	Energy Efficiency Measure	X	•	X	•
3	Natural Lighting	•	•	X	•
4	Ventilation	•	•	X	•

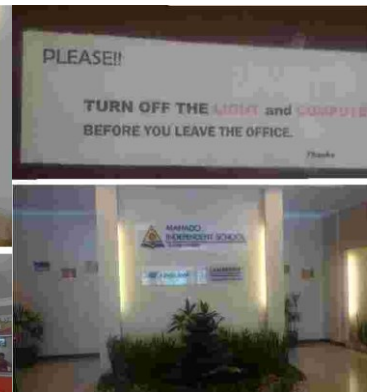


Figure 4. Natural lighting at unit of analysis 2

Figure 5. Electrical lighting for all day at unit of analysis 3

The field observation result for water conservation shows in **Table 2**. The application of water conservation of four unit of analysis at schools in North Sulawesi is the implementation of the total amount of water use, water circulation, rain water catchment (**Figure 6**), and efficiency (**Table 7**) in using the water for the field, and also the availability of water absorption at school environment. Four unit of analysis schooling in North Sulawesi didn't apply water use reduction, water fixtures, and alternative water resources.

Table 2. Implementation of the water conservation

No	Green Building Criteria	Unit of Analysis			
		1	2	3	4
1	Water metering	•	•	•	•
2	Water circulation	•	•	•	•
3	Water recycling	•	X	X	•
4	Rainwater harvesting	X	•	X	X
5	Water efficiency landscaping	X	•	X	X

The field observation result for indoor health and comfort shows in **Table 3**. The application of indoor health and comfort aspect of four unit of analysis at schools in North Sulawesi is about the application of fresh air circulation from outside to inside the room (**Figure 8**), minimizing the use of machine or motor transportation that produces CO, no smoking area at every corner of the schools, paying attention to the thermal comfort and protecting each classroom from noises.

**Figure 6.** Rainwater harvesting at unit analysis 2**Figure 7** Water inefficiency landscaping at unit analysis 3**Table 3.** Implementation of indoor health and comfort

No	Green Building Criteria	Unit of Analysis			
		1	2	3	4
1	Outdoor air introduction	X	•	X	X
2	CO monitoring	X	•	X	X
3	Environmental tobacco smoke control	X	•	X	•
4	Thermal comfort	X	•	X	•
5	Acoustic level	X	•	X	X



Figure 8. Landscape of unit of analysis 2 **Figure 9.** Availability of trash bin and waste application of fresh air circulation from outside to inside the room separation in unit of analysis 1 and unit of analysis 4

The field observation result for waste managerial shows in **Table 4**. The availability of trash can in every corner of school environment; along with the regular schedule to dump the trash are the aspects that have been done at the observed four unit analysis (see on **Figure 9**). Four unit of analysis schooling in North Sulawesi didn't apply composting the waste and didn't use waste incinerator

Table 4. Implementation of waste managerial

No	Green Building Criteria	Unit of Analysis			
		1	2	3	4
1	Availability of trash bin	•	•	•	•
2	Waste separation	X	X	•	•
3	Regular Schedule to dump waste at the landfills	•	•	•	•

In general, the implementation of green building concept at four unit of analysis at schools in North Sulawesi, which are: the first unit of analysis has implemented 29.63%, the second unit of analysis has implemented 55.65 %, the third unit of analysis has implemented 18.52%, and the fourth unit of analysis has implemented 40.74%.

3.2 Students' Green Behavior

Students' green habits toward energy conservation and efficiency aspect can be measured from; students preference to use natural lighting than man-made lighting or electric lamp, students always turn off the lamp after they use the room, students that choose to let the window open and the air can circulate freely, students are automatically can always make sure that they have turned off the electrical tools before they leave the room. Students' green behavior toward the water conservation can be measured from, students are sure to turn off the tap water every time they leave the kitchen, bathroom/ lavatory, students also care to make sure that they have turned off the tap water at outside the room after they finish. Students' green habits toward indoor health and comfort aspect measured by, students prefer to use natural air conditioner than machine one, students do not smoke at school, and students do not make unnecessary noises around the learning environment. Students' green ha-bits toward the waste management aspect can be measured by, students always throw the trash at the bin, students are able to separate organic and non-organic waste, and dangerous waste toward the environment, students with their creative effort use the waste to create a product, and also the students know how to make fertilizer [8][9].

The result of questionnaire data toward students' green behavior shows in **Table 5**.

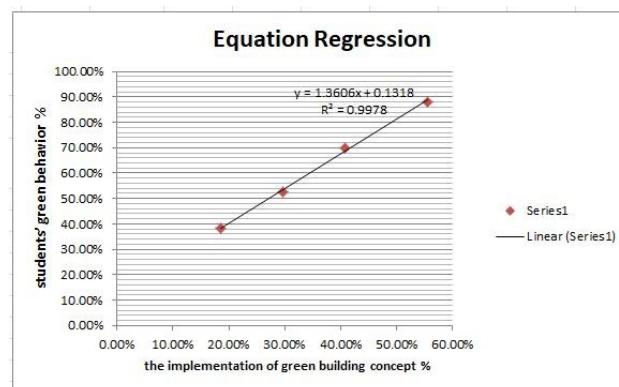
Table 5. Questionnaire data result toward students' green habits

Unit of Analisis	1	2	3	4
Students' green behavior	52.56%	88.21%	38.46%	70.00%

3.3 The implementation effect of green building concept at school toward students' green habits

The analysis impact of the schools' effort to apply green building concept toward students' green habits using simple regression has shown in **Figure 10**. The simple equation regression output shows: The intercept or constants worth 13.18 % shows that without the implementation of green building concept, students' green behavior are 13.18 %. From the positive equation relationship in which every escalation of variable X; which is the implementation of green building concept, can escalate the variable Y; which is the students' green behavior. The coefficient regression 0.1318 shows every improvement/escalation of the green building implementation concept at every unit of analysis 1% can escalate 13 % students' green behavior. The discussion of simple regression analysis shows the wider/bigger the green building implementation concept can improve the establishment of students' green behavior. This result suits with the behavioral theory argue that every architect can influence those who use the building.

$$Y = 1.3606X + 0.1318 \quad (1)$$

**Figure 10.** The graphic of equation regression

4. Conclusions

There are 4 Green building concept aspects that has been implemented at schools in North Sulawesi, Indonesia, which are: energy efficiency and conservation, water conservation, indoor health and comfort, and waste managerial. The implementation of green building concept has proven to give significant influence toward students' go green behavior at school in North Sulawesi, Indonesia. The wider/ bigger the implementation of green building will improve/escalate the establishment of students' green behavior. The result is accordance with the Gesalts Psychologist theories, that architecture can change the user's behavior [10].

References

- [1] Khishnani N 2012 *Greening Asia Emerging Principles for Sustainable* BCI Asia Construction Information Pte L.td
- [2] <http://www.mongabay.co.id/2014/01/17/banjir-bandang-manado-18-warga-tewas-1-000-an-rumah-rusak> Accessed Oct 1, 2017
- [3] Esa M R B et al 2011 Obstacles in Implementing Green Building Project in Malaysia *Australian Journal of Basic and Applied Sciences* **5**(12) 1806-1812
- [4] Li Y et al 2017 A Review of Studies on Green Building Assessment methods by Comparative Analysis *Energy and Building Journal* **146** 152-159

- [5] Huang K T S et al, 2015 Implementation of Green Building Specification Credis for better thermal conditions in Vaturally Ventilated School Buildings, *Building and Environment Journal* **86** 141-150
- [6] Wines J 2015 *Green Architecture* Taschen: Hongkong
- [7] *Green Building Rating tool for Existing Building ver 1.0* 2012 Rating Development Departemen Green Building Council Indonesia
- [8] Elham N A W and Shyan T S 2011 Factors Influencing the Green Purchase, Behavior of Penang Environmental Volunteers *International Business Management* **5** 38-49
- [9] Zhao D-X, He B-J, Meng F-Q 2015 The Green School Project: A means of Spending up Sustainable Development? *Geoforum Journal* **56** 310-313
- [10] Canter D and Stringer S 1975 *Environment Interaction in Architecture* International Universities Press, New York

Acknowledgments

The authors wish to express appreciation to Lembaga Penelitian dan Pengabdian Masyarakat of Manado State University which had finance all of the research activities, and Rector of Manado State University, Indonesia who has proposed research grant.