

## Conference Paper

# The Relations Between Green Building Concept and Pro-Environmental Behavior in Vertical Housing

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## Abstract

Residential building in a post-occupation phase and building operations consume large amounts of energy and cause environmental degradation. To reduce the negative impact of energy consumption in residential building, green concept through occupant behavior (pro-environment behavior) is useful. Implementation of green concepts on buildings is expected to trigger the emergence of pro-environmental behavior. This study aims to analyze the correlation of green values in a residential building with the value of pro-environmental behavior, especially on student vertical housing. Based on purposive sampling (non-random/non-probability sampling), correlation analysis shows that the concept of green building has a high correlation with a significant value of  $<0.05$  towards pro-environmental behavior. The application of the green concept in improving pro-environmental behavior can be made by considering three priority categories, namely the site development, energy efficiency, and the use of materials.

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## 1. Introduction

Based on data from the World Green Building Council, buildings accounted for 33 percent of carbon dioxide emissions, consumed 17 percent of clean water, 25 percent of wood products, 30-40 percent of raw materials and 40-50 percent of energy use for development and operation. In addition, Krishan [1] argues that based on its activity sector, the composition of energy use in buildings is dominated by operational activities of 45 percent. As the second largest energy user sector, energy consumption in the occupancy sector is dominated by electrical energy that is 71 percent of total energy consumption in 2013. The amount of energy consumption only includes energy activity in residential buildings, not including activities around the residential environment. It proves that in the post-occupation phase and building operations, residential buildings consume tremendous energy and cause environmental problems.

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In anticipation of increasing energy consumption and the threat of environmental destruction, the concept of green building is considered as one solution to reduce environmental damage, minimize carbon emissions as the main cause of global warming, and minimize the energy crisis [2]. In the development of the green building concept, one aspect becomes the most important study, i.e., the behavior aspect. According to Huat [3], the behavior of residents can have a direct impact on the performance of the building. Behavior in the application of the green concept is called pro-environmental behavior.

Pro-Environmental behavior of residents is one important aspect of viewing the green performance of a building in the residential period. That behavior can be described as an interaction that occurs between the occupants of the building that shows the existence of green concepts, namely efficiency in energy use and support for environmental sustainability. The improvement of pro-environmental behavior can be made by identifying the factors that have an influence on the formation of the behavior, one of which is the value of the application of the green concept in the building. Implementation of green concepts on buildings is expected to trigger the emergence of pro-environmental behavior.

This study aims to identify patterns of pro-environmental behavior in vertical residential buildings and to identify the application of green concepts that influence the formation of pro-environmental behavior. So that will get a recommendation in the improvement of pro-environmental behavior of residents based on the green concepts category.

In the literature [4–8] discussing the performance assessment of green buildings, there are several categories in buildings and behavior aspects related to green concepts. Grouping of these aspects can be useful in evaluating the green value of occupant behavior and building. The categories of green concept can be grouped into 6 (six) aspects, namely the development of the site, energy efficiency, water conservation, indoor comfort, material use, and environmental management. Meanwhile, there are 2 (two) main categories in viewing patterns of pro-environmental behavior of residents, namely curtailment behavior and investment behavior [9–11].

## 2. Research Methodology

Assessment instrument in this study using the correlation analysis of the relationship between pro-environmental behavior and green values in residential building. There

are 285 respondents in this research chosen by purposive sampling (non-random/non-probability sampling). This technique is a method of determining to sample based on a specific purpose [12]. The selected case study is vertical residential buildings in Bandung, with residents who are specialized for the college students: Rusunawa Sangkuriang ITB, Rusunawa UNPAS, and Asrama UPI.

Pro-Environmental behavior of occupants is divided into investment behavior and curtailment behavior and given five-scale Likert in the questionnaire. Meanwhile, the collecting data method of green building concept value is done by a survey of building physical characteristic supported by structured interview. Data processing is done by assessing each category and combining based on the weight of the predetermined assessment. This assessment is based not only on physical characteristics but also includes a control system on buildings. The determination of green building concept value is an appraisal aspect in this research is based on the existing performance appraisal of GREENSHIP New Building, GREENSHIP Existing Building, and PERMEN PUPR NO. 02 / PRT / M / 2015 “Bangunan Hijau.” From the three assessments, a new green building concept assessment group was made with some adjustments, which are adjustments to the six aspects of the predetermined green concept and the adjustment to the research object as a building not designed with the green concept. The weight of the category assessment is based on the importance of the GREENSHIP assessment by looking for the average value to be used as the weight of the new green building concept assessment.

### 3. Case Study

The case studies raised in this study are dormitory located in Bandung City: on three case studies in Bandung City: Rusunawa Sangkuriang ITB, Rusunawa UNPAS, and Asrama UPI. The selected case study is vertical residential buildings managed by colleges in Bandung, with residents who are specialized for the college students.

#### 3.1. Rusunawa Sangkuriang ITB (Bandung Institute of Technology)

Managed by ITB and Located at Jalan Sangkuriang Dalam no. 55 Bandung, this dormitory was built around 2010 by Ministry of Public Works and currently managed by UPT Asrama ITB. It has a total of 196 units of rooms with a total capacity of 384 people (48 male rooms and 48 female rooms). The current number of Rusunawa Sangkuriang is 172 residents.

This dormitory consists of 1 twin block that functioned as a male dormitory (block A) and female dormitory (block B). Each building consists of 5 (five) floors. The first floor functioned as service and public areas, while the second floor to the fifth floor functioned as a residential area with 12 units of rooms/floor. Rusunawa Sangkuriang has shared facilities such as a multipurpose area on the first floor and a common room on each floor.

### **3.2. Rusunawa UNPAS (Pasundan University)**

Rusunawa UNPAS is the only dormitory managed by UNPAS. This dormitory is located in the Campus IV area of Pasundan University on Jalan Setiabudi no.193 Bandung. The Ministry of Public Housing built Rusunawa UNPAS. This dormitory is for female students.

This apartment consists of 1 block of building with a height of 5 floors. Each floor consists of 24 units that can be occupied up to 4 residents. The total unit of Rusunawa UNPAS is 96 units with a total capacity of 384 residents. In addition to residential facilities, Rusunawa also provides other facilities such as a library, laundry, cafeteria, and common room.

### **3.3. Asrama UPI (Indonesia University of Education)**

Asrama UPI is a boarding house owned by UPI consisting of 3 dormitory buildings, which are a male dormitory, female dormitory, and rusunawa building. In this study, case studies are aimed only at male dormitory and women's dormitory buildings. Asrama UPI is located inside the campus area of UPI Jalan Setiabudi no 229 Bandung, built by UPI around 2010.

The male and female dormitory building is a twin building with a height of 4 floors. The entire floor functioned as a residential area. The total of all rooms is 136 units with a total capacity of 272 residents. Other facilities available in UPI dormitory are a common room, multipurpose room, canteen and photocopy.

## **4. Result & Discussion**

#### 4.1. Pro-environmental behavior

The analysis shows that residents of dormitories rarely to behave pro-environmental in their living environment. It can be seen from the mean of pro-environmental behavior in all case study is in a moderate category with value 2,85.

In all case studies, the pro-environmental behavior of residents tended to be the same (see Figure 1), with a medium value of 3.01 (Rusunawa ITB), 2.80 (Asrama UPI) and 2.76 (Rusunawa UNPAS). It suggests that all residents of the dorm tend to have similar pro-environmental behavior patterns. However, based on the type of behavior performed, the value of investment behavior has a lower value than curtailment behavior. In detail, the average value of investment behavior in all case studies is low with a value of 2.43. While the average value of curtailment behavior is worth a value of 3.28. It shows that in pro-environmental behavior, occupants tend to make savings by reducing the intensity of energy consumption by changing behavior rather than making investment efforts to reduce energy use.

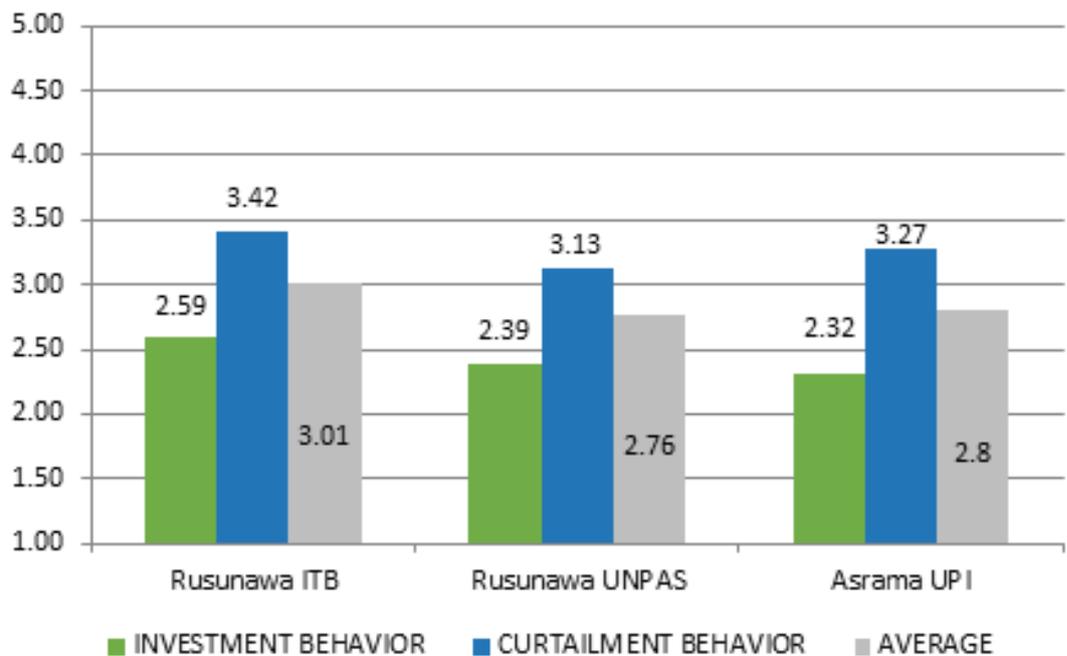


Figure 1: Pro-environmental behavior values.

#### 4.2. Green building concept assessment

The assessment of green building concept is based on the green building criteria, which is the building assessment on the application of the green concept. A five-scale

Likert performs this assessment in each of the rating categories. Physical performance categories are divided into 6 (six) categories: site development, energy efficiency, water conservation, indoor comfort, material use, and environmental management. Input assessment is not only derived from the physical characteristics of existing buildings but also derived from interviews structured to the administrator of residential buildings.

The analysis of green building concept values can be seen in Figure 2. Based on the analysis results showed that the highest green building concept value obtained by Rusunawa ITB with the fulfillment of 40.8percent green concept value (moderate). While Rusunawa UNPAS and dormitory ITB has a low green concept value.

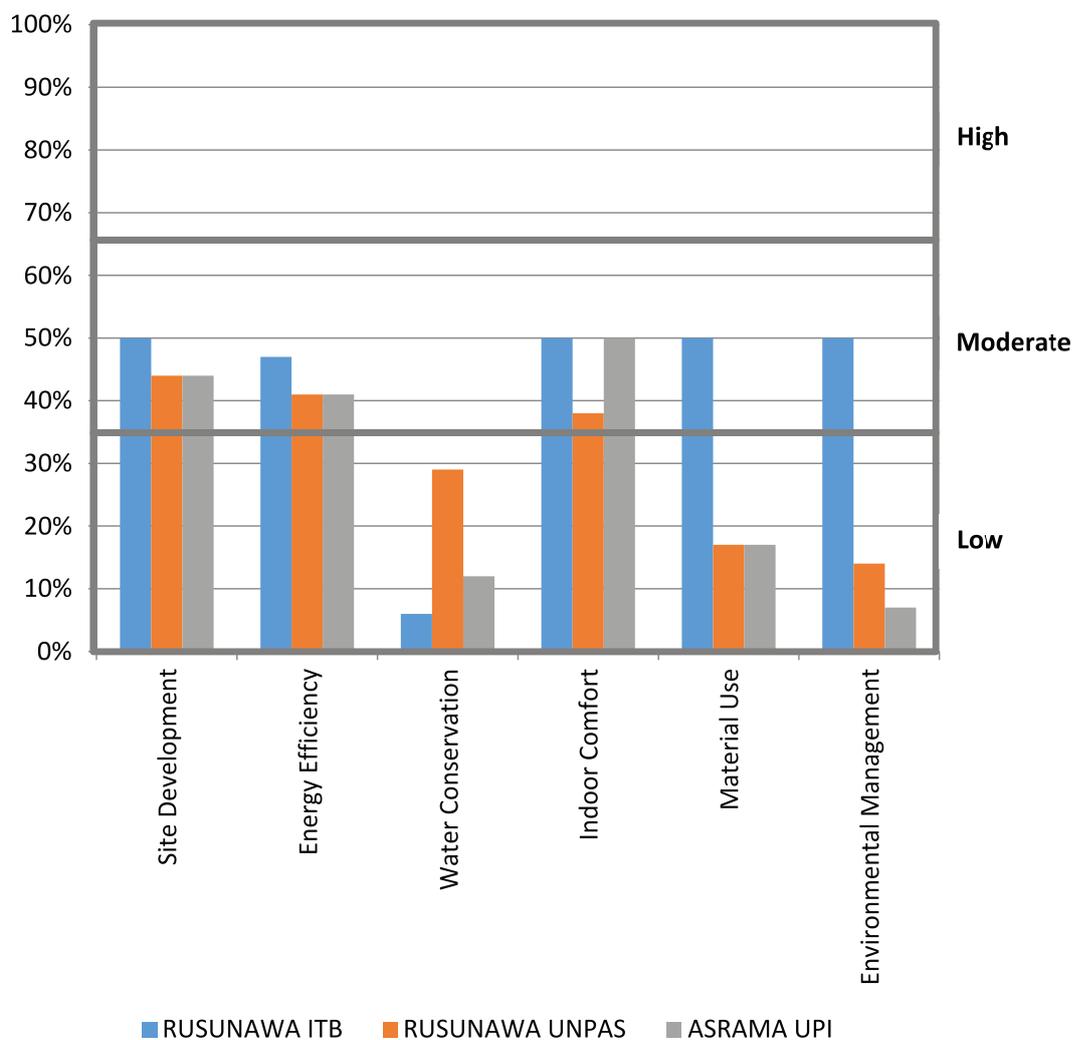


Figure 2: Green building concept values by category.

### 4.3. Relationship of pro-environmental behavior and green building concept

The analysis of green building performance values includes the total value of green building performance along with the value of each category of performance assessment, i.e., site development, energy efficiency, water conservation, indoor comfort, material use, and environmental management. Data input in this analysis obtained based on the analysis of physical characteristics of buildings. The purpose of this relationship analysis is to get a category of green concepts that tend to produce high value on the pro-environmental behavior of the inhabitants so that it can be used as a reference in the improvement and in designing the student vertical dwelling that produces the green concept in the inhabitant behavior. Relationship analysis is done by comparative analysis and correlation. The comparative analysis is used to find out the correlation of the average pro-environmental behavior of the residents with the value of green building performance in each case study. Meanwhile, the correlation analysis is done to determine the relationship structure between the variables it has.

Based on the results of comparative analysis (see Table 1), it was found that the Rusunawa ITB obtained the highest average pro-environmental value with 3.01 average grade, and with the highest green performance value of 40.8percent (moderate). The result of comparative analysis is only used to see the comparison of the relationship between case studies, while the relationship between variables is done by correlation analysis.

TABLE 1: Comparative value of pro-environmental behavior and green building concept.

CASE STUDY	PRO-ENVIRONMENTAL BEHAVIOR	GREEN BUILDING CONCEPT
RUSUNAWA ITB	3.01 – Moderate	40.8percent – Moderate
RUSUNAWA UNPAS	2.76 – Moderate	32.8percent – Low
ASRAMA UPI	2.80 – Moderate	30.3percent – Low
<b>AVERAGE</b>	<b>2.85 – Moderate</b>	<b>34.6percent – Low</b>

Further correlation relationship is done to all variables analysis. The result of correlation analysis can be seen in Table 2. Based on the results of the analysis, it is found that the value of green building performance has a significant relationship with the formation of pro-environmental behavior, namely investment behavior in the use of materials and environmental management, and curtailment behavior in environmental management. All of these correlation relations have significance values  $<0.05$ . The correlation obtained each has correlation value 0,1481 and 0,4095 to investment behavior of

material use and environmental management, and correlation value 0,1428 and 0,4861 to curtailment behavior of site development and environmental management.

The results of the analysis show that the higher of green building performance value, the occupants have a high-value trend in the investment behavior of material use and environmental management, as well as on curtailment behavior of site development and environmental management. Buildings with high green performance values will stimulate users to behave in a pro-environmental environment.

TABLE 2: The Relations Between Green Building Concept And Pro-Environmental Behavior.

PRO-ENVIRONMENTAL BEHAVIOR	GREEN BUILDING CONCEPT	GREEN BUILDING CONCEPT CATEGORIES					
		Site Development	Energy Efficiency	Water Conservation	Indoor Comfort	Material Use	Environmental Management
<b>INVESTMENT BEHAVIOR</b>	***	***					
IB - Site Development	0.0647	0.0293	0.0293	0.0871	-0.1155	0.0293	0.0535
IB - Energy Efficiency	0.0880	0.0539	0.0539	0.0671	-0.0992	0.0539	0.0773
IB - Water Conservation	-0.0607	-0.0562	-0.0562	0.0232	-0.0099	-0.0562	-0.0595
IB - Indoor Comfort	0.0366	0.0567	0.0567	-0.0978	0.1002	0.0567	0.0434
IB - Material Use	0.1481	0.1466	0.1466	-0.0917	0.0635	0.1466	0.1484
IB - Environmental Management	<b>0.4095</b>	<b>0.4486</b>	<b>0.4486</b>	<b>-0.4121</b>	<b>0.3540</b>	<b>0.4486</b>	<b>0.4247</b>
<b>CURTAILMENT BEHAVIOR</b>	***	***					
CB - Site Development	0.1428	0.1838	0.1838	-0.2437	0.2360	0.1838	0.1571
CB - Energy Efficiency	0.1177	0.1114	0.1114	-0.0540	0.0292	0.1114	0.1163
CB - Water Conservation	-0.1225	-0.0838	-0.0838	-0.0612	0.1017	-0.0838	-0.1105
CB - Indoor Comfort	-0.0706	-0.1084	-0.1084	0.1845	-0.1888	-0.1084	-0.0834
CB - Material Use	0.1017	0.1440	0.1440	-0.2217	0.2223	0.1440	0.1161
CB - Environmental Management	<b>0.4861</b>	<b>0.5244</b>	<b>0.5244</b>	<b>-0.4592</b>	<b>0.3864</b>	<b>0.5244</b>	<b>0.5014</b>

\*\*\* Correlation Analysis: high if close to 1 & significant <0.05

The relationship between green building performance and pro-environmental behavior has the most significant relationship, both to investment behavior and curtailment behavior. The most significant relationship indicates that the priority level on green

performance aspect in applying the green concept in a building can trigger the formation of pro-environmental behavior of occupants (see Table 3).

TABLE 3: The priority level of green building concept against the pro-environmental behavior of residents based on the correlation value of the most significant relationship.

LEVEL OF CORRELATION	GREEN BUILDING CONCEPT CATEGORIES	PRO-ENVIRONMENTAL BEHAVIOR	
		Investment Behavior	Curtailment Behavior
1	Site Development	0.4486	0.5244
	Energy Efficiency	0.4486	0.5244
	Material Use	0.4486	0.5244
2	Environmental Management	0.4247	0.5014
3	Water Conservation	-0.4121	-0.4592
4	Indoor Comfort	0.3540	0.3864

The analysis showed that there are three categories of green building performance aspects that have the highest correlation value toward the pro-environmental behavior value, namely the development of the site, energy efficiency and material usage. Therefore, efforts to improve the behavior of pro-environmental behavior can be made by creating a physical setting of the dwelling that applies the concept of green to the building thoroughly, by prioritizing aspects of site development, energy efficiency, and material used.

## 5. Conclusion

Based on the result of green building performance with high significance value toward the pro-environmental behavior of the residents, the recommendation criteria of vertical dwelling design tends to form the pro-environmental behavior of the inhabitants. Recommendation criteria of vertical housing related to the formation of pro-environmental behavior are the support of green building concept application, that is the physical characteristics of buildings that show the existence of efforts in the creation of green concepts in the building environment. With a design that supports the application of green building concept, the value of building performance will tend to increase, and indirectly residents get a stimulus in pro-environmental behavior. It is in line with Mazar and Zhong’s statement [8] that buildings that have adopted the green concept can be moderators in the formation of pro-environmental behavior.

Support for the application of green concepts not only covers the application of the physical design of the building design but also related to the performance focus to be achieved. The findings of the analysis show that there are three categories of

green building performance aspects that have the highest correlation value toward the pro-environmental behavior value, namely site development, energy efficiency, and material use. Therefore, efforts to improve the pro-environmental behavior can be made by creating a residential setting that applies the green concept to the building with prioritizing aspects of site development, energy efficiency, and material use.

Based on the determination of assessment criteria in this study, it is recommended to apply each concept of the green category to be the main priority in improving the pro-environmental behavior of the residents.

## References

- [1] Krishan, A. (2001). *Climate Responsive Architecture: A Design Handbook for Energy Efficient Buildings*. New York : McGraw-Hill Book Company.
- [2] Yulianta, F. (2015). *Analisis Perbandingan Konsumsi Energi Pada Kegiatan Operasional dan Pemeliharaan Bangunan Gedung dengan Konsep Green Building dan Bangunan Gedung Konvensional*. Master's thesis, Universitas Gadjah Mada.
- [3] Huat, N. B. (2013). *Development of Energy-Efficient Building Environmental Quality Evaluation Framework*. Master's thesis. Universiti Tun Hussein Onn Malaysia.
- [4] Choi, In Young, Cho, Sung Heui dan Kim, Jeong Tai. (2012). *Energy consumption characteristics of high-rise apartment buildings according to building shape and mixed-use development*. *Energy and Buildings*, 46, 123–131.
- [5] Hori, S., Kondo, K., Nogata, D., dan HanBen. (2013). *The determinants of house hold energy-saving behavior: Survey and comparison in five major Asian cities*. *Energy Policy*, 52, 354-362.
- [6] Kang, N. N., Cho, S. H., dan Kim, J. T. (2012). *The energy-saving effects of apartment residents' awareness and behavior*. *Energy and Buildings*, 46 , 112-122.
- [7] Larson, L. R., Stedman, R. C., Cooper, C. B., dan Decker, D. J. (2015). *Understanding the multi-dimensional structure of pro-environmental behavior*. *Journal of Environmental Psychology* 43, 112-124.
- [8] Wilkinson, S. J., Kallen, P. V., dan Kuan, L. P. (2013). *The Relationship between the Occupation of Residential Green Buildings and Pro-Environmental Behavior and Belief*. *JORSE*, 5.
- [9] Han, Q., I.Nieuwenhijzen, Vries, B., E.Blokhuis, dan W.Schaefer. (2013). *Intervention strategy to stimulate energy-saving behavior of local residents*. *Energy Policy*, 52, 706–715.

- [10] Wenshun, W., Xiaohua, L., dan Hualong, L. (2011). *Empirical Research of the Environmental Responsibility Affected on the Urban Residential Housing Energy Saving Investment Behavior*. *Energy Procedia*, 5, 991-997.
- [11] Yue, T., Long, R., dan Chen, H. (2013). *Factors influencing energy-saving behavior of urban households in Jiangsu Province*. *Energy Policy*, 62, 665-675.
- [12] Kumar, R. (2005). *Research Methodology: A Step by Step Guide for Beginner*. Sage Publication, London.