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Murtyas, Solli

Interdisciplinary Graduate School of Engineering Sciences, Kyushu University

Ridwan, Mohammad

Department of Nuclear Engineering and Engineering Physics, Universitas Gadjah Mada

Budiarto, Rachmawan

Department of Nuclear Engineering and Engineering Physics, Universitas Gadjah Mada

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Occupancy Rate and Water Utility Effects on Energy Consumption of Commercial Building: Case Study Grand Inna Malioboro Hotel in Indonesia

Solli Murtyas^{1*}, Mohammad Ridwan², Rachmawan Budiarto³

¹Interdisciplinary Graduate School of Engineering Sciences, Kyushu University, Japan

^{2,3}Department of Nuclear Engineering and Engineering Physics, Universitas Gadjah Mada, Indonesia

*Corresponding author email: murtyas.solli.438@s.kyushu-u.ac.jp

Abstract: Hotel is the one of the major consumers of the energy for commercial buildings sector that have directly correlated for energy conservation effort. This study emphasizes the correlation of each energy supply such as electricity, fuel and LPG that used to the occupation rate and water consumption in the hotel to utilize the building based on data collection. As Result, electricity was the major energy to use in the hotel with 28985.04 GJ (88%). The other two energy resources were 1900 GJ (6%) for fuel and 1883.2 GJ (6%) for LPG. The behavior of occupants were dominantly affecting the use of electricity than other energy. The use of LPG was tightly correlated with the use of water due to kitchen activity that mainly devices used LPG than electricity or fuel.

Keywords: Energy Consumption; Electricity; Fuel; LPG; Water consumption.

1. INTRODUCTION

The buildings contributed for 40% of world's energy consumption [1]. Hotel is the one of the major consumers of the energy for commercial buildings sector that have directly correlated for energy conservation effort. In the other hand, average global efficiency of fossil-fueled power generation has remained stagnant for decades at 35% to 37% [2]. Meanwhile, reducing energy consumption will increase energy security of the country [3].

In Indonesia, tourism has been significantly grown in the last decades. Consequently, it stimulated the growing of hotel buildings. This will continue to intersect with the principles of natural balance and energy management as the key roles on conducting sustainable tourism. The government has a role to arrange General Energy Planning based on UU No. 30 year 2007 about energy policy. The goals of government in future based on this, is to create competitive commercial industries based on efficiency of energy, green environment and renewable energy [4]. In the other hand, behavior of the occupants of a building contribute more significant to the energy consumption than specific features of a particular building [5].

This study emphasizes the correlation of each energy supply such as electricity, fuel and LPG that used in the hotel to utilize the building based on data collection in the period of 2011 and 2012. This study applied a statistical measurement to explain the strength or weak relationship among energy resources to the occupants and water utility. In addition, it will explain the use of energy for the building's utilization in conducting operational activities such as electrical equipment, kitchen and portable power generator (power genset). The result will give a benefit to arrange the strategy to increase energy efficiency in the energy supply and usage stage of the hotel as commercial buildings.

2. METHODOLOGY

2.1 Study Area

Grand Inna Malioboro Hotel is located in the heart of Yogyakarta. Its specific location in Jl. Malioboro No. 60 Suryatmajan Danurejan Yogyakarta the Sultan Palace, 42

kilometers from the famous Borobudur Budhist temple, 17 kilometers from the Hindu temple of Prambanan [6]. The hotel consist of two main buildings: main building in the north and extension building in the south. The hotel has 7 floors for each building. Total area of the building is 23792 m² and the ground's area is 18000 m².



Figure 1. Gran Inna Malioboro hotel [6]

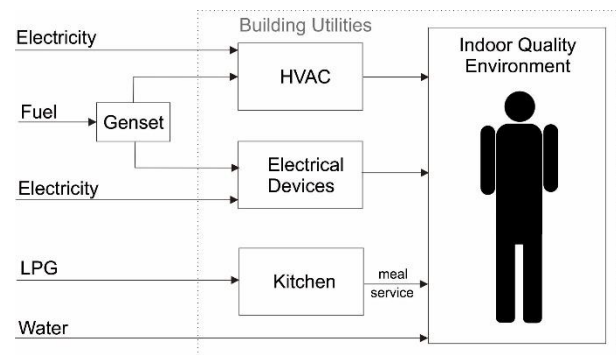


Figure 2. Energy supply model for building hotel of Grand Inna Malioboro

2.2 Energy Supply Schematic

The hotel use energy to achieve the main function in conducting indoor quality environment and operational process including kitchen activity, laundry etc. The main energy supply is electricity provided by National Electricity Company (PT. PLN). The portable power generation (genset) was used supply the electricity in case of power drop occurrence. The main energy resource for genset was fuel. LPG was used to cook meal in the kitchen. The water was the additional resource for laundry activity beside electricity for the washing and iron machine. Schematic of the energy supply model is shown in figure 2.

2.3 Data Collection

Data of energy consumption was collected in the period of 2011 and 2012 based on the documents that the hotel’s manager provided. It consisted of data energy consumption from electricity, fuel, LPG and water per month. We included the water as parameter that has direct correlation with the energy consumption especially in some activities including shower, laundry, swimming pool, food and beverage.

3. RESULT AND DISCUSSION

3.1 Energy Consumption Trend

The operation of hotel exhibits some characteristics that have a direct impact on the energy consumption of the building [7]. It operates in basis, which means that services, equipment and several areas in the building were used continuously. The behavior of the building occupants has also a direct impact on the energy consumption record.

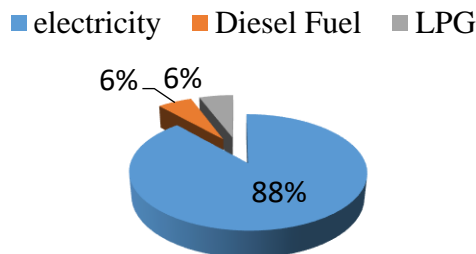


Figure 3. Energy consumption based on type in the period of data collection

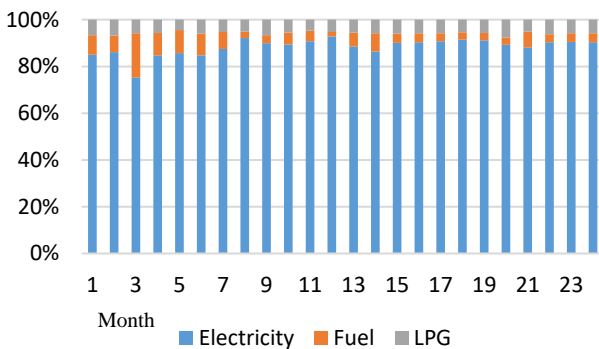


Figure 4. Monthly percentage of energy consumption based on the type

Electricity was the major energy to use in the hotel with 28985.04 GJ (88%). The other two energy resources were 1900 GJ (6%) for fuel and 1883.2 GJ (6%) for LPG. The

fuel was used to substitute the electricity when it dropped or extinguished by PLN (National Electricity Company). Therefore, the rate of consumption was not much as the electricity LPG usage was stable every month and it was not significantly affected when the electricity drop. In month 3 (March 2011) there was electricity drop and it showed in figure 4 that fuel consumption was increasing but in the same time electricity consumption decreased.

3.2 Occupation Rate Effect on Energy Consumption

Based on the data, there were various number of occupant for each month. The minimum occupation rate usually conducted on September, it because of lack of holidays at that month. In addition, September is the beginning of rain season. It was the reason for the tourists unwilling to come. In the other side, international tourist come mostly on July-August (summer) and December-January (long holiday). Thus, maximum occupation rate was on November 2011 and January 2012. It is shown in figure 5.

Occupation rate has significant contribution on electricity consumption. It shows on figure 6 that the correlation expressed by R^2 was 0.9126. This positive linear regression also indicates that the number of electricity consumption will increase as the number of occupation increase. In addition, the guest mostly use the devices and services from the hotel that mostly powered by the electricity.

Fuel and LPG have weak correlation with the occupation rate. Fuel had the weakest energy consumption affected by the occupation rate with 0.0093. It because the fuel was only a substitutive energy component instead of electricity. Thus, it was not very significant correlation. LPG has positive correlation with the occupation rate (0.3608) even though it was not as strong as electricity. LPG was tightly correlated with the meal production in the kitchen. Based on this, we concluded that LPG was the second energy that tightly correlated with the guest of hotel due to it was the main resource energy that used in the kitchen.

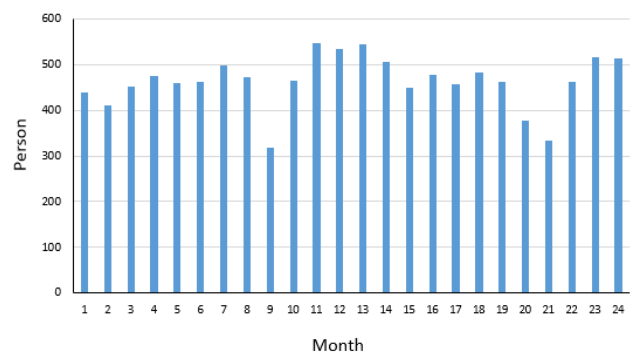


Figure 5. Occupation rate

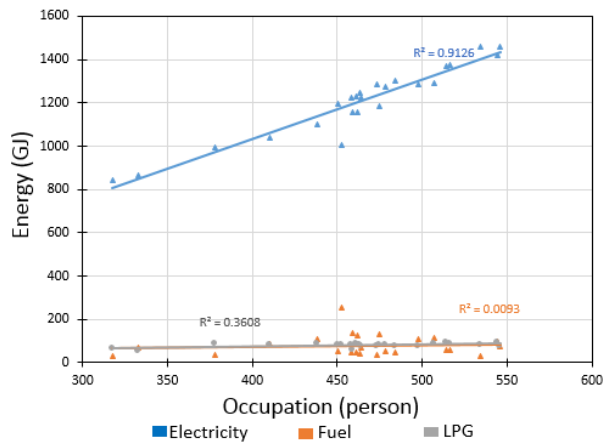


Figure 6. Linear regression between occupation rate and energy consumption by type

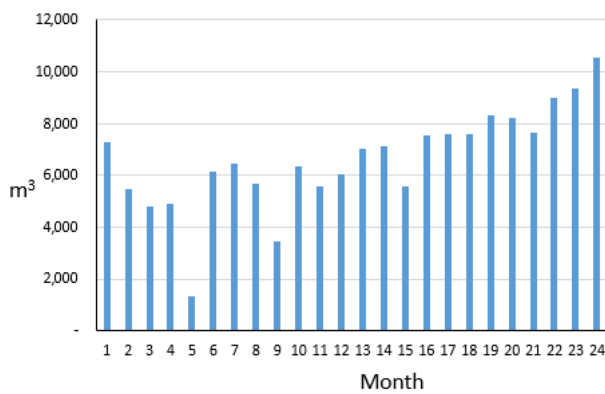


Figure 7. Water consumption

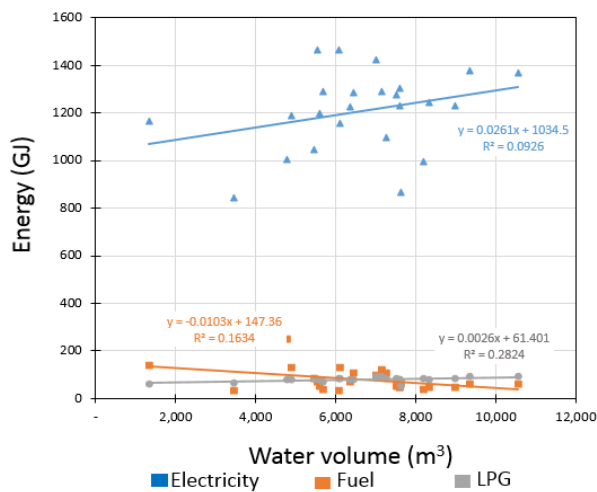


Figure 8. Linear regression between water utility and energy consumption by type

3.3 Water Utility Correlation on Energy Consumption

Water was the one of natural resources that used to kitchen and laundry activity in the hotel. The water supplied by National Water Company (PT. PDAM). The use of water was not strongly affected by the occupation rate ($R^2 = 0.0444$). It indicates that mostly visitor was not using water from the hotel except for limited activities such as laundry and shower.

However, the water usage have different pattern in affecting the use of energy. Kitchen activities consumed more water. It directly correlated to the LPG usage. Thus, the number of R^2 was the highest with 0.2824. The use

electricity do not contribute significantly to the water. Some electricity devices that correlated to the water such as heater and laundry machine were directly use the water. Generally, it has small effect to achieve positive correlation between this two more than 10% dependency each other. It was parallel with the correlation the use of water and fuel, even though it was higher value of R^2 than electricity (0.1634). The use of water in portable power supply was in order to cool the machine. It was the only direct correlation between water and fuel consumption in the hotel.

4. CONCLUSION

The energy consumption of Grand Inna Malioboro hotel during 2011 and 2012 consist of electricity, fuel and LPG. The amount electricity consumption is 28985.04 GJ (88%). It was more than the others energy conversions used in the hotel including diesel fuel is 1899.9 GJ (6%) and LPG 1883.2 GJ (6%). In general, electricity as the major energy-consumed and it was increasing 3% during 2011 and 2012. The behavior of occupants were dominantly affecting the use of electricity than other energy. The use of LPG was tightly correlated with the use of water due to kitchen activity that mainly devices used LPG than electricity or fuel.

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