Comparative Study of Energy Consumption between OTTV and Sefaira in a House

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Abstract. Education is one of the aspects that support the establishment of smart city, especially in the study of architecture. The study aims to provide easiness, anticipate the unexpected incident, and to manage resources efficiently while designing a building. In the process, assisted by the software, OTTV and Sefaira are different software in the calculations. OTTV counts manually while Sefaira counts digitally. Sefaira is easier in its calculations, but its accuracy rate needs to be examined. Therefore, this research will discuss how big a difference in calculation of the manual one by OTTV and the digital one by Sefaira. The object of the research was the building of the House, so that it is easier to understand. Expected results of this research are that we can get a selection of software that is easier, more efficient, and more accurate to be used in the learning process.

Keywords: Education, Efficient, Sunhour, OTTV

1. Preface
The education system is the aspect that plays an important role in the concept of smart city. With the educational system, the better it will affect the quality of resources for creative and innovative thinking. The development of technology and information in the smart city concept is the basis of the concept of smart city. It is included in the learning process design in the field of architecture. Building a building is not just talking about the aesthetics, but also talking about the efficiency of energy use.

Energy efficiency is closely linked with the transfer of heat into the building through conduction and radiation [1]. To calculate the heat transfer value, in 1975 ASHRAE (American Society of Heating, Refrigeration and Air-conditioning Engineers) proposed OTTV (Overall Thermal Transfer Value) which was standardized in the ASHRAE Standards 90-75 and 90-80A. Now in Indonesia, it was already standardized in SNI 6389:2011 about energy conservation Building on the Sheath. The value of the heat transfer from the outside into high impact low load cooling system also indirectly affects the use of energy.

Calculation tools regarding the value of the heat transfer is already undergoing development, i.e. with the use of digital calculation software called Sefaira. Sefaira has a function similar to that of OTTV but both have levels of ease and accuracy.

Study on the energy consumption is very important because each passing year energy consumption requirements increase, [2] mainly on buildings to be designed. In Bandung, there are approximately 6 universities which have Departments of Architecture. There are Bandung Institute of Technology, Parahyangan Catholic University, Indonesia University of Education, National Institute of Technology, Indonesian Computer University, and Langlangbuana University.
Based on this, there is the potential for learning about energy consumption calculations used in the design of a building, either a manual calculation by OTTV or digital calculation by Sefaira. Both of the software are compared, with the goal of getting more efficient, easier, and more accurate calculation tools, so that it can support the learning process because it can be a reference design to be built.

The object of research is a residential building, which is the house that is located in the city of Bandung. The results show that the values of the resulting heat transfer of both software are not much different, meaning that both have the same degree of accuracy. However, from the level of ease, Sefaira is easier to use than OTTV. This is due to the calculation of sefaira that is done digitally and it certainly is more efficient because it does not take much.

2. Literature Review

2.1. Design Standard
Criteria for the design of objects that will be examined are a sheath. A building must meet the criteria below:
- Applies only to components of the walls and roof of the building in a condition (has an air system)
- Through thermal displacement for the walls and roof should not exceed the value of the overall thermal displacement, i.e. does not exceed 35 W/m².

2.2. OTTV (Overall Transfer Thermal Value)
OTTV (Overall Thermal Transfer Value) is the overall thermal transfer value on the outer wall that has a direction or orientation. OTTV issued by ASHRAE (American Society of Heating, Refrigeration and Air-conditioning Engineers) has been standardized in the SNI 6389:2011 [3]. Calculation of OTTV is calculated through equation:

\[
OTTV = \alpha \left( (UW \times (1 - WWR) \times TDEk) + (Uf \times WWR \times \Delta T) + (SC \times WWR \times SF) \right)
\]

(2.2) OTTV calculation formula

with:
- OTTV = Overall Thermal Transfer Value thoroughly on the outer wall that has a direction or orientation (W/m²)
- \(\alpha\) = absorbance of solar radiation.
- UW = wall thermal Transmittance translucent (W/m² K)
- WWR = comparison of broad window with the entire exterior wall on the specified orientation
- TDEk = Difference in temperature equivalents (K)
- SF = factor of solar radiation (W/m²)
- SC = coefficient of shade from the fenestration
- UF = Transmittance thermal fenestration (W/m² K)
- \(\Delta T\) = temperature Difference between the outside and inside

However, in its application, it had been provided in the form of OTTV Microsoft Excel, so the users keep entering the required data manually. The procedure design of OTTV is shown by the following diagram:
2.3. **Sefaira Architecture**

Sefaira is a kind of software that serves to calculate the performance of a building. Technically, this software works quickly to calculate the energy used and also provides recommendations of appropriate design to maximize results of the draft. This bias software is accessible through the website as well as the copies of the bias software Sketch Up. In the process of 3D building modelling, it should be made in advance as an object that will be analyzed, then enter the general data of the object, and the result will come out quickly.

3. **Design Review**

3.1. **Design Object**

The object of the research is a fictional House that is located in the city of Bandung. The size of the house is 56 m². The specification consists of one-story house, Garden, 2 bedrooms, 1 bathroom, 1 dining room, and 1 living room. The roofing material uses lightweight steel roof, ceramic tile, wall material uses masonry, floor uses ceramics, and glass with a standard of 3 mm thickness.

3.2. **Climatic Condition**

The average temperature in the city of Bandung in the range of 26 °C and the average wind speed is about 5 km/h. We use this result as a reference design that fits within the climatic conditions. So, we can get used to the design process.

4. **Analysis and Result**

4.1. **Floor Plan**

The 56 m² sized house has 8 window openings scattered in different sides, 4 pieces on the south side, two pieces on the north side, and 2 pieces on the west side. The size of each window is the same, which is sized at 45 cm x 120 cm; 6 doors on the North, South, and West sides with the size of each door at 80 cm x 200 cm. Veil of house building, the walls use brick and the glasses uses 3 mm glasses, and the roof tile uses ceramic tiles. The orientation of the house faces south with the position of the floor plan and there are tanks on the road/hook. The description of the layout of the floor plan is described as below (red to blue and the door to the window).
### 4.2. OTTV Calculation

Manual calculation of OTTV begins by entering data about the unveiling of the building featured in the design of each of the different sides, the results of the heat transfer value is described in the table below:

| No | Side     | Wall Cond. Watt | Window Cond. Watt | Window Radiation Watt | Total Watt | Façade area m² | OTTV Watt/m² |
|----|----------|-----------------|-------------------|-----------------------|------------|----------------|----------------|
|    |          | A               | B                 | C                     | D = A + B + C | E              | D / E          |
| 1  | North    | 172.05          | 200.07            | 1,248.74              | 1,620.86   | 56.00          | 28.94          |
| 2  | Northea st | -              | -                 | -                     | -           | -              | -              |
| 3  | East     | 160.86          | 240.08            | 1,763.53              | 2,164.47   | 64.00          | 33.82          |
| 4  | Southea st | -              | -                 | -                     | -           | -              | -              |
| 5  | South    | 201.42          | 106.70            | 529.25                | 837.37     | 56.00          | 14.95          |
| 6  | Southwe st | -              | -                 | -                     | -           | -              | -              |
| 7  | West     | 193.87          | 237.42            | 2,030.10              | 2,461.39   | 64.00          | 38.46          |
| 8  | Northwe st | -              | -                 | -                     | -           | -              | -              |
|    | Total    | 728.20          | 784.27            | 5,571.62              | 7,084.09   | 240.00         | 29.52          |

**Figure 2. Floorplan**

**Figure 3. OTTV Result**
The results of calculation of the manual OTTV revealed that the value of heat transfer conduction through walls of the accumulation, conduction through the openings and radiation through aperture of each side, then the total average OTTV is 29.52 Watt/m².

4.3. Sefaira Architecture
Calculation in digital by creating prefixed with Sefaira 3D model first, and then calculated with the variable that you have prepared. The data used and the results provided by Sefaira are as follows:

| No | Model Properties           | Value  |
|----|-----------------------------|--------|
| 1  | Wall Insulation             | 0.72 w/m²k |
| 2  | Floor Insulation            | 0.49 w/m²k |
| 3  | Roof Insulation             | 0.22 w/m²k |
| 4  | Glazing U-Factor            | 2.27 w/m²k |
| 5  | Visible Light Transmittance | 0.42 w/m²k |
| 6  | Solar Heat Gain Coefficient | 0.25 w/m²k |
| 7  | Infiltration Rate           | 7.2 w/m²k  |
| 8  | Ventilation Rate            | 10 w/m²k  |
| 9  | Equipment                   | 5 w/m²k   |
| 10 | Lighting                    | 10 w/m²k  |

**Figure 4.** Sefaira Calculation Variable

After that each section of side sheath, the building is divided in accordance with its functions, as described below:

| No | Entity Types     | Total |
|----|------------------|-------|
| 1  | Roof             | 12    |
| 2  | Floor            | 51    |
| 3  | Wall             | 53    |
| 4  | Shading          | 8     |
| 5  | Fixed Glazing    | 0     |
| 6  | Operable Glazing | 24    |
| 7  | Internal Wall    | 7     |
| 8  | Internal Glazing | 0     |
| 9  | Ignore           | 0     |

**Figure 5.** Entity Types the Object

The functions of the divisions of the side of the building aims to ensure that no useless functions of the buildings, so that the calculation could be more accurate, and can use Sketch Up plug-in, can also update the model to the Sefaira website.
After the model is ready for analysis, then an analysis of living begins. Sefaira will be producing more than just the value of the heat transfer. Sefaira will provide more appropriate design recommendations to maximize the design. The result of the Sefaira about heat transfer with the same object is 12 Watts/m² with details, Warm up Load of 10 Watts/m², Wall Loss of 1 Watt/m², and Roof Loss of 1 Watt/m². In addition to providing the results of heat transfer, Sefaira calculates the total energy is also the home of IE 51 kWh/year. Calculation of energy consumption becomes important because one of the benchmarks save money whether a building is from the intensity of energy consumption (IKE) [4].

5. Conclusion
The results show that both have a difference of about 17 Watts/m², and the results indicate that the levels of accuracy are both to be embedded and are not too large, and Sefaira could be an option for the learning process, because in addition to easier use, calculation of Sefaira is more quickly. First, there are given design recommendations. However, it does not mean that the manual calculation of OTTV is not better and arguably more accurate. This is because the formula that is used includes everything that is focused on the building of the sheath, the detail window size, building materials, and also the colors used. So, when in the learning process Sefaira is more supportive, because the process of creating the architectural form of the data or design process refers to trials and errors [5]. Thus, it is the software that is more efficient and effective for used.

6. References
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