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Malang, 18-19 September 2015

Innovation in Islamic Perspective for Sustainable Development Action Toward International Challenges

Science and Technology Faculty
Maulana Malik Ibrahim Statae Islamic University
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FOREWORD

Sustainable development is development which meets the needs of the present without comprising the ability of future generations to meet their own needs. Sustainability is important because all the choices we pursue and all the actions that we make today will affect everything in the future. We need to make careful decisions at present in order to avoid limiting choices of the next generations at the future.

Sustainable development implies the fulfillment of several conditions: preserving the balance of the environment, preventing the exhaustion of natural resources, and optimizing the energy consumption. In the sustainable development action, there are many major challenges to be addressed. It requires us to re-think our growth in terms of social live that is more economical in its use of raw materials and energy. In this context, sustainable developments are now become an essential obligation.

Within the concept of rahmatan lil alamin, Islam considers it essential to preserve the environment and that the environmental management relies heavily on our actions today. To accommodate the above issues, the Faculty of Science and Technology of Maulana Malik Ibrahim State Islamic University dedicates an international seminar on science and technology "Innovation in Islamic perspective for sustainable development action toward international challenges".

We are delighted to invite the academicians, researchers, and practitioners to participate in this international seminar of

1. Natural science
2. Mathematics and Modeling
3. Computational Technology
4. Applied Science and Technology
5. Architecture
6. Pharmacy and Medical Technology

Best Regards

Committee

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STRATEGY ON GREEN BUILDING TO REDUCE OVERALL THERMAL TRANSFER VALUE IN THE ORTHOPEDIC HOSPITAL IN THE TROPICS

Hendro Trilistyo[1], Erni Setyowati[2]

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ABSTRACT

This research is focused on the design of the *Wijaya Kusuma* Building at Orthopedic Hospital of Prof. Dr. *Soeharso, Surakarta*, Indonesia as a center of medical rehabilitation services and Orthopedic Medicine which should provide comfort for patients, visitors and medical occupants of the hospital. Although the position of the building extends in East-West to reduce radiation, but tropical conditions inside the building was still less convenient. This study will review the OTTV (Overall Thermal Transfer Value) of the building in accordance with the principle of energy conservation. The research method used was simulation using Excel and sketch-up software. The facade redesign effort was only able to reduce the value of OTTV at about 6.03%, while a windows replacement, the effort was able to reduce the value of OTTV at about 19.56 – 21.19%. The combination efforts of the windows replacement and facade redesign could decrease OTTV up to 31.63 – 33.11%.

Keywords

Overall Thermal Transfer Value (OTTV), facade redesign, windows replacement

INTRODUCTION

Located in the centre of hospital complex, the *Wijaya Kusuma* building as the executive wing of Orthopedic Hospital of Professor Dr R. *Soeharso* (OHPSS), is a building that serves patients for medical rehabilitation, outpatient, inpatient, ICU, and Central of Operating Theatre (COT). The first floor is an executive outpatient service of OHPSS. The inpatient facilities are on the second floor. The third floor are ICU (Intensive Care Unit) and Central of Operating Theatre [1, 2, 3].

In the preliminary assessment, it was found that the OTTV was 41.16 Watt/m^2. The very high conductivity value became the researcher judgment that the building envelope was high enough in radiation, and it was considered by researchers in providing suggestions and reducing radiation by facade redesign. In the previous study, researcher was describing and providing an alternative proposal wall construction material that was environmentally friendly of foam-brick, the new waste based environmental friendly material. [4,5] Meanwhile, the factor of comfort and healing atmosphere must be created to achieve the concept of Green Hospital [6]. Unlike the previous research, this research was focused on how the efforts to reduce OTTV of building which was quite high. According to SNI (Indonesian National Standardization) that buildings OTTV in Indonesia should not exceed 35 watt/m^2.[7]

LITERATURE REVIEW

The concept of the Green Hospital Sustainability requires integration consists of several multi disciplinary professionals. The integration of the whole called by the

Integrated Design Process is starting from planning, implementation to operational buildings. [8] The Integrated Design Process makes a sustainable, green and high performance building designed, constructed, and operated to make the world a better place by improving the environment through nurturing lives, restoring environmental assets, and offering inspiration by drawing on the collaborative experience of a multi disciplinary team of professionals. Furthermore, the Integrated Design Process generates sustainable concepts that aim to minimize the impact of building on the global, regional and local environment. The integrated Building process is an achieving good design for long term sustainability and it must start at the beginning of a project and should continue throughout the building operation.

In addition, not all of the construction process will have a positive impact in terms of human resources comfort in hospital of both patient and medical staff. Some cases even lead that conduciveness of occupants reduced during wards renovation. Conduciveness of patients and medical staff is more comfortable on the old wards than in the new wards. [9] Therefore, the level of satisfaction of users is a very important aspect and can shorten the patients healing process. The shortened healing process can save the cost of hospital in the treatment of patients and positively impact the overall cost savings.

METHODOLOGY

This research was focused on the exploration of the simulation and facades redesign to reduce building OTTV which was very high. Research methodology used OTTV's simulation method which used Sketch-Up and Excel computer's software. Sketch-Up model was used to determine shading on all facades: North, South, West, East facades. While in conducting simulation and optimization of the building OTTV, researchers used Excel software. The conductivity value of building envelope in both solid and transparent was approached by using the formula of the conductivity, whereas for calculating thermal caused by the use of transparent materials in buildings, researchers used the radiation formula.

Conservation on the Building Envelope

Control heat internally affected by thermal conditions outside the building. So the value of the difference between the outside temperature and the frigid temperature in the building is expected to comfortably be a very important factor. Level of thermal comfort standards have temperatures between 26° C - 27° C, and the humidity between 60% - 65%.[10].

Meanwhile, a tropical climate that tends to heat causes the heat transfer, because of the temperature difference between inside and outside the building. With this temperature difference there will be a heat gain to the building due to heat transfer from the hot temperatures to the cold temperatures. There are three kinds of heat recovery can occur in buildings: radiation, conduction and convection.

Quantity shadowing on the building envelope will affect the heat gain in the building. This research will be limited to the OTTV of the building envelope. The largest component in the OTTV is the radiation of transparent walls in building facade. Solid wall radiation is the second influential components against OTTV of building envelope. Radiation on the wall is affected by the type of the wall elements and finishing materials of building facade.[12] Conductivity value of the building envelope is formulated as follows:[11]:

$Q_c = A \times U \times \Delta t$ (in Watt) (1)

Whereas A is element area (m²), U is transmittance of element (W/m²°C), Δt is temperature difference between outdoor and indoor (°C). If the space is covered by a number of different elements (floors, walls, windows, roofs), total conduction heat flow is:

$Q_c = \Sigma (A \times U) \times \Delta t$ (2)

that is, the sum of all the components of the heat flow. Formula A x U can be summarized only for elements exposed to the same differential temperature. This term (AxUx Δ t) for a complete building referred to as the flow rate of heat conduction unit: q (in W / °C). Thus:[11]

$Q_c = q_c \times \Delta t$ (3)

Where q_c is building parameter and Δ t is the environmental parameter. Building parameter (q_c) depends on two factors: area (A) expose and transmittance (U-value) of each element.

Overall Thermal Transfer Value (OTTV) of Building Envelope

Control heat internally affected by thermal conditions outside the building. So the value of the temperature difference between the outside temperature and the temperature inside the building is expected to be comfortable is a very important factor. Standard of comfort level has a temperature between 26 ºC - 27 °C, and the humidity between 60% - 65% .[9] To calculate the OTTV, researcher used OTTV formulation as belows:[10]

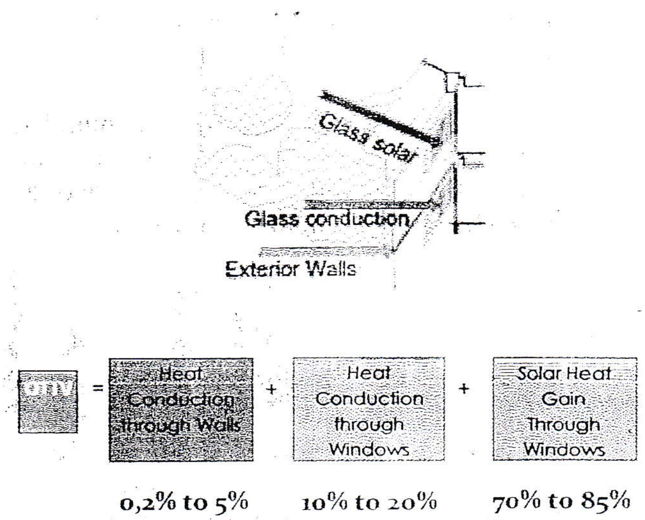


Figure 1: The formulation of OTTV in building

and the equation of OTTV is:

$$OTTV = \alpha[U_W \times (1 - WWR)] \times TD_{EK} + (U_F \times WWR \times \Delta T) + (SC \times WWR \times S$$

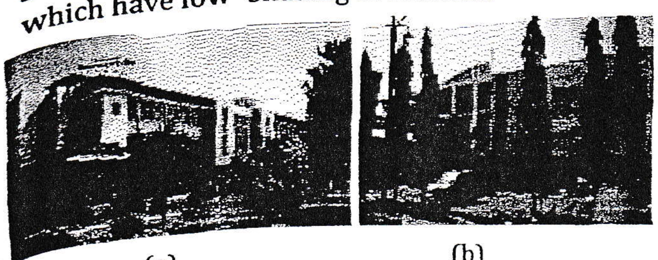
(3)

With OTTV is Overall Thermal Transfer Value on the building envelope that has a direction or certain orientation (W/m²), α is absorbance of solar radiation, U_W is thermal transmittance of solid wall (W/m².K), WWR is the comparison of square field of window with total external facade on the specified orientation. TD_{EK} is equivalent of temperature difference (K), SF is solar radiation factor (W/m²), SC is sunshading coefficient of building's fenestration system, U_F is thermal transmittance of building fenestration (W/m².K), ΔT is The difference in temperature between the outside and inside of the building (5K).

RESULTS AND DISCUSSION

Based on OTTV calculations on existing building, then the obtained values of OTTV was 41.16 Watt/m². This value does not meet the standards of building OTTV, because the value permitted is 35 watts/m^2.[7]

Therefore, the redesign of the building shoul be made and facade of glass material should be replaced with certain glasses which have low- shading coefficient.



(a) (b)

Figure 2: (a) Front or Southern facade of hospital (b) Rear or Northern facade of hospital

Two alternative ways to reduce OTTV are:

1. The addition of shading on building facades Shading system is an attempt at reducing solar radiation enters through the transparent areas of building facade.
2. Replacement of the glass on the facade with glass material that has a low SC (Shading Coefficient).

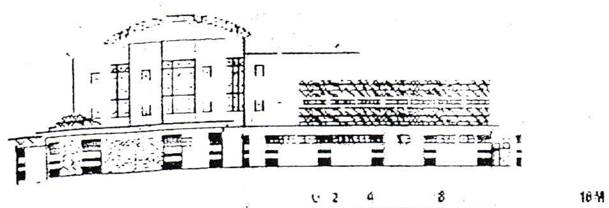


Figure 3: Sample of eastern facade of the hospital

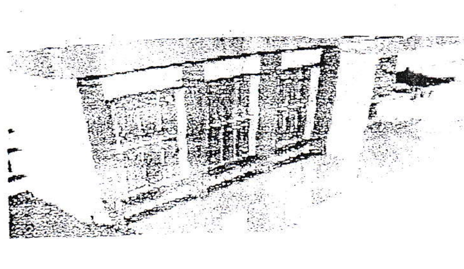


Figure 4: Sample of Facade Re-design efforts to reduce OTTV in the hospital

It is known from OTTV calculations that building OTTV of the existing condition is 41.16 watts/m^2. Then after a redesign on the building facade with the addition of sun shading, the value of OTTV of buildings dropped to 38.68 Watt/m^2. If the redesign was not conducted, then the glass of windows must be replaced with low-radiation glass which has low shading coefficient. Calculations showed that by the replacement of glass with 8 mm stop sol glass, OTTV will drop to 32.44 watts/m^2. While, if the glass replaced with stop sol classic green 5 mm, then the OTTV will drop to 33.1064 watts/m^2. See table 2.

From the table 2, it is known that the replacement of glass with dark blue and stopsol green was very effective in lowering OTTV on building's facade. The value of allowable OTTV is 35 Watts/m^2 [7]. The value of OTTV dropped to 32.44 Watt/m^2 by using dark blue stopsol glass, thickness 8 mm. While the value of OTTV will be dropped to 33.11 Watt/m^2 by using glass stopsol classic green 5 mm thick.

From table 4, it is noted that the efforts to decrease OTTV values can be done in two ways: (1) by facade redesign effort; (2) by windows replacement effort. Facade redesigns in this research are sunshading devices addition. Sunshading device not only lowers the value of OTTV but also conserve the use of electricity in building. [13, 14]. According to a study about the ratio between the length of the sunshading and dimensions of the window, [15] this research refers on the dimensions of sunshading mentioned in research conducted by W.K. Chow and K.T. Chan. However, the most effective effort is by combining both of these efforts. The combination of facade redesign and windows replacement that used dark blue stopsol glass 8 mm was capable of lowering the OTTV of 24.59%. Meanwhile, the merger of the facade redesign and windows replacement that used glass stopsol classic

green 5 mm would reduce OTTV until 23.15%.

Tabel 4: OTTV Comparation with windows replacement between Existing and redesign condition

Condition	Building Facade	Heat Conduction through walls (W/m²)	Sub Total (1) W/m²	Heat Conduction through windows (W/m²)	Sub Total (2) W/m²	Solar heat gain through windows (W/m²)	Sub Total (3) W/m²	Total OTTV (Watt /m²)	Percentage of OTTV decrease (%)
Facade Redesign with additional sunshading	South	9.509	12.99	11.245	8.33	19.569	17.36	38.68	6.03
	North	9.959		11.435		21.675			
	West	14.578		3.556		15.343			
	East	17.907		7.100		12.844			
Windows replacement Stopsol dark blue 8 mm SC=0,39 + facade redesign	South	9.509	12.99	11.114	8.24	11.061	9.811	31.04	24.59
	North	9.959		11.301		12.251			
	West	14.578		3.514		8.672			
	East	17.907		7.017		7.859			
Windows replacement Stopsol classic green 5 mm SC=0,41 + facade redesign	South	9.509	12.99	11.114	8.24	11.628	10.314	31.63	23.15
	North	9.959		11.301		12.879			
	West	14.578		3.514		9.117			
	East	17.907		7.017		7.601			

From table 4, it is noted that the efforts to decrease OTTV values can be done in two ways: (1) by facade redesign effort; (2) by windows replacement effort. Facade redesigns in this research are sunshading devices addition. Sunshading device not only lowers the value of OTTV but also conserve the use of electricity in building. [13, 14]. According to a study about the ratio between the length of the sunshading and dimensions of the window, [15] this research refers on the dimensions of sunshading mentioned in research conducted by W.K. Chow and K.T. Chan. However, the most effective effort is by combining both of these efforts. The combination of facade redesign and windows replacement that used dark blue stopsol glass 8 mm was capable of lowering the OTTV of 24.59%. Meanwhile, the merger of the facade redesign and windows replacement that used glass stopsol classic green 5 mm would reduce OTTV until 23.15%.

CONCLUSION

The decrease of building OTTV was influenced by efforts to redesign of the facade and glass replacement of windows. Indirectly, the longer the length of a shading (overhang or sidefin) in a building glass facade, the lower the value of building OTTV. This is because the value of the resulting effective shading coefficient will be lower too. And if the glass material glass is replaced with other low SC glass materials, the value of building OTTV will be lower effectively and significantly.

According to Vale, B (1991) that In the Green building concept requires some ratios consist of building layout design (10 percent), consumption and water management (10 percent), electrical energy needs (30 percent), building materials (15 percent), air quality (20 percent), and the breakthrough of innovation (technology, operations) at about 15 percent. Hence the effort to redesign the building included on one of the percentage of all the efforts in the green concept.[10]

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