Ecotect design simulation on existing building to enhance its energy efficiency

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Abstract. Ecotect Software has been used to calculate building’s energy consumption by simulating its context within the environment. Mostly use by architects and building engineers to enhance their design advancements, the software is embedded to the main Autodesk CAD architecture, fully compatible with Autodesk REVIT. Research Studies on many existing buildings have been performed to evaluate its building’s performance. It is related to its environment, especially on dealing with solar heat, its nature for day-lighting, natural airflow for ventilation, and its energy consumption for man-made systems such as Air Conditioning and Lighting.
This research is conducted to reach basic optimum efficiency of an existing building at UI Campus in Depok. After using ecotect software we presumed that some strategic upgrading design propositions should be done to minimize the daily energy consumptions on air conditioning and lighting. Sensitive to the annual solar path and air/wind direction, we could propose an alternative to maximize the use of natural resource to reduce the building’s energy consumption.

1. Introduction

Human being builds to fulfil their needs of shelter. We make shelters for living and other activities. Architecture has evolved and changed tremendously nowadays, that we can easily simulate our buildings in advance. Using many software applications [1], we now can even simulate the level of comforts by making calculations towards the buildings’ aspects in relations to nature. CAD (Computer Aided Design) technologies has come to a degree where we can measure and simulate our future built environment, by not only predicting its spatial forms, its spatial quality, and even further, its performance. The objectives of the writing are to deepen understandings the use of Ecotect Software on architecture, its green building concepts, and its applications for building performance evaluations, especially on an existing buildings. By simulating an existing building performance, we could then propose a better alternative solutions for renovations to achieve the maximum building’s energy efficiency.

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2. Environment and Nature

Architecture is a compromised environment for man. People built to provide a more comfortable environment to live in. It is a necessary matter that people highly consider the nature as the main resource for comforts. But not until the discovery and intervention of AC (air conditioning) system and technology, architecture changed into a more industrial and technology dependent ones. AC system mimics the nature of air and climate and stabilizes the interior air conditions of buildings. They put a lot of tokens on general energy consumption.

3. Ecotect Simulation

3.1. Existing Condition

The Engineering Center (EC) building of the Faculty of Engineering Universitas Indonesia, were observed to find the performance and energy consumption flaws of the building. This effort was done as a pilot project within the faculty complex to enhance the green aspects of most buildings.

Energy consumption on existing structure like the EC Building, surprisingly has come to a state where it is necessary to be evaluated. Buildings with less consideration to green aspects, consume over too much energy comparing to buildings with consideration. On a quick observation of the building, some spots within floors were identified as uncomfortable as they contrary wished by design. These heat weaknesses then will be confirmed later after the Ecotect spatial thermal analysis, to find out on why the uncomfortableness happen.

3.2. Calculation Aspects

ECOTECT software is an environmental analysis tool that allows architects and designers to simulate building performance right in conceptual phase [2]. On building’s energy efficiency efforts, research usually relates to the daylight factors, shadow parameters and thermal analysis to examine its performance level [3]. Those mentioned analysis leaned to a thermal simulation program named Ecotect by CAD-Autodesk for green building simulation. It is used to optimize solutions through modification of the existing condition, new design intervention to propose and making changes towards a better building’s energy performance. These calculation aspects are the simulation tools for analysis to indicate possible optimized solution from this investigation.

Investigation was conducted to identify the issue/problems of the building. Façade details and materials were analyzed to see how they relate to the calculation aspects. Daily factors were simulated at first to map clearly the affected spaces within the building.
4. Research Method

Observative and quantitative method is used to measure the building performance based on several indicators. Ecotect Software application was done by first, recreating basic CAD drawings of the existing building. This drawings then generated into 3D Modelling with all building materials indicated. Solid and void parts are also clearly marked to simulate the sun-path effects to building.

5. Research Results

Ecotect can simulate accurately the annual solar trace and positions (figure 2 and 3). It also provides accurate statistics of the building area’s solar radiation intensity. According to the annual daily average solar radiation distribution, we can figure out solar radiation or day lighting [4] distribution of the building area and the shadings it generated. Shading analysis of floor samples based on sun-path applied on 3D model can be seen on figure 5 for sun’s turning-points of June 23rd. On figure 6, the shadings generated for sun’s turning-points of December 23rd.

Comparing the observation and the sun path on the area, we can assume that the building orientation was decided correctly by the architect to avoid maximum heated areas created. Sunshades are important aspect towards energy efficiency [5]. But yet, the curvaceous plan forms had created heated spots at some sun’s position. These have been indicated after building’s thermal analysis on figure 2. This building plan model is similar to courtyards building type [6], where the building footprint and plans can become a significant aspects for wind and solar movements that affecting the entity. The result analysis showed the facts that there are quite many heated spots which need to be fixed. Additional shadings or solid material board/wall should be applied to minimize the heated spots, especially along the inner corridors which face the afternoon sun directly. Even so these areas are
affected by the robust sunrays, alternative model for shadings are always welcome to allow indirect sunlight to come in.

Figure 5. Shading analysis of floor samples based on sun-path applied on 3D Model turning points of June 23rd.

Figure 6. Shading analysis of floor samples based on sun-path applied on 3D Model turning points of December 23rd.

6. Conclusion

The solar radiation analysis, solar orbit analysis, and sunlight time of the planning area can be reflected visually and clearly by Ecotect [2]. After thermal and shading analysis conducted, the proposed changes are delivered based on possible fix by adding shading panels or walls for renovation in the future. Figure 7 and figure 8 are samples of proposed changes for consideration.

Building design performance evaluation provide overviews of conclusions with the design guideline from the investigated outcomes [7]. These results would maximize the energy efficiency for future use by considering the significant green building aspects for calculation. The building criteria for designing and building new environments should be based on the evaluation of existing ones, and modified when appropriate in the context of the design process. Rapid development in Indonesia and problems with the energy shortage, make ecological buildings and sustainable development have become the new focus of the society. It is very urgent to explore more ecological planning methods and strategies towards building performances. The Green Building Council of Indonesia has adopted
strategies to evaluate aspects for improvement to the living comfort of buildings, which at the same time also reduce its energy consumption.

![Figure 7. One proposed façade of the building. Northern Side.](image)

![Figure 8. Sample details of the proposed Façade parts.](image)

Architects and designer should give full consideration to various ecological energy-saving methods in the concept design by analyzing and then offer alternative designs. Software like Ecotent helps them to be sensitive to natural condition of a place where the building would be built. By considering nature as major potential source of energy, award winning designs would become more ecological, consume lower energy, and ultimately create better living environment. In the future, it is very significant to ensure that the building planning phase to be scientific to create a more comfortable, ecological, and energy-saving working/studying environment. As different place have different climates, temperature, and rainwater density, the global practice of green/ecological building and application, should also consider the local wisdom context. This is required to deepen understanding and define the local ecological knowledge for further research on this field.

7. References

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