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Building Information Modeling- Emerging Trend in Lowering CO_2 Footprint and Energy Savings Buildings Design and Construction

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Abstract—*In this paper an incorporated idea of sustainable building design and of Building Information Modeling (BIM) by methods for usage of the Green BIM is investigated, through the crystal of a contextual analysis based research. The examination approach embraced has prompted more educated economical answers for remodels phases of project, with a by and large lower level of development (LOD) and computational or modeling required. As a contextual investigation Building of Faculty of Architecture situated at 13C Nieszawska Street, Poznan is chosen. The models of the current building were made by utilizing Revit, Green Building Studio and Vasari to calculate the energy and CO2 emissions of the building. With the assistance of these outcomes a concept model is acquired to limit the energy utilization and carbon footprint.*

1. INTRODUCTION

Global warming caused by greenhouse gas, especially CO2 emissions (carbon emissions), constantly dangers the presence of human and biological condition and has caused a progression of worldwide concerns, for example, rising ocean levels, ozone depletion, crop failures, desertification, and numerous. The building industry is anticipated to contribute 35% of carbon discharges to add up to worldwide outflows and 52% by 2050 [1]. In Europe, the building and construction industry represents more than 40% of total energy consumption [2], and contributes almost half of carbon emissions discharged in the climate. Amid the life cycle of a building, the embodied energy and construction related energy may take up in the vicinity of 10% and 60% of total energy utilized [3]. In the United States (U.S.), development exercises are in charge of 40% of carbon emanations of non transportation portable sources [4] and discharges from development hardware and plants represent over half of most sorts of outflows. In the United Kingdom, development division related exercises represent an expected 47% of aggregate CO2 emanations [5], and transmitted 42.6 Mega huge amounts of CO2e (MtCO2e) in 2011,among which inexact 10 MtCO2e related with development operational exercises and 22 MtCO2e credited to material generation [6]. To restrain carbon emissions and to save energy in the construction and built environment, a progression of evaluations has been set up all inclusive. Among these appraisals, two predominant methodologies at both the macro and micro level have been connected in evaluating carbon emissions in construction [7]. At the macro level, input output modeling and life cycle assessments have been most commonly used. Building effectiveness speaks to one of the simplest, quickest and most savvy approaches to decrease carbon emissions. Green BIM gives best answers for the building plans with the minimum carbon discharge and energy savings. This study introduces the strategy and innovation for coordination of practical plan investigation with Building information modeling (BIM). The take-up of BIM has been quick as of late. The training is still genuinely new and general specialists are bewildered by both the sum and multifaceted nature of software solutions available.

2. GREEN BIM APPLICATION

Construction industry is increasingly tested to think of more environmentally friendly methods for construction. An imperative parameter in the ecological issue is the utilization of energy and the CO2 emissions and other greenhouse gasses which result from the energy necessities. In tending to ecological issues distinctive methodologies and ideas have been created in the course of the most recent decades. With the advancement of Green BIM, a coordinated system is important to additionally stimulate innovation and process changes that help economical improvement. Green BIM is a current move went for advancing the reception of green building standards and expanding the procurement of sustainable buildings and infrastructure. Public authorities and private developers are requesting more sustainable methods because of developing natural concerns and increasing expenses of energy. BIM assumes a critical part in this change by empowering more compelling cooperation, frameworks reconciliation and streamlining. Green BIM enables the goals and decision making processes of project stakeholders to be aligned and making its process more effective and efficient [8].

3. CASE STUDY

The building of Faculty of Architecture is educational institution building, is built at the street Nieszawska, Poznan situated in the interface between two districts Zawady and Główna. It is in the north-eastern zone of the city of Poznan. Poznan is the authentic capital of the Greater Poland area and is right now the regulatory capital of the region called Greater Poland Voivodeship in Poland. The zone close to the building is essentially industrialized. Here ventures are created on a substantial scale. In this region, we can see business structures like present day generation offices PEBECO, The Rolling Bearings Factory. Poznan-Bydgoszcz railway line was built in the year 1872 in this zone. Following the development of industries, the city building extension begins on a full scale. No post-war vision of urban districts (or rather the lack of implementation of the project transform into a large residential complex with 1963), implied that this region has experienced major architectural and social degradation, but on the other side retained the old, small-town atmosphere, characteristic of working-class suburbs of Poznan.

Fig. 1: Building Location

Fig. 2: Building Location in Google maps

The design concept was to produce a building with a very low imprint on the site, related to the annual energy consumption and CO_2 emissions. Basic model energy calculations estimate that the building will produce more energy from the non renewable sources. The inventive utilization of available sources, testing the low energy potential of highly insulated, sustainable and locally sourced materials. The project speaks to a chance to embrace look into in two key territories, monitoring of building performance with regard to energy consumption and embodied carbon.

Fig. 3. Actual Building

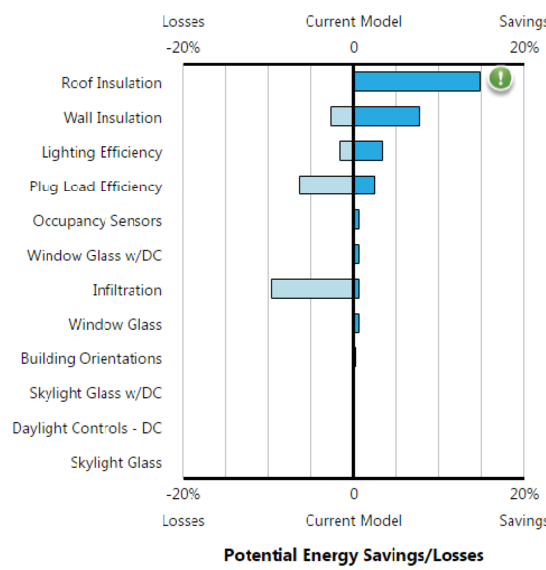

Fig. 4. Potential Energy Savings/Losses

Here are six possible ways to save energy for the proposed research undertaken, but first three are considered in this project.

1. More or better roof insulation
2. More or better walls insulation
3. Better windows glazing or frame material
4. Using photovoltaic cells
5. Using more solar energy
6. Reducing the resource consumption need

Some of the factors affecting the potential energy savings or losses are explained in the following Fig. 4.

Building embodies both demonstrated and developing green advances close by passive energy sparing measures. The plan encapsulates the standards of texture initially approach, through the making of an exceedingly protected, breathable building, built utilizing neighborhood materials and outfitting nearby assets. Coordination of BIM and sustainable design and assessment of the building plan and execution regarding its natural supportability is necessary through testing the utilization of breathable and low exemplified carbon materials and conventional ideas. Utilization of the proposed advancement as a proving ground for long haul execution observing, by means of joining amongst BIM and sustainable design. The software used are Autodesk © Revit, Green Building Studio and Vasari to provide ease of iterations between conceptualization and calculation stage. The analysis and details of materials are specified beneath.

Basic model:

1. Windows:

a) Single glazing

• Heat transfer coefficient (U): 3, 69 W/ (m2*K)

• Thermal resistance (R): 0, 27 (m2*K)/W

b) Frame profile

• Aluminum: 5x10 cm

• Thermal Conductivity: 230 W/ (m*K)

2. Walls [Resistance: 5, 12 (m2*K)/W]

a) Structure layer

• Brick: 38 cm

• Thermal Conductivity: 0, 54 W/ (m*K)

b) Thermal layer • Rock wool: 25 cm

• Thermal Conductivity: 0,034 W/ (m*K)

3. Roof [Resistance: 2, 77 (m2*K)/W]

a) Structure layer • concrete: 24 cm

• Thermal Conductivity: 1,046 W/ (m*K)

b) Thermal layer • Rock wool: 7 cm

• Thermal Conductivity: 0,034 W/ (m*K)

Concept model:

1. Windows:

a) Triple glazing

• Heat transfer coefficient (U): 1, 45 W/ (m2*K)

• Thermal resistance (R): 0, 69 (m2*K)/W

b) Frame profile

• Stainless steel: 5x10 cm

• Thermal Conductivity: 16, 2 W/ (m*K)

2. Walls [Resistance: 9, 16 (m2*K)/W]

a) Structure layer

• Brick: 38 cm

• Thermal Conductivity: 0, 54 W/ (m*K)

b) Thermal layer

• Rock wool: 25 cm

• Thermal Conductivity: 0,034 W/ (m*K)

3. Roof [Resistance: 9, 20 (m2*K)/W]

a) Structure layer

• Concrete: 24 cm

• Thermal Conductivity: 1,046 W/ (m*K)

b) Thermal layer

• Rock wool: 25 cm

• Thermal Conductivity: 0,034 W/ (m*K)

Building model (lower LOD)

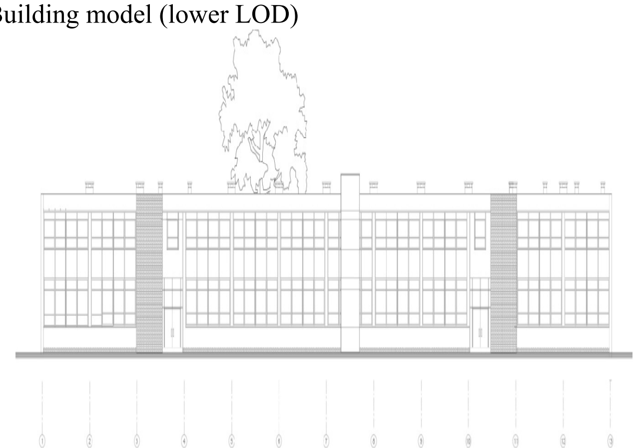

Fig. 5: South elevation

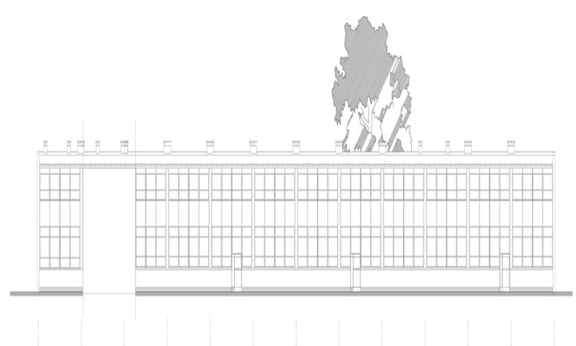

Fig. 6: North elevation

Fig. 7: East, West elevation

Analysis report for basic model:

Energy, Carbon and Cost Summary	
Annual Energy Cost	zł42,392
Lifecycle Cost	zł577,385
Annual CO2 Emissions	
Electric	93.3 Mg
Onsite Fuel	89.2 Mg
Large SUV Equivalent	18.3 SUVs / Year
Annual Energy	
Energy Use Intensity (EUI)	1,463 MJ / m² / year
Electric	199,645 kWh
Fuel	1,789,213 MJ
Annual Peak Demand	66.3 kW
Lifecycle Energy	
Electric	5,989,356 kW
Fuel	53,676,390 MJ

Analysis report for concept model:

Energy, Carbon and Cost Summary	
Annual Energy Cost	zł41,757
Lifecycle Cost	zł568,724
Annual CO2 Emissions	
Electric	87.1 Mg
Onsite Fuel	82.6 Mg
Large SUV Equivalent	18.0 SUVs / Year
Annual Energy	
Energy Use Intensity (EUI)	1,458 MJ / m² / year
Electric	197,150 kWh
Fuel	1,756,588 MJ
Annual Peak Demand	65.1 kW
Lifecycle Energy	
Electric	5,914,494 kW
Fuel	52,697,640 MJ

Monthly data: Basic model

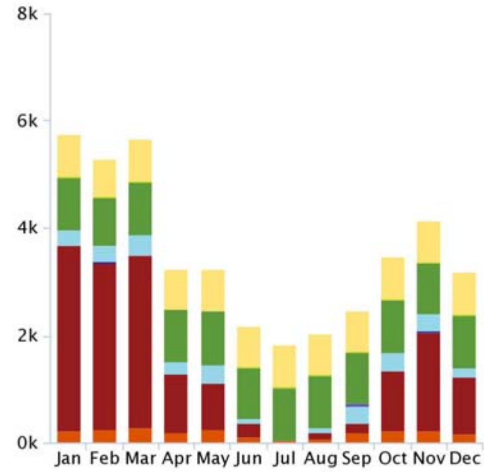

Fig. 8. Cost total energy

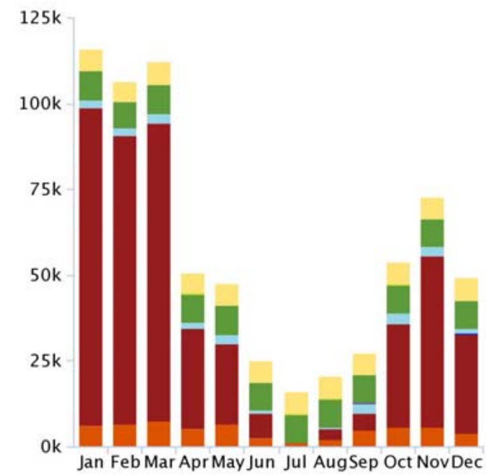

Fig. 9. Total energy

Concept model

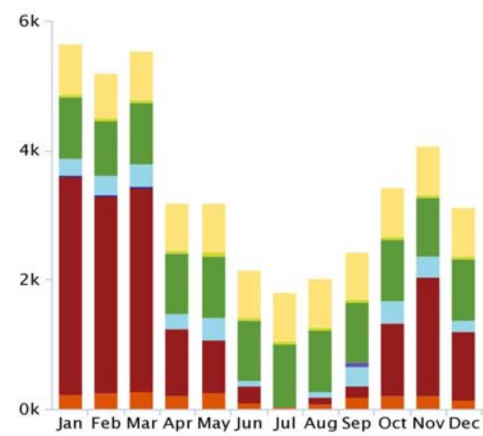

Fig. 10. Cost total energy

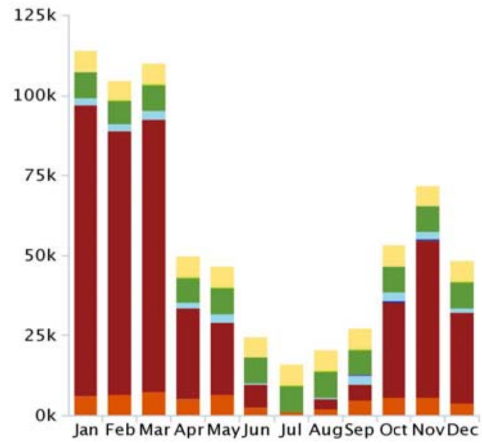

Fig. 11. Total energy

4. DISCUSSION AND CONCLUSIONS

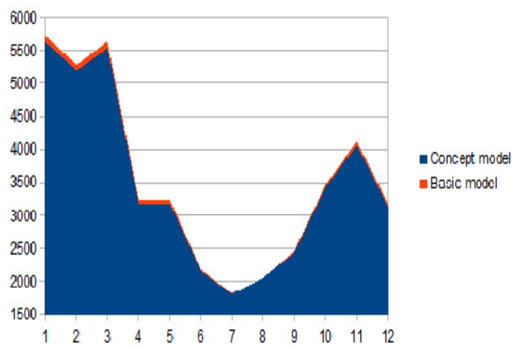

Fig. 12. Total energy cost monthly data

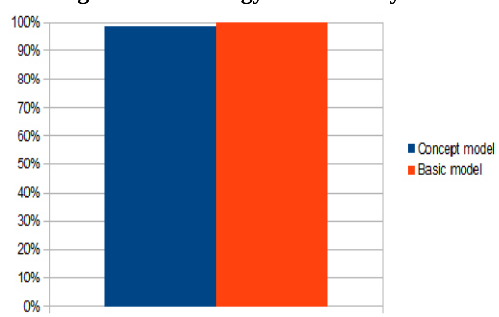

Fig. 12. Total energy cost in one year rates summary

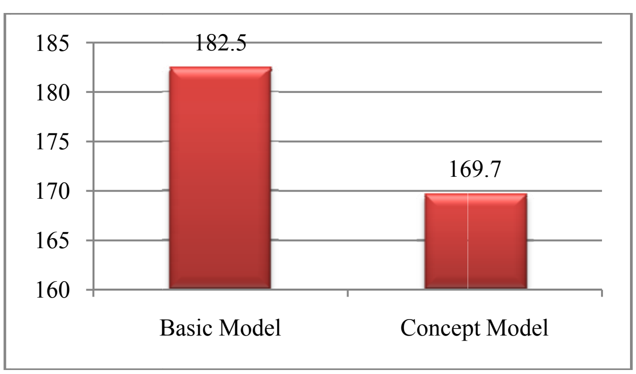

Fig. 13: Carbon emissions in Mg

Fig. 13 shows the Carbon footprint (annual CO2 emissions) in both the models.

Basic model: 182,5 Mg

Concept model: 169,7 Mg

This contextual analysis based research introduces the technique and innovation for integration of sustainable design analysis with BIM. Carbon emissions, thermal analysis and energy use calculations in Autodesk Green Building Studio and Vasari were created utilizing building development particulars, in this manner taking into account building energy calculations to be produced without the sense of duty regarding precise determination of structures segments. The approach required a lower LOD [LOD:100 to LOD:300], bringing about for the most part less computational or displaying exertion required. In addition, the final investigation for carbon emissions and energy estimations for the concept model were resolved. Results presumes that the annual carbon emissions are brought down to 182,5 Mg to 169, 7 Mg. It demonstrates the advantage of sustainable design with BIM. At early stages of the project the cost of design changes is at its most minimal, yet the capacity to affect the general task costs is at its most noteworthy. This capacity reduces as the outline advances while the cost of changes increment. Thus, the capacity to control costs and the exertion required to roll out improvements is at its most advantageous at early stages of design and construction.

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