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Comparing the Effects of a Building's Glass Type, Size, and Location on Its Average Annual Energy Usage Through BIM Software

Energy: Physical

Research Plan

a. RATIONALE: Include a brief synopsis of the background that supports your research problem and explain why this research is important and if applicable, explain any societal impact of your research.

Buildings are a major contributor to global energy usage. With the issues of climate change and the rise in population, building professionals have been looking towards sustainable solutions and simulating building performance before construction to make design decisions and optimize energy savings.

My research will potentially support building professionals to understand various effects on a building's energy usage. Also, the world-scale study will hopefully contain results that can be used by policymakers around the world to make regulations and guidelines towards more energy-efficient buildings.

b. RESEARCH QUESTION(S), HYPOTHESIS(ES), ENGINEERING GOAL(S), EXPECTED OUTCOMES: How is this based on the rationale described above?

- How does a building's distance from a large body of water affect its energy consumption?
- How do a building's size, location, and glass type affect its annual energy usage intensity (EUI)?

Hypothesis:
The ten-story building will have the greatest EUI compared to the twenty and thirty-story buildings in the same locations. This is based on the idea that buildings with a larger surface area to volume ratio are more responsive to fluctuating temperatures and weather conditions.

c. Describe the following in detail:

• Procedures: Detail all procedures and experimental design including methods for data collection. Describe only your project. Do not include

work done by mentor or others.

1. Create a list of cities from around the world that have a human population of 1 million people or more to include in the research.
2. Model a typical thirty-story office building in the Autodesk Revit program.
3. Make ten and twenty-story variations of the building.
4. In each building, identify the function of each room in Revit.
5. Make duplicates of three buildings for each of the locations.
6. In each Revit file, identify the location, generate an energy model, and export the file to Autodesk Insight.
7. For each building, adjust the glass type of each side of the building in Autodesk Insight and collect the building's annual energy unit intensity (EUI) in kBtu/sq.ft. For each building, this must be done four times four the four glass types: Single Clear, Double Clear, Double Low-E, and Triple Low-E glass.
8. Enter the data into a Google Spreadsheet.
9. Calculate the difference in EUI between using different glass types.
10. Create graphs based on different relationships such as the effects of a building's size, glass type, location, and latitude on its EUI.
11. Observe the relationships found in each graph.
12. Record the findings.
13. Write a research paper describing past research in the field, the methodology, results, limitations, future research, discussion, and conclusion.

Risk and Safety: Identify any potential risks and safety precautions needed.
There are no potential risk and safety precautions needed to conduct this research.

Data Analysis: Describe the procedures you will use to analyze the data/results

1. Organize specific data into different Google Spreadsheets.
2. Create graphs for the different organized data.
3. Determine if the data supports my original hypothesis.
4. Interpret the findings of each graph and think about why this was found and what it means on a larger scale.

d. BIBLIOGRAPHY: List major references (e.g. science journal articles, books, internet sites) from your literature review. If you plan to use vertebrate animals, one of these references must be an animal care reference.

- The Journal of Energy and Buildings
- The Journal of Building and Environment
- The International Symposium on Automation and Robotics in Construction
- Energy Procedia

Addendum

The original list of locations that the buildings were planned to be simulated in using Autodesk Revit contained 154 cities. However, the software had trouble generating data with these 13 locations: Quito, Ecuador; Lagos, Nigeria; Kano, Nigeria; Ibadan, Nigeria; Kaduna, Nigeria; Dar es Salaam, Tanzania; Kumasi, Ghana; Luanda, Angola; Lusaka, Zambia; Harare, Zimbabwe; Antananarivo, Madagascar; Khartoum, Sudan; and Kampala, Uganda. As a result, these locations were removed from the study, and the buildings were only digitally analyzed in 141 locations.