A Review on Educational Design by Building Information Modeling (BIM) Applied TO: Cloudy Climates

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Introduction

In designing a building two factors are the most important for designer the first one is satisfaction of the persons who are living in it and the second factor is the cost that they should pay for using this building. The satisfaction of customer in educational spaces depends on relaxation and performance of student during their study research show that the sustainable design could improve the student attendance beside their improvement in their study and also it could evaluate the healthy environment for student by eliminate some illness.

The cost of using school spaces is another factor that could be concern able by the government or management. Because the comfortable condition in a school atmosphere needs some facility like air condition and lightening, that use the big amount of energy during the day and it caused wasting money.

BIM is a group of beneficial software’s that help the designer two gatherings sufficient information for most optimized designing.

Sustainable design is a positive criteria that could improve the efficiency of a building. There are several factors that impact the quality of the atmosphere of educational spaces, like furniture, lightening, noise, air quality, day lightening and temperature. This research purposed to focus on adjusting the suitable lightening and the temperature in educational spaces.

For improving healthy environment in these spaces 4 factors need to be optimized. These factors are:

- Noise
- Thermal
- Air quality
- Lightening

In this research lightening item chooses because of two reasons:

- Importance of lightening item in Malaysian schools because of its cloudy weather
- The importance of optimizing energy consumption in this factor

Now a day’s energy consumption is one of the most concern able matter in architectural design. And using the natural resource of energy is the key that could help the designer to decrease this. This project aimed to find a solution to optimizing energy consumption by using day lighting in classroom spaces instead of lights.
Objectives of research:
The aim of this study is to optimize the classroom design by improving the following factors:
1. To extract the database of information for the classroom atmosphere for daylight analysis.
2. To utilize the context of database from BIM for design optimization.
3. To analyze the life cycle of buildings.

Literature review:

Lighting:
Good natural light helps to create a sense of physical and mental comfort, and its benefits seem to be more far-reaching than merely being an aid to sight. This is owned in part to the soft and diffused quality of natural light, its subtle changing value and color which electric lighting does not have. Low ceilings and deep classrooms can cause pupils to experience a gloomy feeling due to the disparity in light levels between the back of the room and the peripheral area near the window. Therefore, natural day lighting should always be the main source of lighting in schools, supplemented by electric light when daylight fades. Overall, the essential requirements for the effective day lighting in schools can be summarized as follows:
- An adequate amount of light: The building is elongated along an East-West axis. Spaces, such as the library and art rooms, where only diffuse daylight is desirable, are located towards the North while the main learning and teaching activity areas can be in the South.
- A satisfactory distribution of the main components of light: Large windows and/or windows placed high in the wall such as clerestory windows optimize daylight distribution and bring light deeper into the space.
- The absence of glare: bringing daylight from two different directions reduces the chances of discomfort glare. Necessary shading control is needed and that can be easily adjusted by occupants. Three practical options are addressed here.

Definition of Sustainable design:
Thomas Jefferson Sustainability Council: Sustainability may be described as our responsibility to proceed in a way that will sustain life that will allow our children, grandchildren and great-grandchildren to live comfortably in a friendly, clean, and healthy world. That people:
- Take responsibility for life in all its forms as well as respect human work and aspirations;
- Respect individual rights and community responsibilities;
- Recognize social, environmental, economic, and political systems to be interdependent;
- Weigh the costs and benefits of decisions fully, including long-term costs and benefits to future generations;
- Assume control of their destinies;
- Recognize that our ability to see the needs of the future is limited, and any attempt to define sustainability should remain as open and flexible as possible.

World Business Council on Sustainable Development:
"Sustainable development involves the simultaneous pursuit of economic prosperity, environmental quality and social equity. Companies aiming for sustainability need to perform not against a single, financial bottom line but against the triple bottom line." Over time, human and social values change. Concepts that once seemed extraordinary (e.g. Emancipating slaves, enfranchising women) are now taken for granted. New concepts (e.g. Responsible consumerism, environmental justice, intra- and inter-generational equity) are now coming up the curve." With these issues in mind we can begin to imagine what a sustainable community might look like and the sort of attitudes, behaviors and values we should be striving for. As listed in various sustainability charters and action programs they include:
- Integrating environmental, social and economic goals in policies and activities
- Dealing cautiously with risk, uncertainty and irreversibility
- Ensuring intergenerational equity
- Recognizing the global dimension
- Appropriately valuing, appreciating and restoring nature
- Conserving biodiversity and ecological integrity
- Ensuring no net loss of human or natural capital
- Providing for equal opportunity and community participation
- Committing to best practice
- Committing to continuous improvement, and
- Recognizing the need for good governance.
Different people will have different views on what a sustainable community looks like. A broad answer to the question however is that a sustainable community is one which enjoys:
- Healthy ecosystems
Social well-being and cohesion, and
A prosperous economy

Sustainable design:
Sustainable design in school:
By addressing the uniqueness of school spaces and children’s health issues, LEED for Schools provides a unique, comprehensive tool for schools that wish to build green with measurable results. The rating system addresses issues such as classroom acoustics, daylight and views, mold prevention, and environmental site assessment.

How does LEED for Schools work?
Intended for use in the design and construction phases of a K12 school building, LEED for Schools facilitates and encourages project teams to use an integrated design approach from start to finish, bringing down overall costs and delivering project goals. To become LEED certified, projects must meet all prerequisites and a minimum number of points within six categories. The number of points earned determines the level of LEED certification the project

Green schools are designed to be healthy for both occupants and the environment while saving water and energy. By promoting the design & construction of green schools, we can make a tremendous impact on student health, school operational costs, test scores and the Environment.

The green school itself also serves as a teaching tool – demonstrating to students, faculty, and Parents practical ways that we can turn back the clock on global warming while creating a Healthier, more efficient learning environments.

Environmental Benefits:
- LEED certified green buildings use 30-50% less energy and 40% less water, and Reduce harmful Carbon Dioxide emissions by 38%.
- Student and Teacher Benefits
- Improved student health, test scores, faculty retention.
- Green schools have better lighting, temperature control, improved ventilation and Indoor air-quality which contribute to reduced asthma, colds, flu and absenteeism. Green schools reduce the dangerous air-pollutants that cause respiratory diseases.
- Financial Benefits
- Building Benefits
Building green offers dramatic reductions in operations and maintenance costs.

Daylight Increases Scores:
In terms of student performance, daylighting has been observed to lead to higher levels of student performance. The most referenced study, by Heschong Mahone Group investigating student performance related to daylighting in classrooms, identified a 21 percent improvement in student learning rates in classrooms with the most amount of daylight compared to those with the least. That connection is promising and, though education and learning are influenced by lots of variables, this study still makes a good case for day lighting.

Another benefit of day lighting is that it improves the student and teacher experience in the school. As Ghita Carroll, sustainability coordinator with Boulder Valley School District says, “the abundance of day lighting flooding Casey (Middle School) is one of the first features students, staff and community members notice about the design.” The feel that one gets in the middle school, which is pursuing LEED for Schools Platinum certification, reinforces the idea that striking views and impressive day lighting facilitated by the LEED process can fundamentally change the way that people feel in the building.

Going through formal LEED for Schools certification also provides teams the pathway, framework and leverage to include daylight modeling, which greatly expands the design team's ability to understand the expected results of a given design as well as to fine tune key elements like window location, glare reduction, shading strategies and contrast.

BIM:
As with traditional physical models and drawings, evaluating building performance based on the graphic representations of conventional CAD or object-CAD solutions requires a great deal of human intervention and interpretation, which renders the analysis too costly and/or time-consuming. A survey conducted by the Center for Integrated Facility Engineering (CIFE) at Stanford University cited that economic reasons are among the primary causes for not implementing sustainable design and construction procedures by the majority of survey respondents.

A Building Information Model represents the building as an integrated database of coordinated information. Beyond graphically depicting the design, much of the data needed for supporting sustainable design is captured
naturally as design of the project proceeds. In addition, the integration of Building Information Model with Performance Analysis tools greatly simplifies the often cumbersome and difficult analysis. This approach gives architects easy access to tools that provide immediate feedback on design alternatives early on in the design process.

Krygiel and Nies (2008) indicated that BIM can aid in the following aspects of sustainable design.

- Building orientation (to select the best building orientation that results in minimum energy costs)
- Building massing (to analyze building form and optimize the building envelope)
- Day lighting analysis
- Water harvesting (to reduce water needs in a building)
- Energy modeling (to reduce energy needs and analyze renewable energy options such as solar energy)
- Sustainable materials (to reduce material needs and to use recycled materials)

For projects pursuing LEED certification, many LEED credits require that drawings be submitted to support the qualification for credit. Although most of these drawings can be prepared using conventional CAD software, BIM software produces these drawings more efficiently as part of the building information model and have the added advantage of parametric change technology, which coordinates changes and maintains consistency at all times. Thus, the user does not have to manually update drawings or links. Similarly, such models carry a wealth of information for many other aspects of sustainable design and/or LEED certification. For instance, schedules of building components can be obtained directly from the model to determine percentages of material reuse, recycling, or salvage. In addition, advanced visualization techniques can convince skeptical clients that green design performs well and looks good. According to Autodesk (2005), up to 20 points for LEED certification can be facilitated using BIM.

Building information modeling (BIM) is an intelligent model–based process that provides insight for creating and managing building and infrastructure projects faster, more economically, and with less environmental impact. The Autodesk BIM software includes a comprehensive portfolio of solutions for design, visualization, simulation, and collaboration that uses the rich information in the intelligent model to inform better decision-making and break down the barriers to better business.

**Using BIM to Optimize the Building Envelope:**

Building Information Modeling (BIM) technology is a software-based approach to building design that incorporates 3D data, performance data, and more. BIM is not new technology. It is, however, just now “rising to the consciousness of a substantial number of people.”

“Building Information Modeling (BIM) technology is a software-based approach to building design that incorporates 3D data, performance data and more,” says Forrest R. Lott, FAIA, LEED-AP, principal of Savannah, Ga.-based Lott+Barber. “In fact, it can include such factors as time and sequence of construction — just about any type of information you can think of can be associated with the model.”

To be sure, BIM is not new technology. It is, however, just now “rising to the consciousness of a substantial number of people,” says Finith E. Jernigan, AIA, president of Salisbury, Md.-based Design Atlantic Ltd.

Perhaps that’s because of its ability to easily transfer information, instead of recreating it, at each stage of the building process. Perhaps it’s because of its ability to give accurate information in real time. “For us, the information is the most important,” confirms Lott. “The ability to attach information is where the real power comes in.”

And perhaps BIM is coming into its own because of its ability to optimize the building envelope to achieve high-performance buildings. Design Atlantic uses BIM, and “optimizing the building has been our bread and butter for a long time,” notes Jernigan.

Research Allows for Better Design Purchasing and using BIM software does not automatically make an architect an expert in building design, much less in optimizing the building envelope. Enter the professionals at RTKL Associates, who made a conscious decision in 2003 to transition to BIM from a CAD-based design process. The firm’s software of choice is Revit. Using BIM gives us an increased efficiency in our workload,” says Douglas Palladino, AIA, principal in the Washington office. “Because it automates the repetition and coordination of items, it has freed us to do the analyses we want to do, which allows us to increase energy efficiency.”

**BIM and Sustainable Design:**

With regards to sustainable building design, perhaps the greatest advantage of BIM is for building analysis. Sustainable building design hinges on the ability to gain insight into a building’s performance through analysis and optimization of the design. But evaluating building performance based on the building representations produced by conventional CAD or object-CAD solutions requires a great deal of human intervention and interpretation—and makes the analyses unduly time-consuming and costly With BIM, much of the data needed for supporting performance analysis is captured naturally as design on the project proceeds. By using a building information model, designers can analyze how a building will perform—even in the very early stages of
— and armed with this information, they can quickly evaluate design alternatives and make better decisions to iterate on a greener design. By streamlining the design and analysis functions, BIM facilitates the necessary calculations needed to optimize building performance.

A BIM-based design model also carries a wealth of information necessary for many other aspects of sustainable design. For instance, the ability to create drawings and details directly from the model (and have the software automatically coordinate these with the model) improves the efficiency and accuracy of green certification. Schedules of building material quantities can be obtained directly from the model to determine percentages of material reuse, recycling, or salvage. Various design options for sustainability can be pursued in parallel and automatically tracked in the model. Advanced visualization techniques can be used for solar studies and to produce 3D renderings and construction animations of a green project. And a digital 3D model supports better understanding and collaborative communication with the various stakeholders in a green partnership (the architect, the owner, consultants, review bodies, and so forth).

Sustainable Design Process in BIM: a typical BIM-based workflow:

To start the building systems design, the mechanical engineering consultant leverages the architectural design model. By using the architect’s model, the mechanical engineer ensures that the building mechanical systems design is coordinated with the architectural model, and eliminates a redundant modeling effort to recreate the architect’s building geometry. The mechanical engineer defines all the heating/cooling spaces and zones—adding information such as the number of people per room, the heat load from equipment in the room such as the number of computers, and so forth—and then exports that model to a gbXML file. In addition to the space and zone information, this file also captures all the building geometry as well as information such as lighting density, people sensible and latent load contributions, building construction thermal properties, etc. As such, it represents a more accurate thermal model of the project.

• That gbXML file is then imported into an analysis package such as Trane TRACE and an analysis is performed to determine the building’s energy usage as well as for heating and cooling load calculations. By leveraging their own design model directly for analysis, mechanical engineers can eliminate the time-consuming, error-prone task of manually entering data into the analysis solution.

• Once the analysis is done, the resulting data can be viewed in a report and also exported back to the BIM-based design model (again using the gbXML file). For example, all of the heating and cooling load requirements for each space are transferred back to the design model, enabling the mechanical engineer to view that information from inside the design environment of the BIM software and use those calculations to size equipment, ductwork, piping, etc.

• The mechanical engineer can then iterate on a better performing design using “what-if” design scenarios—changing the R-values of some walls for instance and rerunning the analysis to see how the changes affect the total energy usage of a building.

• In addition, some BIM software includes built-in heating and cooling load analysis tools that can be used to more accurately predict the peak heating and cooling loads for a building. This assists engineers in quantifying needed airflow and properly sizing the HVAC equipment, helping to ensure that energy is not wasted on powering oversized equipment. This design/analyze/optimize workflow is typical in today’s BIM-based practices. Emerging approaches for tighter integration with analysis packages are on the horizon. For example, some BIM software platforms feature programmatic links (that don’t require the export/import to a neutral file format) to analysis software solutions. By further streamlining design/analyses workflows, these integrations facilitate conceptual-stage inline analysis and enable more complete round-tripping of information. In addition, even enhancements in construction techniques—such as streamlining the workflow for direct digital fabrication of ductwork to cut material waste—are becoming more prevalent.

Revit architecture:

Autodesk Revit software works the way architects and designers think, so you can develop higher-quality, more accurate architectural designs. Using tools specifically built to support Building Information Modeling workflows, you can capture and analyze concepts and maintain your vision through design, documentation, and construction.

During the early design stages of a project, key decisions are made that affect a building’s sustainability. In fact, a building’s environmental impact is largely determined by decisions made in the design phase. Autodesk® Revit® Architecture can help perform conceptual energy analysis that enables better assessment of the potential impact of design options. With Revit Architecture, you can now assess energy consumption and carbon emissions without leaving the Revit software environment.
Ecotect:
Sustainable design is more important than ever. Building information modeling (BIM) solutions make sustainable design practices easier by enabling architects and engineers to more accurately visualize, simulate, and analyze building performance earlier in the design process.

The intelligent objects in the building information model enable the advanced functionality of the desktop tools that are included with Autodesk Ecotect Analysis software*. Using Autodesk Ecotect Analysis, architects and designers can gain better insight into building performance earlier in the process, helping to achieve more sustainable designs, faster time to market, and lower project costs.

Autodesk Ecotect Analysis sustainable design analysis software is a comprehensive concept-to-detail sustainable building design tool. Ecotect Analysis offers a wide range of simulation and building energy analysis functionality that can improve performance of existing buildings and new building designs. Online energy, water, and carbon-emission analysis capabilities integrate with tools that enable you to visualize and simulate a building’s performance within the context of its environment.

- Whole-building energy analysis Calculate total energy use and carbon emissions of your building model on an annual, monthly, daily, and hourly basis, using a global database of weather information.
- Thermal performance Calculate heating and cooling loads for models and analyze effects of occupational, internal gains, infiltration, and equipment.
- Water usage and cost evaluation Estimate water use inside and outside the building.
- Solar radiation Visualize incident solar radiation on windows and surfaces, over any period.
- Day lighting Calculate daylight factors and luminance levels at any point in the model.
- Shadows and reflections Display the sun’s position and path relative to the model at any date, time, and location.

ECOTECT is a software package with a unique approach to conceptual building design. It couples an intuitive 3-D design interface with a comprehensive set of performance analysis functions and interactive information displays. The latest version of ECOTECT contains quite a few new refinements for the export of building models to Energy Plus (and Radiance, too). This means that you can work within an advanced modeling and visualization interface, making use of a vast array of conceptual design tools, while still using Energy Plus, the very best analysis and validation software.

Sample of Research methodology to Future work:
The result of this research will demonstrate by a 3d model exterior of Rivet Ecotect data with gbXML type, that are readable by architect software. And initial information will collect from journal papers, relevant reports to sustainability issues, official sites that are design for sustainable design and beam application and some standards for students' environment.

In this research a typical school plan in any cloudy country can be simulate. And the result demonstrate by comparing the current model with optimized model.

Items that are optimized in this research, Thermal energy that is sufficient for classrooms.

Primary stages:
Investigating in paper journals and report to find the sustainabilities standards for educational spaces In primary stage we had some observation in school site for measuring some essential item like plan rotation and another measurement.

Data collection:
Then fix the measurement with the current plan, and based on this information start our modeling export the data as GBXML files

Analysis and report:
Then import GBXML files to Ecotect software and get the analyses about thermal condition and compare the result with optimized model.

Conclusion:
School environment plays a specific role in children healthy and also could be effectual on their performance. Researches show that the healthy atmosphere has the direct and indirect effect on students' performance and health. In this scope, building healthy atmosphere for student’s increases rapidly and new, high-tech buildings are constructed to meet the increasing demands for comfort. In this research can improve optimization of the sustainable factors in school that are improvable by BIM software. Now a day's energy consumption is one of the most concern able matter in architectural design. And using the natural resource of energy is the key that could help the designer to decrease this. This research can help future work to find a solution to optimizing energy consumption by using day lighting in classroom spaces instead of lights.
On the other hand, this research can be apply to most cloudy places such as Malaysia and et al.

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