UNIVERSITI TEKNOLOGI MARA
Cawangan Perak
Kampus Seri Iskandar

e-Proceeding

v-GOGREEN2020 29 - 30 SEPT

VIRTUAL GO-GREEN: **CONFERENCE & PUBLICATION**

"SUSTAINABLE ENVIRONMENT, RESILIENCE AND SOCIAL WELL-BEING"

Organiser :
Research, Industrial Linkages, Community & Alumni Network (PJIM&A)

Co-organiser :
Faculty of Architecture, Planning and Surveying (FSPU) & Centre for Post Graduate Studies (CGS)

Publication Date : 22nd February 2021

Virtual Go-Green Conference and Publication 2020

UNIVERSITI TEKNOLOGI MARA, PERAK BRANCH
February 2021

Main Committee
Virtual Go-Green Conference and Publication 2020

Advisor 1	*: Prof Sr Dr Md Yusof Hamid, AMP*
Advisor 2	*: Assoc Prof Dr Nur Hisham Ibrahim*
Chairman	*: Sr Dr Asmalia Che Ahmad*
Co-Chairman	*: 1. Sr Dr Yuhainis Abdul Talib 2. Sr Dr Haryati Mohd Isa*
Treasurer	*: Mohamad Haizam Mohamed Saraf*
Secretary	*: Noorliza Musa*
Head of v-Conference	*: Sr Dr Nor Suzila Lop*
Head of e-Proceeding	*: Dr Junainah Mohamad*
Head of Scopus Indexed Journal Planning Malaysia Journal (PMJ)	*: Assoc Prof Gs Dr Mohd Fadzil Abdul Rashid*
Head of Scopus Indexed Journal Malaysian Construction Research Journal (MCRJ)	*: Sr Dr Natasha Khalil*
Head of Paper Reviewer	: *Dr Asniza Hamimi Abdul Tharim*

Committee Members
Virtual Go-Green Conference and Publication 2020

E-Proceeding Paper Reviewer

Noraini Md Zain
Shafikah Saharuddin
Nur Fatiha Mohamed Yusof
Farrah Rina Mohd Roshdi

E-Proceeding Formatting

Nurulanis ahmad @ Mohamed
Jannatun Naemah Binti Ismam
Najma Binti Azman

E-Proceeding Language Reviewer

Dr Hjh Shazila Abdullah
Dr Daljeet Singh Sedhu A/L Janah Singh
Zarlina Mohd Zamari
Dr Mary Thomas
Iza Faradiba Mohd Patel
Farahidatul Akmar Awaludin
Wan Faridatul Akma Wan Mohd Rashdi
Jeyamahla Veeravagu
Wan Nurul Fatihah Wan Ismail
Nazirul Mubin Mohd Noor
Noor Aileen Ibrahim
Noraini Johari
Dr Hajah Norakmarwati Ishak

Virtual Conference

Norazlin Mat Salleh	*Registration*
Shahela Mamter	*Auditor*
Mohd Esham Mamat	*Auditor*
Noor Anisah Abdullah @ Dolah	*Auditor*
Mohamad Tajudin Saidin	*Certificate & Conference Kit*
Fairiz Miza Yob Zain	*Logistic*
Mohd Firdaus Zainuddin	*Logistic*
Farah Hanna Ahmad Fuad	*Promotion & Publicity*
Mohamad Shahin Shahdan	*Promotion & Publicity*
Mohd Asrul Hassin	*Liason Officer*

UNIVERSITI TEKNOLOGI MARA

Organiser:
Research, Industrial Linkage Community and Alumni Network Office (PJIM&A)
Universiti Teknologi MARA, Perak Branch, Seri Iskandar.
Malaysia

Co-Organiser:
Faculty of Architecture, Planning and Surveying (FSPU)
and,
Centre for Post Graduate Studies (CGS)
Universiti Teknologi MARA, Perak Branch, Seri Iskandar.
Malaysia

e ISBN 978-967-2920-06-9

9 7 8 9 6 7 2 9 2 0 0 6 9

EVALUATING ENERGY OPTIMIZATION THROUGH BIM SIMULATION ANALYSIS FOR OFFICE BUILDINGS IN MALAYSIA

Mohamad Shahin Shahdan[1], Mohammad Nazrin Zainal Abidin[1], Farah Hanna Ahmad Fuad[1] and Ahmad Faiz Hassan Naziri[1]
[1]Department of Architecture, Faculty of Architecture, Planning and Surveying, Universiti Teknologi MARA, Perak Branch, Seri Iskandar Campus, Seri Iskandar, 32610 Perak, Malaysia

Abstract

Energy efficiency can be described simply as using less energy to do the same job, which is to minimize energy waste. Buildings are expected by most nations to attain an energy-efficient rating, which may be done effectively via monitoring thermal load. Nowadays, with the advanced technology and new software, there are many tools that can be used by the designer to help them in achieving the energy efficient building status. Therefore, by using Building Information Modelling (BIM) software, energy optimization can be explored and analyzed effortlessly at the early design stage. However, this software is not being used by all building professionals in a project since not all consultants own this software, thus hindering the coordination among them. Consequently, the exploration of BIM software is limited and sometimes overlooked and left too late at the end of the design process thus eliminating its maximum potential. Hence, this paper aims to study the capability and competency of BIM simulation tools software through Autodesk Revit in helping the designers to evaluate and analyze energy optimization in a building; therefore, helping with the design decision making. As for simulation, office building has been chosen to be evaluated concerning the energy optimization on thermal load by manipulating various materials thermal transmittance. Based on the analysis report, it is easy to determine the best measure for energy optimization regarding the thermal load value. In conclusion, along with the designer skills and knowledge, energy simulation tools of the selected BIM software does have the capabilities to help designers explore various methods at the early stage before the commencement of any building. Lastly, we would like to suggest any future studies related to this topic to experiment with different simulation tools or software.

Keywords: *energy efficient; BIM software; energy simulation tools, thermal load*

1.0 INTRODUCTION

Energy efficiency can be described simply as using less energy to do the same job, which is to minimize energy waste. A method of minimizing energy consumption is used to produce the same amount of beneficial performance. Energy efficient buildings refer to buildings that are created and built to provide and have a substantial reduction in the energy requirement for heating and cooling, regardless of the resources and equipment chosen for heating or cooling the building itself.

Buildings are expected by most nations to attain an energy-efficient rating, which may be done effectively via monitoring thermal load. Getting an energy efficient building is becoming increasingly important as energy is emerging as a critical economic problem due to high energy demand and unsustainable energy supplies. Buildings are responsible for the annual consumption of 40% of the world's resources, according to figures from the World Watch Institute. Energy-efficient buildings, manufacturing processes and transportation could slash by one third of the world's energy needs by 2050 and help regulate global greenhouse gas emissions. It is important because it conserves the natural resources of the planet and safeguards habitats from degradation. In addition to this, energy efficient buildings are built to conserve energy and resources, recycle materials and mitigate hazardous product emissions over their life cycle.

Building professionals aim to maximize building performance and then integrate green energy technology, leading to a zero-energy building. Changes should also be made within the established structures to reduce energy consumption and costs. Over the years, Malaysian Institute of Architect (PAM) has been designing and gradually working on a more sustainable and green architecture in Malaysia. In August 2008, PAM Council endorsed and authorized the establishment of the new Sustainability Committee which was primarily charged with designing and setting up the Green Building Index and the corresponding Green-rated building certification and accreditation body.

Nowadays, with the advanced technology and new software, there are many tools that can be used by the designers to help them in achieving the energy efficient building status. For example, energy simulation software tools such as Building Information Modelling (BIM) through Autodesk Revit is an important support used for designers or researchers to reduce the cost of energy in buildings. These energy tools help to precisely calculate certain variables that can assist designers in making decisions on the right steps to implement for each building to be built or already existing. Optimization of buildings helps define design that decrease overall ownership costs while optimizing energy savings. The building may be built simultaneously as building optimization is done before construction or retrofit starts, leading to a more streamlined, whole-building solution. Efficiently built structures minimize energy usage and costs, while increasing safety and efficiency for the building occupants

In this era, designers need tools that, even during the initial design process, respond to very specific questions and decision making. Relevant options (e.g., heating and cooling) may be contemplated by designers with the use of energy simulation tools. They can also forecast the thermal behavior of buildings when they are constructed, and simulate energy costs in existing buildings under their current conditions, establishing the best thermal retrofitting steps to be taken in the buildings under study.

2.0 LITERATURE REVIEW

Although there are a lot of advanced technology tools and new softwares like energy simulation software tools, unfortunately these tools are not widely used especially in Malaysia. Moreover, submissions to our local authorities do not have relevant regulation regarding energy optimization, unlike other developed countries. In Portugal, for example, they have introduced three regulations which designers should follow in terms of energy optimization; namely the Regulation of Thermal Performance Characteristics of Buildings (RCCTE), the Regulation of Energy Systems and Climate in Buildings (RSECE) and the National Energy Certification System and Indoor Air Quality in Buildings (SCE).

On top of that, the BIM software is not being used by all building professionals in a project since not all consultants own this software, thus hindering the coordination among them. Consequently, the exploration of BIM software is limited and sometimes overlooked and left too late at the end of the design process thus eliminating its maximum potential. The aim of using BIM software simulation tools is to avoid any post-construction modifications involving energy optimization which can result in additional expenses.

Thus this paper aims to study the capability and competency of BIM simulation tools software through Autodesk Revit in helping the designers to evaluate and analyze energy optimization in a building thus helping with the design decision making at the early stage of design development phase.

3.0 RESEARCH METHODOLOGY

3.1 Introduction

The inauguration of the building energy simulation software tools is to provide assistance for building designers to be able to at least calculate and judge the extent of proposed strategies concerning the energy optimization of the building early on. Now, most of the building energy simulation tools are already incorporated with other software notably the Building Information Modelling (BIM), a model-based process for designing and governing all of the project data, facts and figures through pre, ongoing and post construction stages. Thus, through this paper, we are encouraging building professionals to make use of the aforesaid tools during pre-construction stages, where the simulation can provide insight for the architect, engineer and contractor to plan, design, construct and manage the desired buildings or infrastructure more efficiently. By stating the word efficiently, we specifically signified the energy optimization of the building. Besides, through the use of energy simulation software, valuable information can be gathered alongside energy consumption, for instance, the thermal behaviour, the needs of mechanical equipment for heating and cooling, indoor temperature, annual operating cost, and so forth.

3.2 Building Energy Simulation using BIM: Revit Software

For this paper, we decide to utilize the building energy simulation tools from one of the prominent BIM softwares which is Autodesk Revit 2021. As shown in Figure 1, various categories of building simulation tools are offered by this software. While there are so many options available, in this paper, we are concentrating on the scrutiny of energy efficiency involving the thermal load of the selected building type.

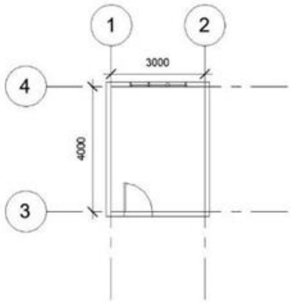
Figure 1: Various categories of building simulation tools offer in Autodesk Revit 2021

3.2.1 Building Type Selection

As stated by Joana Sousa (2012) in her paper, about one third of the energy consumption in buildings is used to improve thermal conditions of the residence and for illumination. Thus, based on the longer period of annual operation plus the high energy usage, we decide that office building is one of the most relevant subjects to be studied and to be evaluated concerning the energy optimization on thermal load.

3.2.2 Simulation Model and Parameter

For the simulation, we designed a simple single occupant office room 4m x 3m x 3m, with only one door facing south and 3 panels of 0.6m x 1.8m window placed adjacent to each other oriented north. The address of the simulation location is at Seri Iskandar, Perak or to be more precise, the office room is located at the coordinate of 4.35658597946167, 100.957305908203. Based on the accessible parameter shown in Figure 2, we only utilised the variables on the value of the schematic types parameter which offer numerous categories to be overridden with an analytic construction where the thermal transmittance (U-Value) of each available option is stated (refer to Table 1).



Parameter
Building Type
Location
Ground Plane
Project Phase
Sliver Space Tolerance
Building Envelope
Building Service
Schematic Types
Building Infiltration Class
Report Type
Use Load Credits

Figure 2: Simulation model plan and parameter

Table 1: Schematic types parameter override category

Category	Override	Analytic Construction
Roofs	☑	Sloping roof - domestic (U=3.3775 W/(m^2·K))
Exterior Walls	☑	Standard wall construction - A (U=0.3495 W/(m^2·K))
Interior Walls	☑	Light plaster, brick, light plaster (U=1.6896 W/(m^2·K))
Ceilings	☑	8 in lightweight concrete ceiling (U=1.3610 W/(m^2·K))
Floors	☑	Passive floor, no insulation, tile or vinyl (U=2.9582 W/(m^2·K))
Slabs	☑	Standard slab construction - A (U=0.2499 W/(m^2·K))
Doors	☑	Solid hardwood (U=2.5572 W/(m^2·K))
Exterior Windows	☑	Uncoated single glazing - 1/8 in thick - clear glass (U=5.9050 W/(
Interior Windows	☑	Uncoated single glazing - 1/8 in thick - clear glass (U=5.9050 W/(
Skylights	☑	Uncoated single glazing - 1/8 in thick - clear glass (U=5.9050 W/(

3.2.3 Simulation Method

By using the same simulation model; the 36m^3 office room, located at the same coordinate, equipped with a fixed building service system for cooling, namely the split system with natural ventilation, we conduct four simulations with various thermal transmittances of each category (refer to Table 2 below).

Table 2: Simulation 1,2, 3 and 4 schematic types parameter

Category	Analytic Construction	Analytic Construction
Roofs	Sloping roof - domestic (U=3.3775 W/(m^2·K))	Flat roof - B (U=0.2277 W/(m^2·K))
Exterior Walls	Standard wall construction - B (U=0.2993 W/(m^2·K))	Brick / block wall (U=0.4396 W/(m^2·K))
Interior Walls	Light plaster, brick, light plaster (U=1.6896 W/(m^2·K))	Light plaster, heavy concrete block, light plaster (U=2.0668 W/(m^2·
Ceilings	Ceiling below joists, no insulation (U=1.3683 W/(m^2·K))	Concrete slab internal (U=1.0687 W/(m^2·K))
Floors	4 in heavyweight concrete floor deck (U=3.8651 W/(m^2·K))	Screed, concrete, dense plaster (U=2.3800 W/(m^2·K))
Slabs	Standard slab construction - A (U=0.2499 W/(m^2·K))	Solid-ground floor (U=0.4063 W/(m^2·K))
Doors	Timber flush-panel hollow-core (U=2.3256 W/(m^2·K))	Solid hardwood (U=2.5572 W/(m^2·K))
Exterior Windows	Uncoated single glazing - 1/4 in thick - clear glass (U=5.9050 W/(	Single-glazed windows - domestic (U=4.8293 W/(m^2·K), SHGC=0.8
	Simulation 1	Simulation 2

Category	Analytic Construction	Analytic Construction
Roofs	Sloping roof including loft (U=0.1589 W/(m^2·K))	Metal roof, R-19 batt insulation, gyp board (U=0.2490 W/(m^2·K))
Exterior Walls	Lightweight concrete-clad wall (U=0.5445 W/(m^2·K))	Brickwork single-leaf construction with insulation and plaster (U=0.
Interior Walls	Light plaster, light concrete block, light plaster (U=1.0539 W/(m^2·K)	4 in single-leaf brick (plastered both sides) (U=1.9709 W/(m^2·K))
Ceilings	4 in reinforced-concrete ceiling (U=3.6842 W/(m^2·K))	Plaster, wood boards, glass wool on joists (U=0.8226 W/(m^2·K))
Floors	Timber flooring, batt, metal deck tray (U=0.9290 W/(m^2·K))	Carpet, underlay, screed, concrete, insulation, building board (U=0.
Slabs	Suspended timber floor (U=0.3857 W/(m^2·K))	Super-insulated (U=0.2756 W/(m^2·K))
Doors	Solid core wood (U=2.6119 W/(m^2·K))	Metal (U=3.7021 W/(m^2·K))
Exterior Windows	Double glazing - domestic SC=0.3 (U=2.8567 W/(m^2·K), SHGC=0.2	Low-E double glazing - domestic (U=1.7356 W/(m^2·K), SHGC=0.65
	Simulation 3	Simulation 4

4.0 RESULTS AND DISCUSSION

By exploring various thermal transmittances for each category, the simulation analysis report is generated as shown in Table 3. Based on the analysis report, it is easy to determine the best measure for energy optimization regarding the thermal load value. For instance, focussing on the wall category, Simulation 2 has the higher value of cooling load, at the figure of 455W, which implied that a greater amount of heat energy in the model area should be eliminated to sustain the appropriate range of thermal comfort for the occupant. In other words, more energy is needed for cooling if brick/block wall is used with thermal transmittance value of U=0.4396W/m^{2}K as compared to the lowest value from the Simulation 01, only at 171W for standard wall construction with the thermal transmittance value of U=0.2993W/m^{2}K.

Table 3. Simulation 1,2,3 and 4 heating and cooling load analysis report

Cooling Components	Total (W)	Percentage
Wall	171	5.26%
Window	735	22.61%
Door	37	1.12%
Roof	2,001	61.55%
Skylight	0	0.00%
Partition	0	0.00%
Infiltration	0	0.00%
Lighting	112	3.45%
Power	146	4.48%
People	50	1.54%
Plenum	0	0.00%
Total	**3,251**	**100%**
Heating Components	**Total (W)**	**Percentage**
Wall	-9	16.70%
Window	-10	17.75%
Door	-3	6.11%
Roof	-32	59.44%
Partition	0	0.00%
Skylight	0	0.00%
Infiltration	0	0.00%
Total	**-54**	**100%**

Simulation 1

Cooling Components	Total (W)	Percentage
Wall	455	26.25%
Window	756	43.55%
Door	77	4.46%
Roof	133	7.68%
Skylight	0	0.00%
Partition	0	0.00%
Infiltration	0	0.00%
Lighting	114	6.58%
Power	148	8.55%
People	51	2.94%
Plenum	0	0.00%
Total	**1,735**	**100%**
Heating Components	**Total (W)**	**Percentage**
Wall	-13	49.28%
Window	-8	29.16%
Door	-4	13.51%
Roof	-2	8.05%
Partition	0	0.00%
Skylight	0	0.00%
Infiltration	0	0.00%
Total	**-27**	**100%**

Simulation 2

Cooling Components	Total (W)	Percentage
Wall	280	31.75%
Window	235	26.63%
Door	40	4.57%
Roof	36	4.03%
Skylight	0	0.00%
Partition	0	0.00%
Infiltration	0	0.00%
Lighting	106	11.99%
Power	138	15.59%
People	48	5.43%
Plenum	0	0.00%
Total	**882**	**100%**
Heating Components	**Total (W)**	**Percentage**
Wall	-16	62.47%
Window	-5	17.66%
Door	-4	14.12%
Roof	-2	5.75%
Partition	0	0.00%
Skylight	0	0.00%
Infiltration	0	0.00%
Total	**-26**	**100%**

Simulation 3

Cooling Components	Total (W)	Percentage
Wall	438	31.58%
Window	424	30.62%
Door	69	4.97%
Roof	146	10.54%
Skylight	0	0.00%
Partition	0	0.00%
Infiltration	0	0.00%
Lighting	112	8.11%
Power	146	10.54%
People	51	3.65%
Plenum	0	0.00%
Total	**1,386**	**100%**
Heating Components	**Total (W)**	**Percentage**
Wall	-20	65.99%
Window	-3	9.18%
Door	-5	17.12%
Roof	-2	7.71%
Partition	0	0.00%
Skylight	0	0.00%
Infiltration	0	0.00%
Total	**-30**	**100%**

Simulation 4

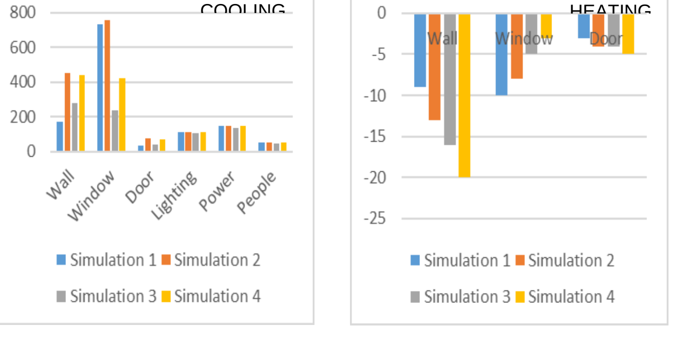


Figure 3. Cooling and heating load for each category

However, it is slightly different for heating load. All of the simulations indicated that the heating load is negative, meaning that heating energy is not needed while demanding more of the cooling energy. This is in fact a common occurrence since the location of the simulation model is positioned at the hot humid climate zone. However, a greater value of cooling energy needed will oppose the idea of energy optimization in the building. Still, bear in mind, that even when the thermal transmittance value is lower, that does not mean it is suitable for all scenario, for instance, the roof on Simulation 1 and 2, while flat roof U-value (U=0.2277W/m^{2}k) is lower than sloping roof (U=3.3775W/m^{2}k), the conventional flat roof is still considered as an unsuitable roof for our climate.

Hence, a designer must not only rely on the simulation tools, but should also have the ability to make judgement on the finest measure for energy optimization after taking into account other related factors namely the regional climate, the total cost of the project and so on.

5.0 CONCLUSIONS

As a conclusion, along with the designer skills and knowledge on the material and construction technology, building energy simulation tools of the selected BIM software; Autodesk Revit 2021 does have the capabilities to help designers explore various methods at the early stage before the commencement of any building. The idea is to prevent any modification to follow post-construction concerning thermal load which may result in extra expenses. Lastly, while there are several energy simulations tools available nowadays, it does require different intensities of complexity and the reaction to the variables. Thus, we would like to suggest any future study related to this topic to experiment with different simulation tools or software.

REFERENCES

Dincer, I (1998) Energy and environmental impacts: present and future perspectives. Energ. Source. 20(4-5) 427-53

Eastman CM, Eastman C, Teicholz P, Sacks R (2011) BIM Handbook: A Guide to Building Information Modeling for Owners, Managers, Designers, Engineers and Contractors. John Wiley & Sons

Iqbal I, Al-Homoud MS (2007) Parametric Analysis of Alternative Energy Conservation Measures in an Office Building in Hot and Humid Climate. Build. Environ. 42(5) 2166-77

Salleh M. H (2016) Review of Green Building Index in Malaysia; Existing Work and Challenges. International Journal of Applied Engineering Research 11(5):3160-3167

Shahdan M. S. Ahmad S. S. and Hussin M. A. (2018) External Shading Devices for Energy Efficient Building. IOP Conf. Series: Earth and Environmental Science 117/012034

Sousa, J. (2012) Energy Simulation Software for Buildings: Review and Comparison. Proceeding of the International Workshop on Information Technology for Energy Applications (IT4ENERGY).

Pejabat Perpustakaan
Librarian Office

Universiti Teknologi MARA
Cawangan Perak
Kampus Seri Iskandar
32610 Bandar Baru Seri Iskandar,
Perak Darul Ridzuan, MALAYSIA
Tel: (+605) 374 2093/2453 Faks: (+605) 374 2299

UNIVERSITI TEKNOLOGI MARA

Surat kami : 700-KPK (PRP.UP.1/20/1)
Tarikh : 20 Januari 2023

Prof. Madya Dr. Nur Hisham Ibrahim
Rektor
Universiti Teknologi MARA
Cawangan Perak

Tuan,

PERMOHONAN KELULUSAN MEMUAT NAIK PENERBITAN UiTM CAWANGAN PERAK MELALUI REPOSITORI INSTITUSI UiTM (IR)

Perkara di atas adalah dirujuk.

2. Adalah dimaklumkan bahawa pihak kami ingin memohon kelulusan tuan untuk mengimbas (*digitize*) dan memuat naik semua jenis penerbitan di bawah UiTM Cawangan Perak melalui Repositori Institusi UiTM, PTAR.

3. Tujuan permohonan ini adalah bagi membolehkan akses yang lebih meluas oleh pengguna perpustakaan terhadap semua maklumat yang terkandung di dalam penerbitan melalui laman Web PTAR UiTM Cawangan Perak.

Kelulusan daripada pihak tuan dalam perkara ini amat dihargai.

Sekian, terima kasih.

setuju.

"BERKHIDMAT UNTUK NEGARA"

27.1.2023

Saya yang menjalankan amanah,

PROF. MADYA DR. NUR HISHAM IBRAHIM
REKTOR
UNIVERSITI TEKNOLOGI MARA
CAWANGAN PERAK
KAMPUS SERI ISKANDAR

SITI BASRIYAH SHAIK BAHARUDIN
Timbalan Ketua Pustakawan

nar