Analysis of energy and heat performance and its impact on passive cooling using environmental analysis software (Khartoum State)

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Abstract:

The paper focuses on studying the behavior of the sun's movement during a building model in Khartoum State, by studying the results of common daylight simulation programs with data measured on-site and in the virtual situation. Verifies the accuracy and limitations of programs when used to calculate daylight illumination or light reflected from other buildings under conditions varying by month or year. The aim of the study is a systematic approach between the actual and expected results and possible predictions, choosing the appropriate design options according to the climatic situation of the region. The study concluded that simulating the diffused daylight in the northern and western facades in particular is the hottest of the year, and this lies in the fact that the treatments and materials used as sun refractors were Tested using Climate Consultant 6.0 programmers, as well as good correlation at low values and higher values in the average thermal comfort, in addition to the size. Information that helps through the Climate Consultant 6.0 programs, and on the other hand, CLIMAPLUS programs, clarifies the important factors that help reduce energy consumption and makes clear to us the aspects What is mitigated is the use of false ceilings and double glazing and the use of materials with poor heat transfer coefficients. We can summarize that the role of programs is very important to save time and save energy.

Keywords: Passive Cooling, daylight simulation software, Radiance, conditions, Khartoum, Sudan.

المستخلص:

تركز الورقة على دارسة سلوك حركة الشمس خلال لنموذج بناء في ولاية الخرطوم , ذلك عن طريق دارسة النتائج برامج محاكاة ضوء النهار الشائعة بالبيانات المقاسة في الموقع ،و الوضع الافتراضي؛ يتحقق من دقة البرامج وقيودها عند استخدامها لحساب إضاءة ضوء النهار او الضوء المنعكس من المباني الاخرى في ظروف المختلفة بالنسبة الى الشهور او السنة . الهدف من الدراسة هو اتجاه منهجي بين النتائج الفعلية والمتوقعة و التنبؤات المحتملة اختيارخيارات التصميم المناسبة حسب الوضع المناخي المنطقة، و خلصت الدراسة إلى أن محاكاة ضوء النهار المنتشر في الواجهات الشالمية والغربية خاصة هي الاكثر بحرارة من خلال السنة وذلك يكمن ان تكون المعالجات المواد كواسر الشمس تم اختبار عن طريق برامج Climate Consultant 6.0 programmers وكذلك ارتباط جيد عند القيم المنخفضة القيم الأعلى في متوسط الارتياح الحرارى باضافة الى الحجم المعلومات التى تساعد من خلال برامج Climate Consultant 6.0 , و من ناحية برامج CLIMAPLUS يوضح العوامل المهمة التساعد على تخفيف استهلاك الطاقة ويتضح لنا من الجوانب تتخفف هو استخدام اسقف مستعارة وللزجاج مزدوج واستخدام مواد ذات معاملات نقل حرارة ضعيفية , يكمن ان نلخص ان دور البرامج مهم جدا لكسب الوقت وتوفير الطاقة .

Introduction:

When passive cooling occurs, we are talking about the technologies and strategies that can be used and that will bring about a positive change in the thermal performance of the building and the thermal rise of the building user, and therefore with the premise of rationalization in the use and focus on renewable alternatives And nature, because many of these technologies have emerged and diversified in different countries, and each according to the environmental and economic situation is one of the determinants of using the most appropriate technologies from an environmental point of view in terms of cold or heat. As for the economic situation, the selection of materials and methods determines how they can be used by the local, available, and available materials, but mostly these are more used and effective in poor, limited-income, and rural areas. [1]

Since we are talking about Sudan, the great challenge is an environmental challenge that we can focus on, which is the temperature of the air. As for the economic situation, here we can focus on the movement of the sun and the effects and temperatures associated with it, especially in different periods and times. Through this research, we will focus on another aspect, not the techniques and strategies used in negative conditioning, with the necessity and importance of research in this direction, which is to focus on The use of computer technologies or specialized software in this field to provide important information that will help in making the appropriate decision, the decision of appropriate technologies or strategies that can be followed in making the appropriate decision in terms of design and technologies that will help thermal comfort in buildings. Technologies, rate of consumption, and rationalization of consumption. [2]

Shading of the built form is one of the major design decisions to be made in a tropical climate like India to achieve thermal comfort in the building by reducing heat gain. The architect and designers have an intuitive general idea about window shading and sometimes the canopy idea is also ignored due to their approach to the aesthetic value of a building. Although irradiance has been lauded for its accurate simulation of indoor illumination, several studies have emerged that compare actual values to measured values. However, none of them were under conditions of heaven comparable to those of Khartoum. The objective of this paper is to examine the congruence between actual and predicted Radiance results. In the event of a significant discrepancy, it will determine when and why Radiance results are different.[3]

2. Objectives:

The importance of passive cooling is a contemporary necessity and in many aspects of man today, an environmental and economic demand, especially in Sudan. Therefore, the importance of the research is in the aspects that help in making the correct engineering and design decisions, especially in terms of blocks. Orientation of the building and external treatments or shaping the building and shading or choosing colors. - As for the environment, the movement of airflow and the flow of heat, especially through windows. The flow of temperatures through them and the ratio of the openings by comparing the area of the facades, and all these aspects are very important in creating a comfortable environment for use and making a successful design in terms of thermal comfort in the place, especially. It is very important to use computer technologies and software specialized in this to provide important information that will help make the appropriate decision in choosing the design, technologies, and mechanisms of energy consumption rate and energy performance.

2.1 MAIN:

a. Achieving energy performance standards and controlling them, whether providing environmental or technical means through the performance of the device or influencing it.
b. Achieving environmental sustainability standards at the level of urban or rural buildings.
c. Providing or rationalizing energy consumption, HVAC systems, central or in situ air conditioning, or contributing to the creation of a sustainable adaptation model in terms of renewable energy of all kinds, whether it is wind energy, solar energy, or otherwise.

2.2 SECONDARY:

a. Contribute to Spreading a Culture of Environmental Sustainability at The Urban and Rural Levels.
b. Encouraging the Creation of Environmental Industrial Models to Save the Effort and Running Costs of Consumption.

c. Encouraging and Developing the Field of Practical Research in This Regard. Searching for New Ways to Save Energy for A Little, In Whole or Part.

3. Literature of review:

Before the invention of mechanical heating and cooling devices, passive heating and cooling methods were exclusively adopted to achieve desirable thermal comfort in residential homes. Today, mechanically driven active devices ensure interior comforts but depend heavily on energy inputs. Total energy consumption distributed according to economic sectors indicated that residential buildings consume about 78% while industrial and other buildings consume the remaining 22% (Ezema, Olotuah & Fagbenle, 2016).[4]

Simulating daylighting and electric lighting in digital architecture models in various stages of design has become quintessential for informing design decisions to meet quantitative and qualitative lighting goals by predicting building performance before construction. Post occupancy evaluations (POEs) of completed buildings and spaces close the loop by providing feedback on the end-quality of a design to the building and construction industry can assess if the project brief was met (Oseland, 2007) as well as serve an important role by allowing researchers to generate knowledge of occupant well-being based on actual user experiences.[5]visual and acoustic performance of buildings. It is very user-friendly software that could potentially integrate with the architectural design process. Thermal performance analysis in Autodesk Ecotect is based on the Chartered Institution of Building Services Engineers (CIBSE

Many measurement-driven POE studies in the research literature are based on single instantaneous measurements and do not utilize long-term monitoring or annual predictive data. Bear and Bell measured illuminance, source luminance, surface reflectance, geometric factors, and subjective information for 471 participants as early as 1992 (Bear and Bell, 1992). Osterhaus surveyed 86 participants in 9 office spaces (Osterhaus, 2001).[6]visual and acoustic performance of buildings. It is very user-friendly software that could potentially integrate with the architectural design process. Thermal performance analysis in Autodesk Ecotect is based on the Chartered Institution of Building Services Engineers (CIBSE

4. Methodology:

We can start talking about what is meant by the methodology in the research, which is the plan that you use to achieve the goal, and its division is as follows: We will choose one or two programs for the proposed case study - Parts of experiments on climatic data for the state of Khartoum on programs. Climate Consultant Knowledge of the external and climatic variables and their effects on the internal variables of the building in terms of thermal comfort.

- Analyzing the information issued by the results of the programs.
- The use of CLIMAPLUS.BETA programs are to create scenarios to compare possible hypotheses by changing the data of finishes and materials used such as glass and the use of natural and industrial ventilation. Hypothetical comparisons and their effect on energy efficiency in the proposed building discuss the results.

5. Case study:

- Primary information:
- Geographical Information Introduction to the research plan
- Information and data analysis (Eui-climaplus-hap-ecotect-Psychrometric)
- Conclusions

5-1. Location:

At the beginning of the paper, we will give a brief introduction to the location of the study case. It is a building designed as a test model in the state of Sudan, the city of Khartoum, the state of Khartoum, and the locality of Khartoum. In the Sudan University of Science and Technology, the southern wing, the building is a test model. The building consists of a room. Room dimensions: 2.5 * 1.33 * 2.5

Finishing of the building: external whiteness of cement whiteness - wall of cement block - floor of red - ceiling of cement. Openings: from the north side a window - from the west side a wall - from the east a door - from the south side a wall.

Climatic information:

It is well known to us that basic climatic information is a logical start to the environmental trends as basic information leads to identifying the determinants that would determine the type of challenges facing the buildings and the human being or the human component inside the building or space. From here it becomes clear to us that the study should start with the study of climate information, and in the paper, we will rely on Climate Consultant 6.0 programs.

5-2. Information on the Climate Consultant 6.0 programmers,

Climate Consultant is a chart-based computer program that helps architects, builders, contractors, homeowners, and students understand their local climate. It uses 8,760 hours of annual EPW-formatted climate data that is provided free of charge by the US Department of Energy (DOE) to thousands of weather stations around the world. Climate Advisor translates this raw climate data into dozens of meaningful graphical displays intended not to simply plot climate data, but instead to organize and represent this information in easy-to-understand ways that show subtle features of climate and its impact on built form. The goal is to help users create buildings that are more energy efficient and more sustainable, each uniquely suited to its particular location on the planet. 3 pm, October 05th, 2015 Climate Consultant [7]the aim of this study is to test the usefulness of applying selected passive cooling strategies to improve thermal performance and to reduce energy consumption of residential buildings in hot arid climate settings, namely Dubai, United Arab Emirates. One case building was selected and eight passive cooling strategies were applied. Energy simulation software - namely IES - was used to assess the performance of the building. Solar shading performance was also assessed using Sun Cast Analysis, as a part of the IES software. Energy reduction was achieved due to both the harnessing of natural ventilation and the minimising of heat gain in line with applying good shading devices alongside the use of double glazing. Additionally, green roofing proved its potential by acting as an effective roof insulation. The study revealed several significant findings including that the total annual energy consumption of a residential building in Dubai may be reduced by up to 23.6% when a building uses passive cooling strategies.”,”author”:[{“-dropping-particle”:””,”family”:”Taleb”,”given”:”Hanan M.”,”non-dropping-particle”:””,”parse-names”:false,”suffix”:””}],”container-title”:”Frontiers of Architectural Research”,”id”:”ITEM-1”,”issue”:”2”,”issued”:{“date

-parts":[["2014"]]},"page":"154-165","publisher":"Elsevier","title":"Using passive cooling strategies to improve thermal performance and reduce energy consumption of residential buildings in U.A.E. buildings","type":"article-journal","volume":"3"},"uris":["http://www.mendeley.com/documents/?uuid=a61498a2-ac21-4bad-a7f5-6020e046127e"]}],"mendeley":{"formattedCitation":"[5]","manualFormatting":"[7]","plainTextFormattedCitation":"[5]","previouslyFormattedCitation":"[5]"},"properties":{"noteIndex":0},"schema":"https://github.com/citation-style-language/schema/raw/master/csl-citation.json"}

By entering the programs, this image appears, which shows the appropriate test. The approved code for this study. We enter the climatic data that we transfer from internationally approved sites, which are from the NASA site and the one site. Building.com And some after entering the programs ASHRE.55 was chosen This is now the choice of the ASHRE.55 system because it accurately distinguishes the results in systems that rely on natural ventilation in particular, and the systems can be chosen according to other calculations according to the cooling system or operation and the nature of the buildings, but here according to the above-mentioned ASHRE.55 is the most appropriate.[8] [9]

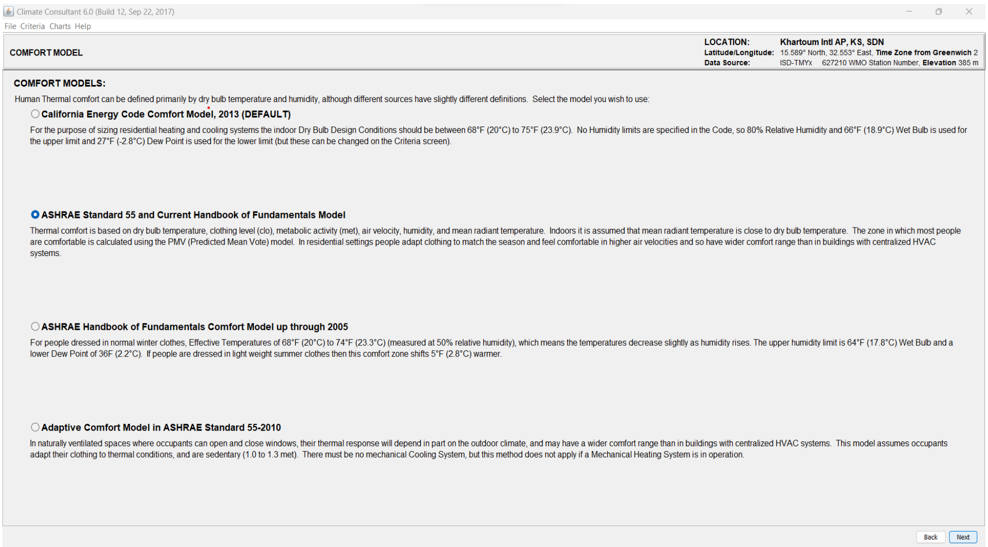


Fig.1 Program entry map and identification of the used code system, the ASHRAE 55.0 system.

Source: Researcher work.

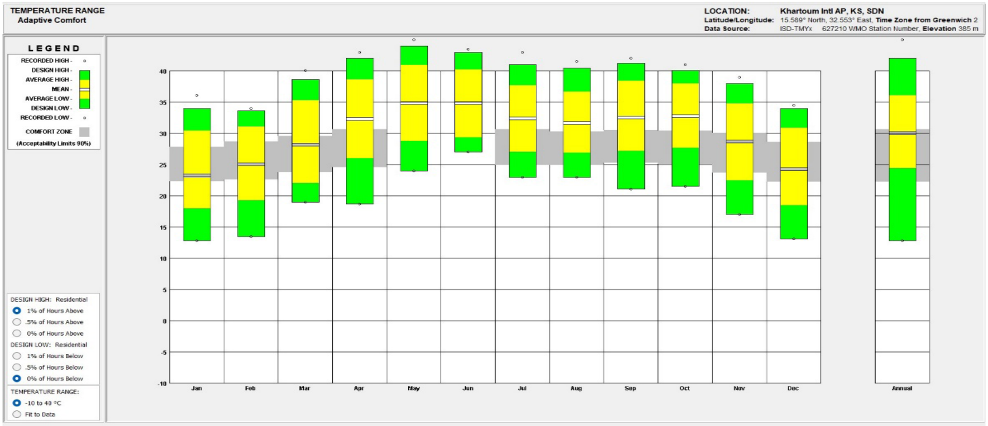


Fig.2 Chart of temperature averages in the thermal comfort zone over different months and the average year-over-year for Khartoum State. Source: Researcher work.

As for the schematic aspect in the figure below, it is clear that the standard of thermal comfort is through the thermal data entered from the one-building website. From the yellow color through the chart, it is clear to us that the average of the highest degrees is C 30, while the lowest level is C 16-, 18 As for the green color, the design level of the temperature at which it is carried out is 33 C. The lowest C is 14, while the general average is C 16-26 It is also clear to us the light and dark gray color, which shows us the average temperature during the summer and winter periods. Temperatures vary according to the month. Below are the months, and to the left of the chart are the temperatures. Through this chart, it is clear to us that in the month of January, within the thermal comfort level in winter, the level of C is 33. The average minimum limit is C 13. For example, in the month of February, it is located within the average thermal comfort, and it is located within the comfortable temperature level. So, it turns out that the average design temperature is 31 C or the lowest, which is C19.

Through this scheme, there are only three programs, and they are within the average temperature, which are: month, January, and December. From looking at the chart, on the one hand, the temperatures in Khartoum state are generally clear, on the other hand, it is clear to us the average temperatures during the year that are outside Through the diagram above, this diagram shows the degree of brightness of the sun according to kilowatts, as the effect of the sun on buildings through the month and day, through the above diagram, the yellow color is the effect of direct light on the buildings, while the green color is the effect of degrees of light resulting from the horizontal reflection of the light, while the brown color is The sum of direct and indirect reflections from the horizontal reflections The white line is the average brightness level at the monthly level as it is located at the bottom of the table, and the energy level kWh is on the left of the table. The number of roofs can be utilized in the sun's energy.

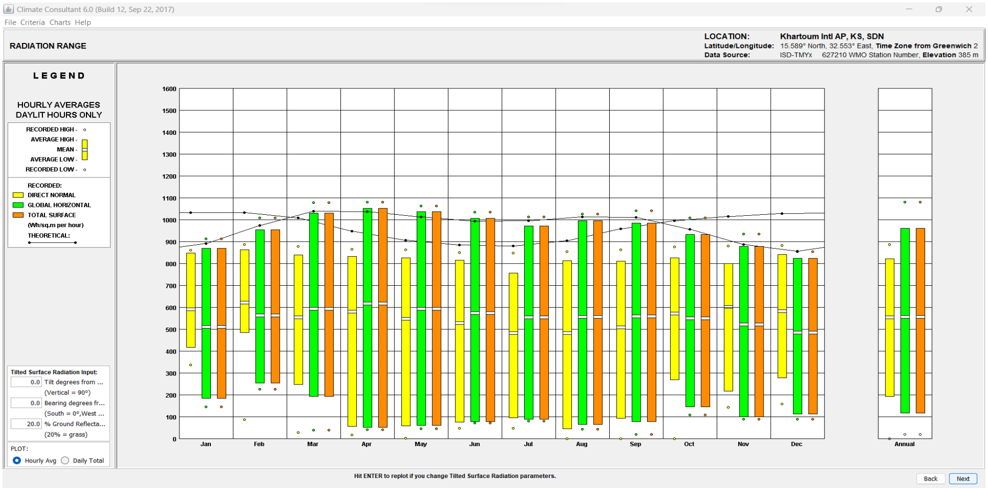


Fig.3 Dry temperatures are evaluated over months and hours through simulation programs.

Source: Researcher work.

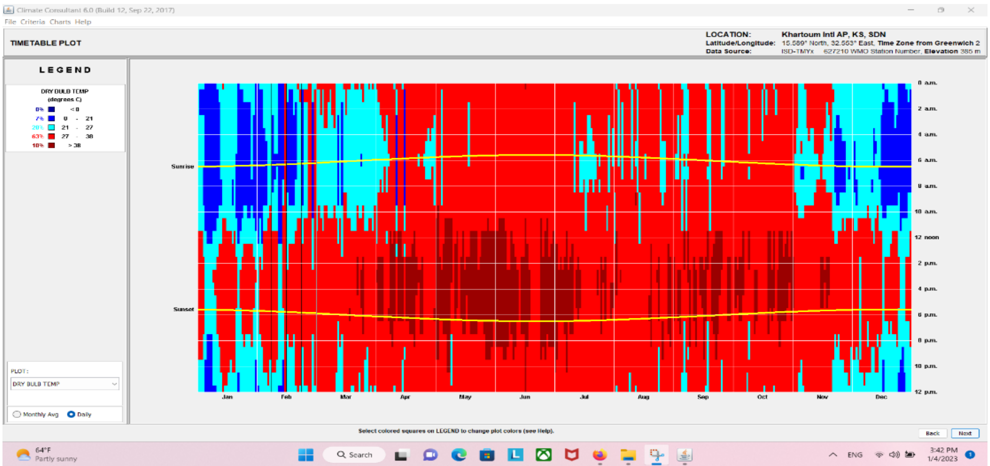


Fig.4 Chart of temperature averages in the thermal comfort zone over different months and the average year-over-year for Khartoum State.

Source: Researcher work.

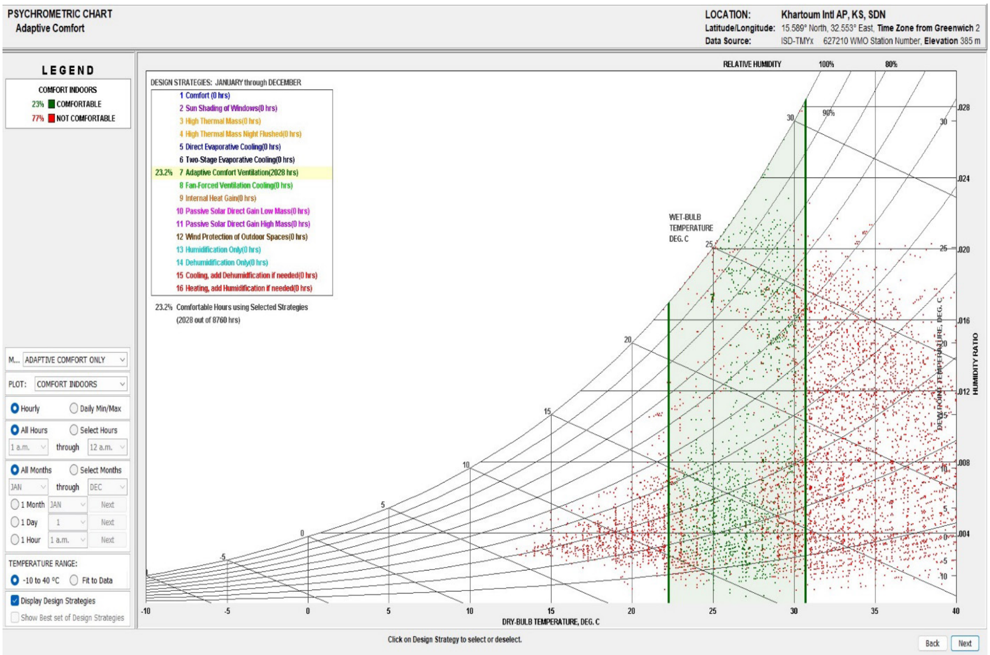


Fig. 5 Psychological chart of non-variables and other influences on thermal comfort

From the programs,

Source: Researcher work.

it becomes clear to us the importance of information in design decision-making on the climatic or environmental data that comes out of the design programs that contain accurate information, although it is known in some aspects to the users, it is not sufficient to deal with it engineering and technical because it depends on the direct sense or the atmosphere and changes in direct observations, in The point we presented this preliminary is the importance of the next partial aspect, which is to talk about one of the most important information provided by the programs, which is the psych chromic chart Information about the psych chromic chart:

Psychometry studies the thermodynamic properties of air related to comfortable thermal design and loads. As well as determining the thermodynamic properties of dry air and saturated water vapor, and thus the air passing through the building, whether it is outside or inside, or in pipes extending conditioned air, which is a mixture of the two and its properties can be derived from these two fluids (dry air and water vapor). This unit defines all the basic psychometric properties of air. At the end of this unit is a discussion on how to obtain changes in these properties using air conditioning parameters. The psychometric map: There are seven psychometric variables involved in building thermal calculation and thermal comfort design

Table.1, shows the Symbol and Appropriation of the psychometric chart

Appropriation	Symbol
Dry bulb temperature	0Cdb
Moisture content	Kg/kg dry air
Wet bulb temperature	0Cwb
Specific volume	m 3 /kg
saturation Percentage	%
Specific enthalpy	kJ/kg

Source: Researcher work.

We have the psychometric map through the programs, the art of the chart above, in which 15 criteria affect the thermal comfort of the building. In the study, the comparison is done. The psychometric map is studied using air-conditioning methods, and the second case is the psychometric map in the use of means that contribute to improving the building's thermal performance. Good shading, shading, formation, and mass orientation techniques. There is a green and red psychometric chart. It is clear that the color is green, thermal comfort by 23%, and red indicates 77%. In the case without using negative conditioning techniques, the thermal performance and all energy were 23%. In the second case, through the chart below, the green color shows us the level of thermal comfort, while the red color is the thermal discomfort, either in terms of the effects of 15 factors, which we will show

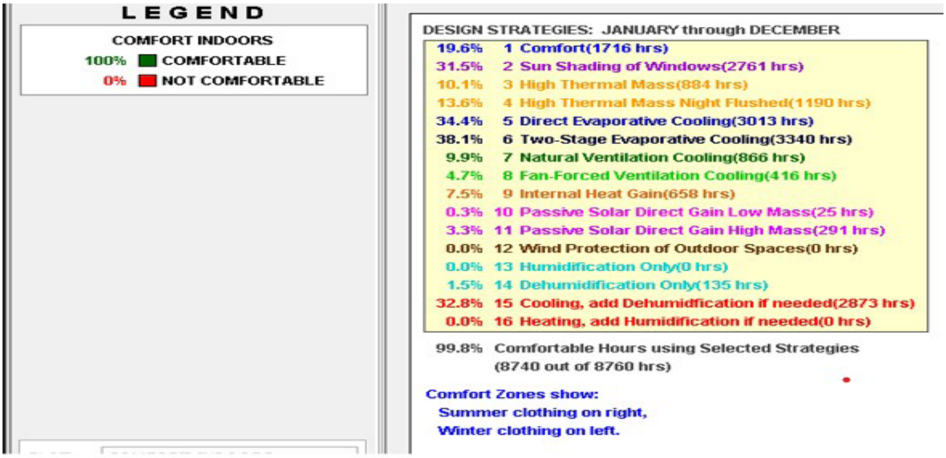


Fig.6 Percentages of strategies affecting passive cooling ,the extent of heat dissipation of buildings in Khartoum state.

Source: Researcher work.

Through the use of these technologies, as shown in the diagram, the most important techniques that have a significant impact on passive air-conditioning, which would reach comfort in the building, are three basic techniques, the use of shading in windows, evaporative cooling, and humidification through air-conditioning devices, and there are other techniques, such as ventilation the nature of passive radiation.....................

The rate of energy and thermal comfort has reached 98.8% thanks to the use of multiple technologies in the building.

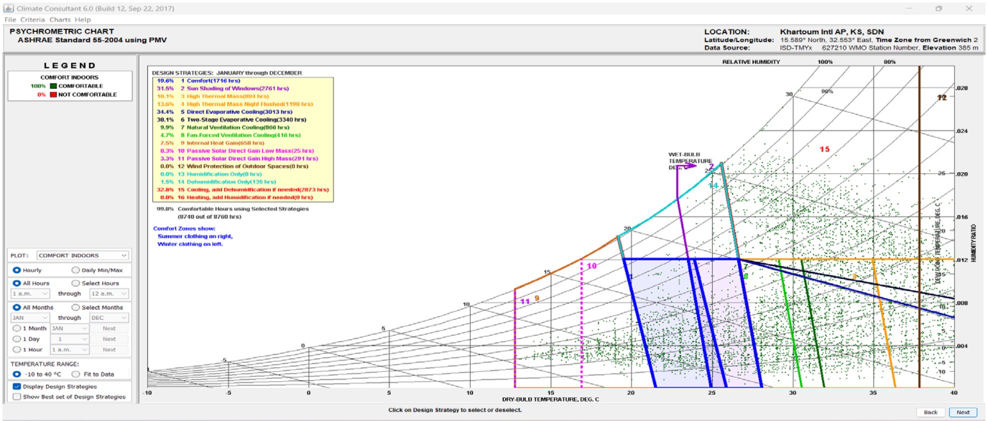


Fig.7 Psychological diagram of the meaning of variables and other effects on thermal comfort using passive cooling uses.

Source: Researcher work.

7- Results:

The role of the importance of programs as an indicator is to determine the correct direction and make the right decisions. Interest in the three techniques mentioned in the above model and their effective role in achieving thermal insulation in buildings.

Interest in the three techniques mentioned in the above model and their effective role in achieving thermal insulation in buildings.

7 .1-Using climaplus software:

In the context of this research, Table 6.2 is built to show a range of available software tools for analyzing thermal performance. Through the review of the tools that are described in Table.2, it can be observed that the Design Builder tool has been specifically developed around Energy Plus allowing all of the Energy Plus fabric and glazing data to be inputted. Databases of building materials, constructions, window panes, window gas, glazing units, and blinds are provided. About Design Builder simulation, the basic concept of sequential simulation is to facilitate the analysis of this research provided by Design-Builder Documentation (2011) as significant parameters: Functionality: The multi-zones approach to modeling allows flexibility in both the types of system that can be modeled and the level of detail. The modeler can describe a building and its systems abstractly and then add more detailed zone descriptions as required. For example, the most basic energy simulation would involve only one domain in a model e.g. the geometry and fabric of the building. If more functionality were required, the model could be augmented with airflow, CFD, and HVAC. Separation of engine and interface: The Design Builder interface allows the simulation engine to work in the mainstream of allowed input-output data without the need for request redesign of the models. Hence, while the model can be constructed from many different and diverse zones, the zones of the building model are connected and they form a consistent mathematical description of the building. Integrated simulation: Design Builder performs a comprehensive simulation. A typical model of a building consists of several coupled polyhedral zones that describe the geometry and fabric of the building envelope. Augmenting these zones are a series of networks, each of which describes an individual zone: heating, an air conditioning plant, and airflow.

Zone Loads	BLAST	GBSim	DeST	DOE-2.1E	ECOTECT	Ener-Win	Energy Express	Energy-10	EnergyPlus	eQUEST	ESP-r	IDAICE	IES<VE>	HAP	HEED	PowerDomus	SUNREL	Tas	TRACE	TRNSYS
Interior surface convection ▪ Dependent on temperature	X	X					p		X		X	X	X		X	X	X	X		X
▪ Dependent on air flow	X						X		p		X		X		X			X		E
▪ Dependent on surface heat coefficient from CFD									E		E		X							
▪ User-defined coefficients (constants, equations or correlations)		X	X	X	X				X		E	R	X		X	X	X	X		X
Internal thermal mass	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X
Automatic design day calculations for sizing ▪ Dry bulb temperature	X	X	X	X	X	X	X	X	X	X		X	X	X	X	p		X	X	
▪ Dew point temperature or relative humidity			X	X		X	X		X	X		X	X	X				X	X	
▪ User-specified minimum and maximum			X	X			X		X	X		X	X	X	X			X	X	X
▪ User-specified steady-state, steady-periodic or fully dynamic design conditions			X			X						X	X	X				X	X	

Building Envelope, Day- lighting and Solar	BLAST	GBSim	DeST	DOE-2.1E	ECOTECT	Ener-Win	Energy Express	Energy-10	EnergyPlus	eQUEST	ESP-r	IDAICE	IES<VE>	HAP	HEED	PowerDomus	SUNREL	Tas	TRACE	TRNSYS
Outside surface convection algorithm ▪ BLAST/TARP	X								X											
▪ DOE-2				X					X	X	X								X	
▪ MoWiTT	X					X		X	X				X		X				X	
▪ ASHRAE simple			X						X		X	X	X			X		X	X	X
▪ Ito, Kimura, and Oka correlation									X		X	X						X	X	
▪ User-selectable																				
Inside radiation view factors		X	X						X		X	X	X				p	X		
Radiation-to-air component separate from detailed convection (exterior)		X	X						X	X	X	X	X				X	X	p	X

X (has capability) / **P** (partially implemented) / **O** (optional) / **R** (research use) / **E** (expert use) / **I** (difficult to obtain input data).

Solar gain and day- lighting calculations account for inter-reflections from external building components and other buildings		p			X				X		X		X			p				X

Infiltration, Ventilation, Room Air and Multi-zone Airflow	BLAST	GBSim	DeST	DOE-2.1E	ECOTECT	Ener-Win	Energy Express	Energy-10	EnergyPlus	eQUEST	ESP-r	IDAICE	IES<VE>	HAP	HEED	PowerDomu s	SUNREL	Tas	TRACE	TRNSYS
Single zone infiltration	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Automatic calculation of wind pressure coefficients		X	P						p				X				X	X		
Natural ventilation		X	P						X	P	X	X	X			X	X	X		O
Multi-zone airflow (via pressure network model)		X	P						X		X	X	X				X	X		O
Hybrid natural and mechanical ventilation		X	P			X					I	X	X			X		X		O
Control window opening based on zone or external conditions			X			X			X		X		X			p	X			O
Displacement ventilation									X		X	X	X					X		O
Mix of flow networks and CFD domains			X								E									
Contaminants, mycotoxins (mold growth)		p									R					p				

X (has capability) / **P** (partially implemented) / **O** (optional) / **R** (research use) / **E** (expert use) / **I** (difficult to obtain input data).

Table 2: Contrasting the capabilities of building energy performance simulation programs

In the context of this research, Table 6.2 is built to show a range of available software tools for analyzing thermal performance. Through the review of the tools that are described in Table.2, it can be observed that the Design Builder tool has been specifically developed around Energy Plus allowing all of the Energy Plus fabric and glazing data to be inputted. Databases of building materials, constructions, window panes, window gas, glazing units, and blinds are provided. About Design Builder simulation, the basic concept of sequential simulation is to facilitate the analysis of this research provided by Design-Builder Documentation (2011) as significant parameters: Functionality: The multi-zones approach to modeling allows flexibility in both the types of system that can be modeled and the level of detail. The modeler can describe a building and its systems abstractly and then add more detailed zone descriptions as required. For example, the most basic energy simulation would involve only one domain in a model e.g. the geometry and fabric of the building. If more functionality were required, the model could be augmented with airflow, CFD, and HVAC. Separation of engine and interface: The Design Builder interface allows the simulation engine to work in the mainstream of allowed input-output data without the need for request redesign of the models. Hence, while the model can be constructed from many different and diverse zones, the zones of the building model are connected and they form a consistent mathematical description of the building. Integrated simulation: Design Builder performs a comprehensive simulation. A typical model of a building consists of several coupled polyhedral zones that describe the geometry and fabric of the building envelope. Augmenting these zones are a series of networks, each of which describes an individual zone: heating, an air conditioning plant, and airflow.

Program	Source	Capabilities	Comments
eQUEST	www.doe2.com/equest	Performs an hourly simulation of the building based on walls, windows, glass, people, plug loads, and ventilation. DOE-2.2 also simulates the performance of fans, pumps, chillers, boilers and other energy-consuming devices.	The building creation wizard walks a user through the process of creating a building model within eQUEST, DOE-2.2
TRNSYS	http://apps1.eere.energy.gov/buildings/tools_directory/software.cfm/ID=58/pagename=alpha_list	Analysis and sizing HVAC, Multi-zone airflow analyses, electric power simulation, solar design, building thermal performance, analysis of control schemes, differing levels of complexity, extensive documentation on component routines, including explanation, background.	Useful for research applications and industry cases where a new or innovative system model is required.
EnergyPlus	http://apps1.eere.energy.gov/buildings/tools_directory/software.cfm/ID=287/pagename=alpha_list	EnergyPlus engine that is based on DOE-2, BLAST, and COMIS software. Time-steps less than an hour, modular systems and plant integrated with heat balance-based zone simulation, multi-zone air flow, thermal comfort, water use, natural ventilation, and photovoltaic systems.	EnergyPlus is a complicated program in which to develop or adjust building models.
ECOTECT	http://apps1.eere.energy.gov/buildings/tools_directory/software.cfm/ID=391/pagename_menu=pc/contacts_landing.cfm	Thermal energy, lighting, shading, acoustics, Tools for climatic analysis.	Real-time animation features are provided along with interactive acoustic and solar ray tracing that updates in real time with changes to building geometry and material properties.
TAS	http://www.edsl.net/main/	Dynamic thermal performance of buildings and their systems, accessing environmental performance, conducting a natural ventilation analysis	
ESP-r	http://www.esru.strath.ac.uk/Programs/ESP-r.htm	An integrated energy modelling tool for the simulation of the thermal, visual and acoustic performance of buildings and the energy use and gaseous emissions associated with associated environmental control systems.	Useful for research applications where high degree of accuracy is required
Energy-10	http://www.nrel.gov/buildings/energy10.html	whole-building analysis, evaluating the energy and cost savings that can be achieved by applying energy-efficient strategies such as day lighting, passive solar heating, and high-performance windows and lighting systems, Natural Ventilation	The simulation software is suitable for examining small commercial and residential buildings that are characterized by one or two thermal zones.
DesignBuilder	http://apps1.eere.energy.gov/buildings/tools_directory/software.cfm/ID=486/pagename_menu=united_kingdom/contacts_landing.cfm	EnergyPlus Engine that is based on DOE-2, BLAST, and COMIS software. Calculates CO2 emissions, solar shading, comfort studies, CFD, HVAC, naturally ventilated buildings, buildings with day lighting control, facades, advanced solar shading strategies.	The DesignBuilder approach to natural ventilation allows detailed models of natural ventilation air flows.

Table 3: Building simulation software

This multi-zone modeling approach is efficient in terms of both the complexity of the model and the numerical solution. The requirements of a particular simulation will dictate time steps from 15 minutes to 1 hour. In conclusion, the selection of Design Builder is based on: Capability: Design Builder is an interface to a dynamic thermal simulation engine that is based on DOE-2, BLAST, and COMIS software and being combined into a new program called 'Energy Plus (Majali et al. 2005). It is the most recent building energy simulation program for modeling buildings and calculating internal heat gain generated through building envelope, solar radiation through windows, and glass facade elements. Additionally, it calculates heating, cooling, lighting, CFD, natural ventilation, and also other energy flows and sizing of HVAC equipment and systems. Moreover, it includes many innovative simulation capabilities such as time steps of less than an hour, modular systems, and plants integrated with heat balance based on zone simulation, multizone air flow, and thermal comfort. Credibility: Design Builder encompasses all building parameters and properties and a fairly accurate depiction of energy use within the structure. The framework starts with the selection of a location and the corresponding weather through a weather file (EPW format), with building geometry representing a definition of the geometry needed for the simulation of the building's thermal performance. Moreover, if one imports DXF files as footprints for the creation of a geometric model, Design Builder provides a variety of country or region-specific templates for the selection of parameters (materials and constructions). Feasibility: Design Builder has good accessibility and information on the control interface, a digital rendering of the final model can also be developed and imported into Google's drawing program Sketch Up (Parke et al. 2010), and better graphical representation of simulation output, simple navigation, and flexible control. It also integrates the design by 122 124 creating a specific thermal building model geometry with the integrated CAD interface and interoperability of the 3D building model. Resources: The latest ASHRAE worldwide design weather data and locations (4429 data sets) are included with the software and about 1258 Energy Plus hourly weather files are available for free using the Design Builder. Broadly speaking, using Design Builder simulation to test the thermal performance of the houses needs various stages for accurate prediction. Nevertheless, actual outdoor weather data can manipulate certain variables to predict the effects of changes on the house characteristics which leads to reshaping the model parameters that can create a design that exactly fits the needs of each simulation. Climaplus is an early design web tool, developed to facilitate the design of naturally ventilated and mixed/hybrid buildings that are energy efficient and low carbon. The tool is being used to teach in an in-house course at MIT, as well as in an open online course (MOOC) on sustainable building design that we developed in collaboration with the MIT Energy Initiative.

Choose or Upload Climatic File Two options are provided for locating your project. Select using the drop-down menu where 2,500 sites are listed. Or download the EPW climate file from Climate. onebuilding Through climaplus programs, we will do a study on the proposed building, as we mentioned in the previous paragraph. The building is an experimental building located in the University of Sudan to study environmental activity. The program tests the following topics: the path of the sun's movement, wind speed, thermal performance, and energy efficiency, in addition to comparing possible scenarios with changing variables that help predict the performance of buildings. We will start studies of external information according to the data that we downloaded from the EPW website from Climate. one building. It is the climate data for the state of Khartoum. outside temperature This graph shows typical daily temperature profiles for each month for a given location. The information can initially be used to measure natural ventilation potential and thermal mass as well as how hot or cold the climate is. The figure shows twelve graphs, one for each month, glued together. Maximum temperatures (orange, average (black), and minimum temperatures (gray) are displayed

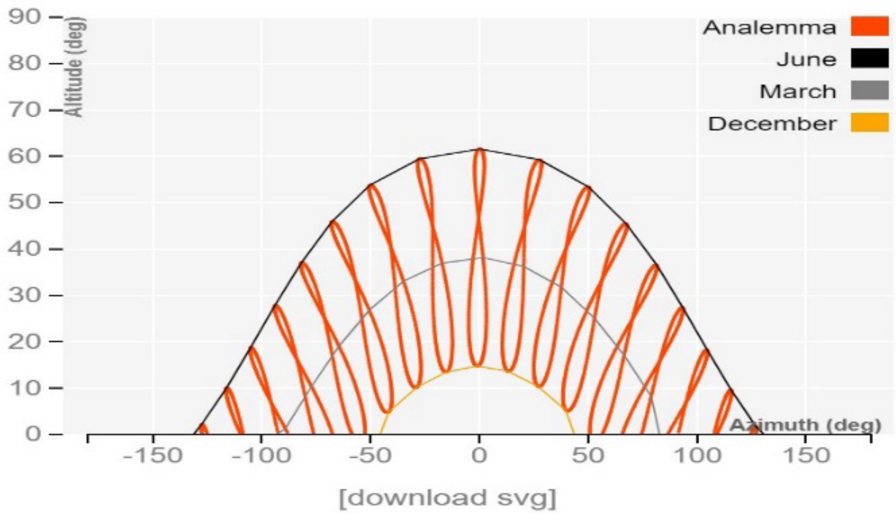
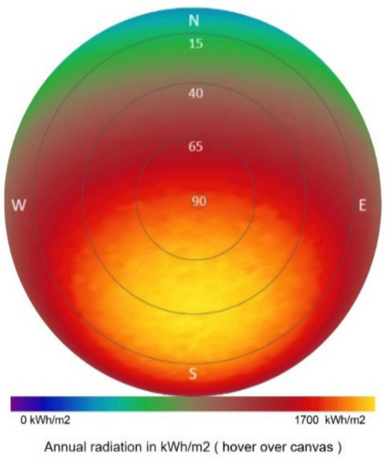


Fig.8 Sun path diagram
Source: Researcher work.

throughout the day for each month. For example, the figure shows that temperatures in January vary at this location between about 5°C at night and 10°C. °C during the day with maximums ranging from around freezing to 10 °C. The two gray horizontal lines show the upper and lower temperature thresholds and can be adjusted. We will study the external and internal conditions according to the climatic data downloaded from the EPW Climate. one building website It was used within the climaplus programs, which will present experiments on the experimental building, output the results, compare them with possible scenarios, and draw the results through the study.

Annual solar radiation maps This graph shows the annual solar radiation that falls on any surface direction from a given location. The graph can be used for the placement and size of the unshaded PV system. The figure shows a false color map corresponding to the potential annual solar radiation range at a given location. The center of the color map corresponds to an upward-facing surface whose normal surface forms an angle of 90 degrees to the horizon. The top, left, right, and bottom values correspond to the north, west, east, and south interface directions. In the example figure, the maximum solar radiation (about 1,700 kWh/m2) occurs for a south-facing roof with an inclination angle of about 40 degrees. If you hover your mouse over the figure, the solar radiation of the corresponding surface direction will be shown below. For more information, please refer to the MIT OCW Environmental Technologies in Buildings, Understanding Climate Solar Radiation or Active Solar Energy as well as Chapter 3 Daylighting and Daylighting Handbook. +This graph shows typical daily temperature profiles for each month for a given location. The information can initially be used to measure natural ventilation potential and thermal mass as well as how hot or cold the climate is. The figure shows twelve graphs, one for each month, glued together. Maximum temperatures (orange, average (black), and minimum temperatures (gray) are displayed throughout the day for each month. For example, the figure shows that temperatures in January vary at this location between about 5°C at night and 10°C. °C during the day with maximums ranging from around freezing to 10 °C. The two gray horizontal lines show the upper and lower temperature thresholds and can be adjusted.



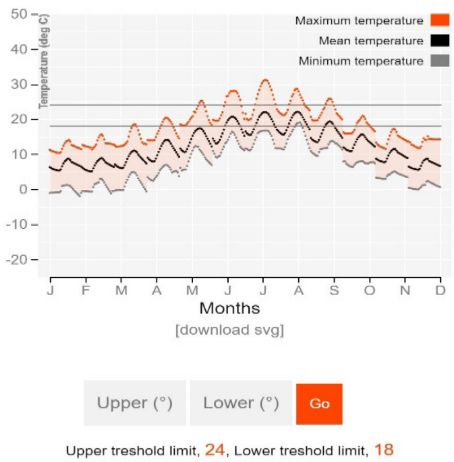


Fig.9 The rate of changes of upper -and lower-degrees.
Source: Researcher work.

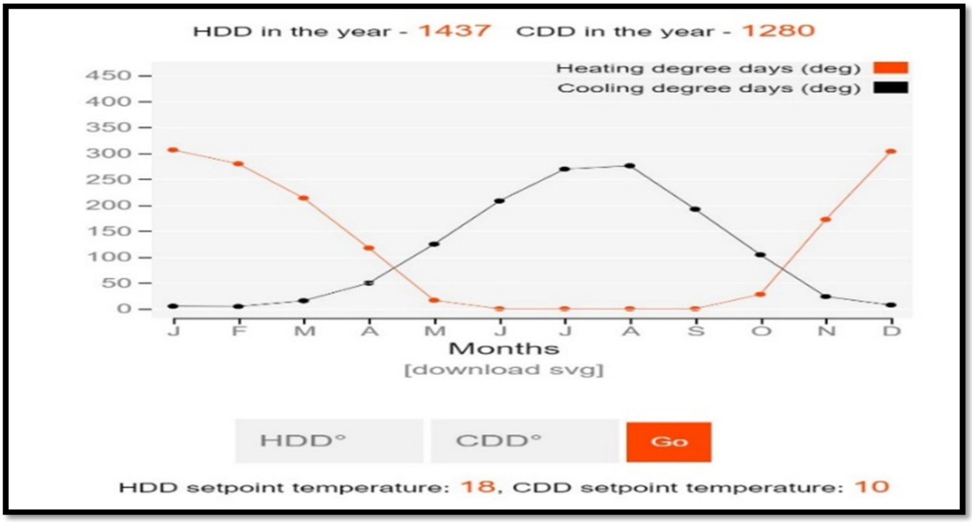


Fig 10 Annual radiation rate.
Source: Researcher work.

8- Study days:

This graph shows monthly heating and cooling degree days for adjustable set point temperatures. Heating/cooling degree day corresponds to the difference between the daily

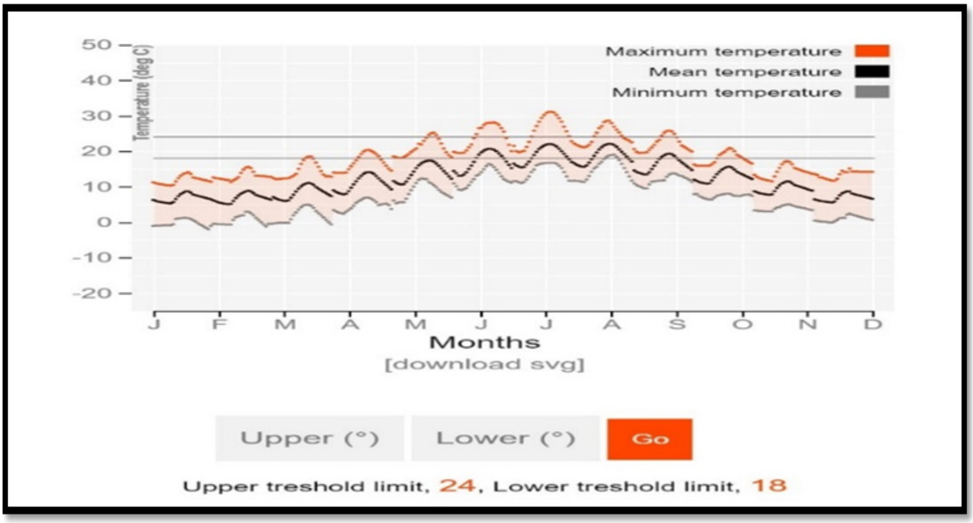


Fig.11 Rates of changes in temperature and humidity are annual energy rates.
Source: Researcher work.

average temperature and the heating/cooling set point temperature. For example, if the average daily temperature is 12°C and the heating/cooling set point temperature is 18°C/10°C, then the heating/cooling degree days for that day are 6DD and 2DD, respectively. If the set point temperatures correspond to the equilibrium point temperature of the building, then heating degree days are a good indicator of when the building is in heating or cooling mode.

8-1. Psychometric chart:

This graph shows the temperature and humidity for all or specific hours of the year for a given location and represents the physical characteristics.

The thermodynamics of moist air in graphical form. (Credit: Taken from the d3 transponder project by James Perakis) Using the select button, the graph provides additional information on wind speed and general horizontal radiance for all hours displayed with false colors. In the example figure, the hours are specified between 8 am and 6 pm for the summer months. The maximum radiation per hour in the specified hours is 1002 W / m2, and the temperature ranges from 10 ° C to 35 ° C.

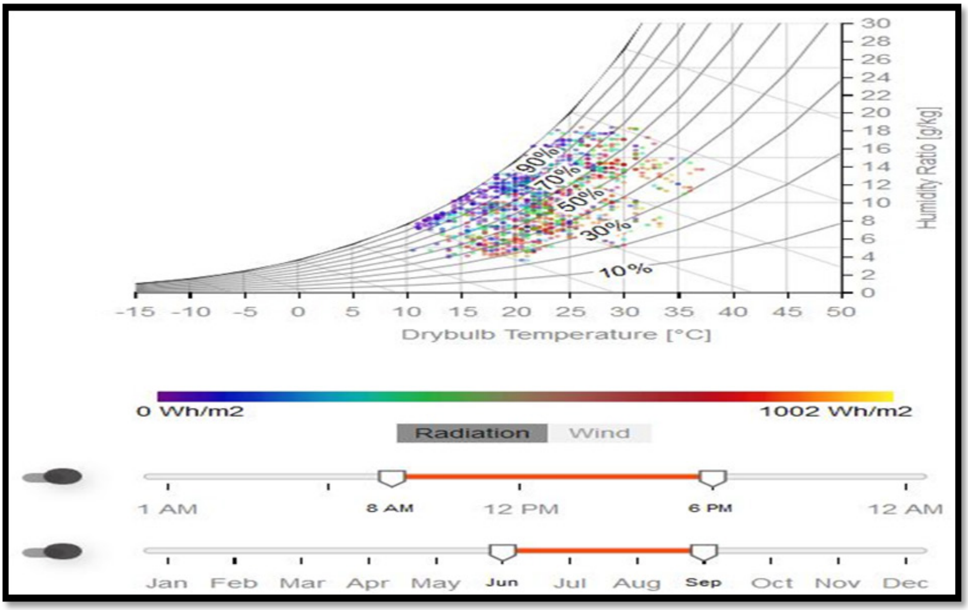
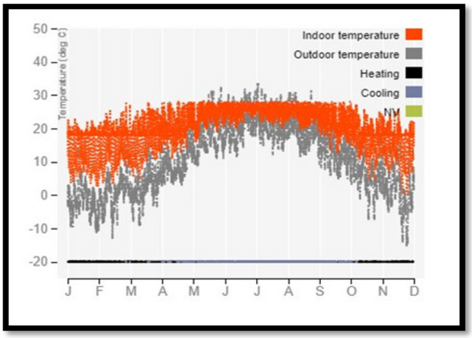


Fig.12 Psychometric diagram of the thermal comfort zone

Source: Researcher work.

8-2 .internal temperature:

The figure shows the hourly indoor and outdoor temperatures throughout the year. This data can be displayed in two ways. Each hour displays a time series of 8760 hours per year.



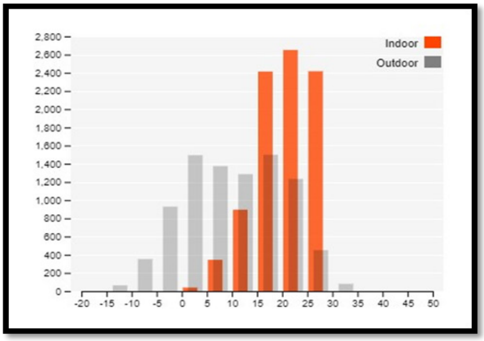


Fig.13 Upper threshold limit, 24, Lower threshold limit, 18. Fig.14 Indoor Temperature

Source: Researcher work.

The iteration version of this graph shows the hours per year that indoor and outdoor temperatures are within a given temperature period.

8-3. Saved scenarios:

This graph shows four different upgrade scenarios that are saved after power calculations are made in the ClimaBox. Starting with the base case, selected building updates can be saved as Scenarios 1, 2, or 3, with an additional custom name. The tests that were carried out within the programs were as shown for the building in the image below.

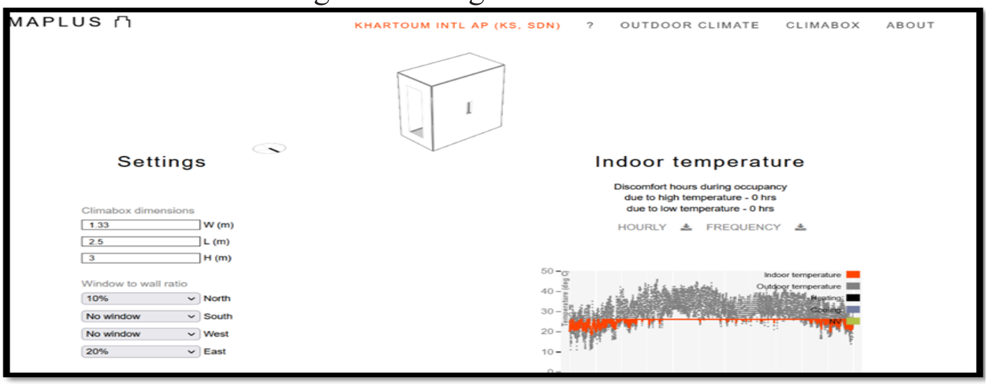


Fig.14 Include building dimensions’ information on climaplus software.

Source: Researcher work.

picture showing the building dimensions of the proposed building according to the openings in the facades

After entering the climatic data in the programs, we determine the dimensions, the openings, and the percentage of the openings in the facade. It is important to determine the percentage of heat gain from other factors, which will be mentioned above. In the north direction, a window represents 10%, and in the east is a door that represents 20%. As for the west and south, there are no openings. We will change the factors and variables on various effects. It identifies several factors, which are 9 factors and variables, as follows:

* Percentage of openings from doors and windows for each facade.
* Finishing materials for walls, ceilings and floors
* Exposed thermal mass (presence of ceilings)
* Sedimentation temperatures.
* The value of heat gains through the materials used in finishing.
* Natural ventilation.
* Central air conditioning.
* Emissions.

But in the study, we will focus on the seven basic factors, and we will exclude emissions and their harmful effects, as well as the cost resulting from the consumption of carbon dioxide. The

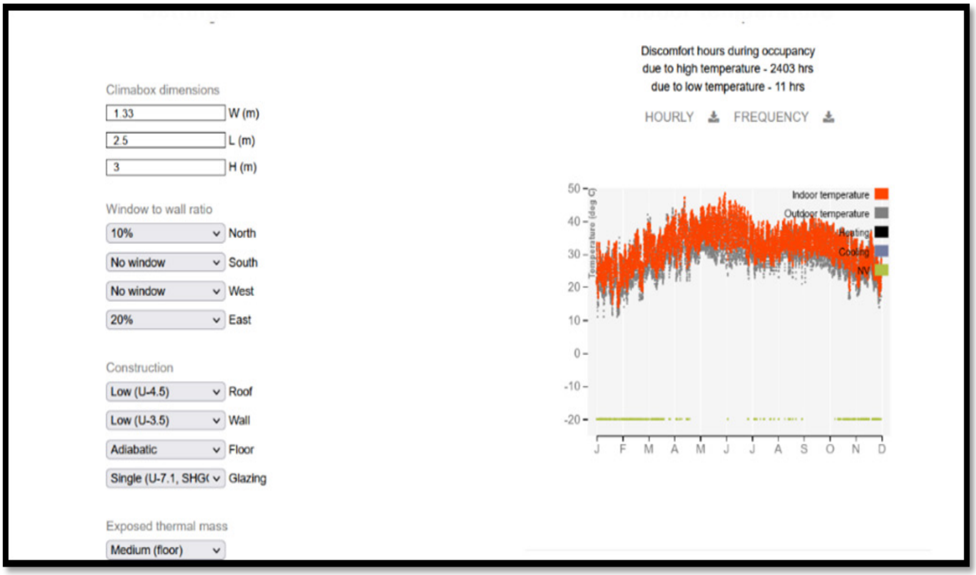


Fig.16 Include construction information on climaplus programs
Source: Researcher work.

experiment will be on the test building that was tested by the Climate Consultant programs. We are doing experiments on the same building. In the case of openings, the percentage is shown in the figure above. In the north, the percentage of openings is 10%, and in the east, the percentage of openings is 20%. There are no openings in the west and south. As for the finishing materials, it was finished with materials with low heat transfer and a system of medium thermal mass heights with low coverage this silverware, appears from the above diagram in orange, the internal temperature is 42 degrees Celsius And the outside is 36 degrees Celsius. This gives an average consumption in a time series per 2403 hours per year. Through the picture, the picture below shows the variables that show the value that affect energy efficiency, including finishes, materials, the presence of suspended ceilings or not, materials, heat transfer, the use of central air conditioning systems, the rate of heat leakage through the openings, the thickness of the glass.

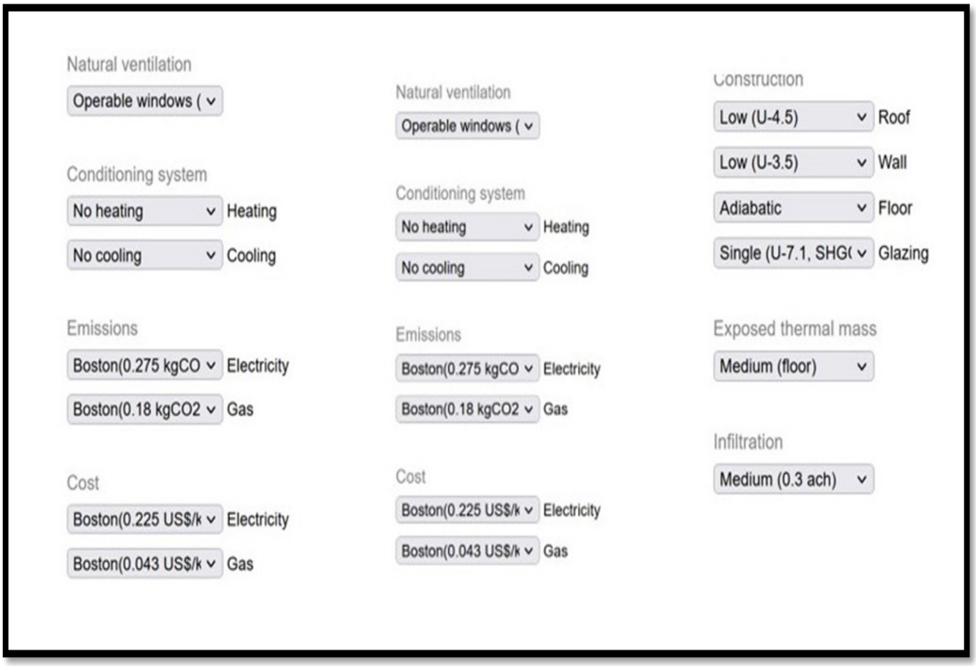


Fig.17 Parameters that must be changed to output energy performance results
Source: Researcher work.

Table 4: Variables and information that are used in Climapilus software, results, and output

variables and factors	Description of the worker							
Window to wall ratio	Construction	Infiltration	**Exposed thermal mass**	**Peak internal gain**	Natural ventilating	Conditioning system		Energy use intensi-.ty in kWh/m2. yr
Case 1	SINGLE GLAZING WALL U=3.5	=REGULAR (0.6ACH)	=LOW HALF FLOOR	REGULAR=10w/m^2	No nature ventilation	No cooling		Energy use intensi-.ty in kWh/m2. yr ,Total:43
Case 2	SINGLE GLAZING WALL U=.13	=TIGHT (0.1ACH)	MEDIUM FLOOR	BEST =6W/M^2	No nature ventilation	No cooling		Energy use intensity in kWh/m2. yr ,Total:28
Case 3	DOUBLE GLAZING WALL U=.13	=TIGHT (0.1ACH)	FLOOR CEILING	BEST =4W/M^2	OPERABE WINDOW	No cooling		Energy use intensity in kWh/m2. yr ,Total:25
Case 4	DOUBLE GLAZING WALL U=.13	=TIGHT (0.1ACH)	FLOOR CEILING	BEST =4W/M^2	OPERABE WINDOW	DX COOLING		Energy use intensity in kWh/m2. yr ,Total:55

Source: Researcher work

+

8-4. Energy and Emissions:

Figure 18 shows the energy intensity of a specific ClimaBox design for cooling, heating, electric lighting, and equipment. Energy intensity is the sum of the building's various energy uses divided by the conditioned floor area. The second figure shows CO2-equivalent emissions from gas and electricity and the last figure shows the cost of energy.

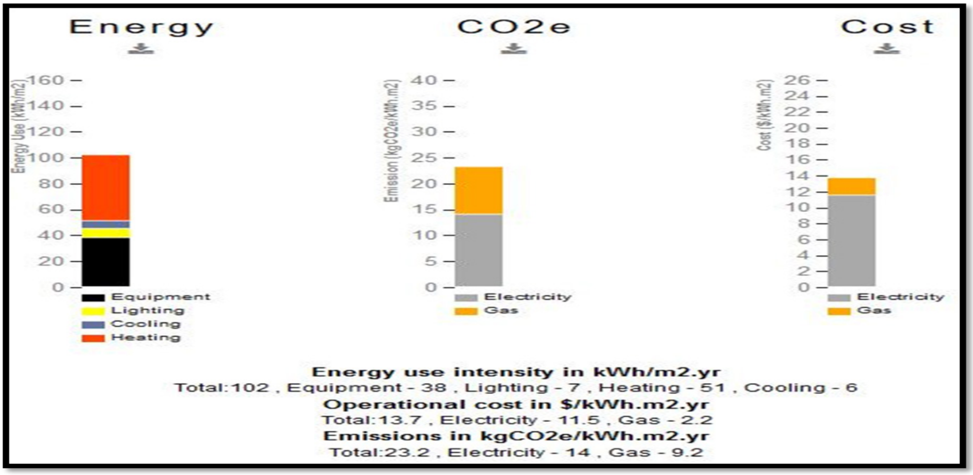


Fig.18 Energy and Emissions

Source: Researcher work

Saved scenarios: This graph shows four different upgrade scenarios that are saved after energy calculations are performed in ClimaBox. Starting with the base case, selected building updates can be saved as Scenarios 1, 2, or 3, with an additional custom name.

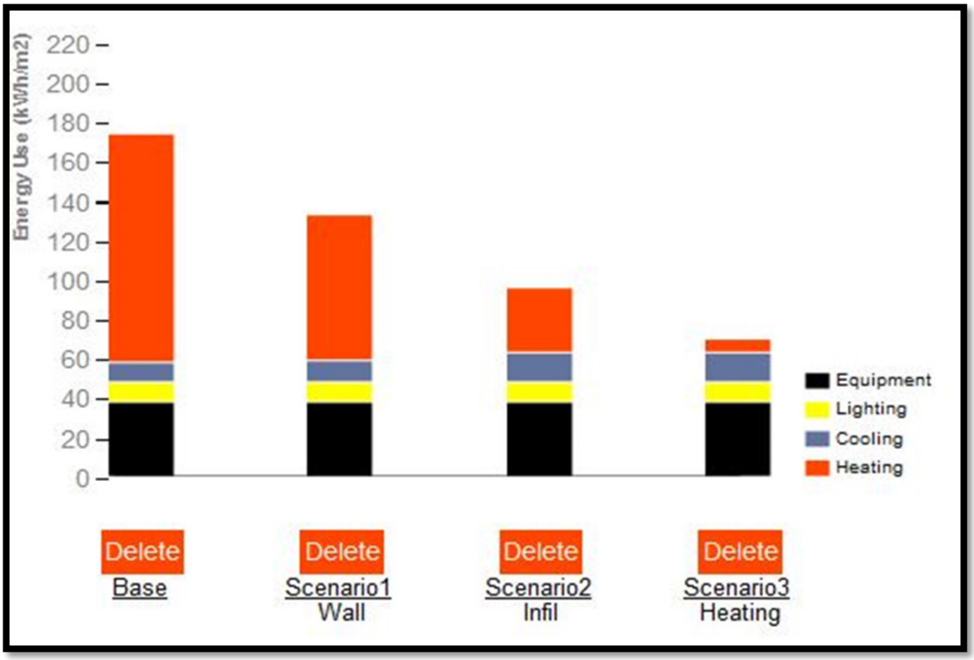


Fig.19 show Saved Scenarios

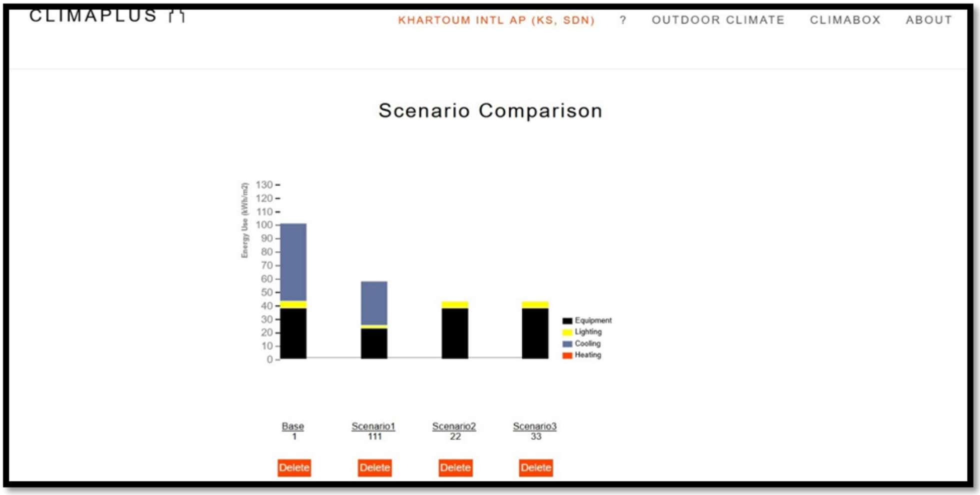


FIG. 20 shows Saved scenarios:

Result and summary of the experiments climaplus:

Abstract Experiments The rate of energy efficiency in the tests of the building is 43, 28, 25, 55 We note that the largest rate of energy efficiency is in the third case, which is 25, and the largest rate is in the fourth case, which is 55. For comparison between the two cases, in the third case, the same materials were used for the walls in terms of temperature transfer from the walls, ceilings, and floors, with very few deposition rates from controlling The way air or heat enters the building is air, with the adoption of openings generally in natural ventilation, in addition to the work of the false ceiling, or reducing the exerted effort that has a direct relationship with the energy exerted to provide thermal comfort in the building without using any mechanical means. As for the fourth case, it can be shared with all the data of the previous third case, except for the use of mechanical means and the false ceiling in the ceilings, and here the big difference is possible. Through openings or deposition of heat or its transmission through ceilings, Figure 20 comparison between the scenarios for the fourth case.

5. Final Results:

The presented results are directed towards analyzing the degree of accuracy of irradiance in predicting daylight when applied to a real building in the Faculty of Engineering, University of Sudan. The simulated outdoor illumination. distribution pattern closely follows the site-measured illumination pattern for all day's analyses. The radiation shows a high level, at the points of obtaining direct sunlight or reflecting through the buildings by adding the average temperatures, the thermal comfort through the days, and the general average over the whole year, there is a good correlation at the low values and becomes weaker at the higher values. The volume confirms the information that helps through the programs of Climate Consultant 6.0 programmers. As for the CLIMAPLUS programs, it explains the important factors that help reduce energy consumption. Programs are very important to gain time, predict, and help test options before implementing them, and this will reduce costs.

6. Conclusion:

The main objective of the study was to achieve this to obtain competition in passive air conditioning and sustainability in buildings, knowing that most of the studies were in astrology, and drawing a systematic pattern through preliminary tests in climate data programs and energy analysis accurately and scientifically, especially in Sudan because the high temperatures, High temperatures, the right lighting tower, and the right atmosphere to work in the right atmosphere. Basho study of sunflower plants.

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