"Sustainable Design in Built Environment"

Nid'a Ali Mohammed Al-Butoun
Architectural engineering
Al-Muwaqqar Municipality

Abstract

This research paper was based on selection a sample of government schools, and studies the energy consumption of this sample of all aspects to reach to series of results.

The research includes two main axes, the first axis deals with Measuring the issues related to the comfort (thermal, visual and acoustic) of the school's users (students, teachers and other staff) through the research questionnaire, and the second axis is how to improve the performance of the building by assessing the impact of proposed strategies on the building performance a simulation program (design builder program).

Keyword: Sustainability; Sustainable Building; Sustainable School; Student Performance.

الملخص

اعتمدت هذه الورقة البحثية على اختيار عينة من المدارس الحكومية ، ودراسة استهلاك الطاقة لهذه العينة من جميع الجوانب للوصول إلى سلسلة من النتائج.

يشتمل البحث على محورين رئيسيين ، المحور الأول يتناول قياس القضايا المتعلقة بالراحة (الحرارية ، البصرية ، الصوتية) لمستخدمي المدرسة (طلاب ، مدرسين وغيرهم من الموظفين) من خلال استبيان البحث ، والمحور الثاني هو كيف تحسين أداء المبنى من خلال تقييم تأثير الاستراتيجيات على أداء المبنى لبرنامج المحاكاة.

الكلمات المفتاحية : الاستدامة ؛ البناء المستدام؛ مدرسة مستدامة ؛ مستوى رضاء الطالب.

Introduction

A building project can be regarded as sustainable only when all the various dimensions of sustainability (environmental, economic, social, and cultural) are dealt with. The various sustainability issues are interwoven, and the interaction of a building with its surroundings is also important. The environmental issues share, in common, concerns which involve the reduction of the use of non-renewable materials and water, and the reduction of emissions, wastes, and pollutants. The following goals can be found in several building sustainability assessment methods: optimization of site potential, preservation of regional and cultural identity, minimization of energy consumption, protection and conservation of water resources, use of environmentally friendly materials and products, a healthy and convenient indoor climate, and optimized operational and maintenance practices(Olson & Kellum, 2003).

Based on the above, the sustainable school is to:

Reduce environmental impact, enhance human health, and increase environmental literacy.

The school building is one of the most important fundamentals of the educational process. And it is more than physical structure, the school come to life when the students come to school and start interacting with each other’s and with teachers, the school environment play a major role to increase the capacity to learn or decrease it, they spend about five to seven hours a day in school for about twelve early years, in all these hours and days the school use energy and electricity to provide a good conditions to the students, in this project we will reduce the energy consumption through reducing of use the electricity and water in the school building and through the proposed sustainable strategies with Ensuring a comfortable environment for students (Yeoman, 2012).

School designs and its relation with student's levels has been a focal point issue through the time, according to many studies; the good school design can apparently effect on students' performance in the school campus and on their learning achievements. According to Earthman; the environment where students spent half of their day in can totally effect on their grades level and behaviors (Earthman, 2004).

The analytic study for Yeng and Kaur in 2014 showed that the interior design of the school building and taking care of all the aspects of interior features increases the level of concretively for the students (Yeung, & Craven, 2014).

Nowadays, the sustainable approaches and renewable energy systems are the main topic of the new world, as what known; sustainable design process depending at the first place on exploit the site forces and the building orientation in order to perfect utilization of the sun path and wind to get users satisfied within the building and reducing the lost energy.

On the other hand; many studies notified that good school designs affect positively on student's interaction in schools spaces, also, the efficient lightening in classrooms, obtain a good noise isolation, getting a good students distribution in class rooms, and taking the whole ventilation and climate issues in mind can effect on students levels and performance within school which apparently reflected on their grades, this also was reported by Yeoman study in 2012 (Yeoman, 2012).

This study is tending to investigate the relation between applying the sustainable design consecrations on schools buildings and its impact on students' health, behaviors, and learning achievements. The participant of this study is consisted of 100 students who studied at (Rofaida al Eslameyeh School), in sahab city. The school was designed by Arch. Buthaina Al Tarawneh office: the architectural engineer: Arch.Arch. Salem Mhafza and the structural engineer: Eng.AdeebNaser.

Building background

The Rofaida Al-Eslameyeh School, located in Sahab, south neighborhood on land no.189. The school is characterized by a dense residential area and a conscious community who cares about the quality of education. The school completed and became ready to use in Jan-2008 with a total area around 5877.000 sqm and the cost was nearly 1million JD.Consists of four floors and basement.Containsthirty-nine class rooms.

The building exterior material is stone and glass in the front elevation (which is the most used material in Jordan) and painted concrete in the others , the use of these materials was because it’s a durable materials with a good appearance and it doesn’t need a regular maintain. The mechanical system was used to obtain a gentrification of life within the indoor functions in building. In fact, Jordanian climate tend to be a desert climate especially in the area where the school was built, so in order to control heat and cold during the year semesters there were a need to use fan and hotplate in building.

It is important to improve the energy performance of existing buildings in order to reduce overall energy consumption across the building sector.

Building energy performance assessment is crucial to ascertain the efficiency of energy use in buildings and is the basis to make any decision for enhancing energy efficiency. In order to assess the energy performance of existing buildings quantitatively, the energy use of the assessed buildings should be quantified first. The quantified energy use will be then used to compare with the assessment criteria to determine the energy performance quantitatively; the building performance assessment is a part of this research paper.

Exterior shots of the school

Figure 1: Exterior shots of the school

Research Problem and Justifications

Sustainable architecture awakens people's awareness of how building interactions with the environment; how much resource does it use and what are its effects on environment and people. Sustainable architecture also focuses on the role of buildings in protecting the environment from the increasing dangers of global warming, carbon emissions and ozone depletion. The problem in this research is that there is no indication to apply the sustainable technique in school buildings specifically in governmental schools, although lack of plans that increase schools environment levels and also the excessive and persistent demand in electricity and as a case study the researcher took Rofaida Al- Eslameyeh School in Sahab/Jordan to assess the sustainability status in the building and to improve the performance of the building by adding proposed strategies to the school building.

Research Purpose

The purpose of this study is to measure the issues related to the comfort (thermal, visual and acoustic) and satisfaction of the school's users (students, teachers and other staff), and to improve the performance of the building by assessing the impact of the sustainability proposed strategies on the building performance Rofaida Al-Eslameyeh school in Sahab/Jordan as a sample of governmental schools in Jordan.

Limitations of Research

The limitation in this study at first is the Lack of cases studies in Jordan and The permission that is needed to collect the data.

Literature review

Sustainable building

Sustainable building can be defined as integration of design construction, renovation and operation process, working all together in order to save energy and reduce environmental impact. Taking in consideration architectural design, building method and materials, and landscaping practices (Kellum, 2003, p. 3), by meeting the needs of today without affecting the needs of future generations according to the World Commission on Environment and Developments. Also these buildings are used to be called as green or high performance buildings because they are designed to increase the efficiency of energy saving , the quality of indoor spaces, providing the maximum environmental and economical performance, using environmental material, and educating occupants of the building about the importance of conservation and productivity(Tascıa, 2014). As a result, a highly efficient designed building can balance the exchange between indoor and outdoor air in order to create a healthy environment (Kellum, 2003, p. 10).

However there are criteria for designing a sustainable building such as: decrease the use of pesticides and provide an outdoor learning environment for students, increased use of day lighting that improve student performance and increase their comfort levels, Good indoor air quality from adequate air filtration and exchange systems and the banning of idling buses or delivery trucks near buildings that eliminate toxins, allergens and other harmful pollutant sources, The use of green supplies and materials to eliminate or minimize possible sources of toxins allergens and other harmful pollutants such as volatile organic compounds, and finally Onsite renewable energy sources, such as photovoltaic, that can be used as a teaching tool to develop Student interest in alternative energy sources (Primary School, 2006).

Sustainable School

Many school administrations believe that sustainable building more cost, but when we talk as long term; the cost and financial benefits of the green building are over ten times the average required of the design and construct green building. Energy savings alone exceed the average increased cost associated with building green, such as Road Middle School project was Wake County's first experience with daylight schools, this school was under budget and the pay back for the day lighting less than two years, This was because of the minimizing of mechanical and electrical systems, due to the reduction in energy costs, made possible by the day lighting. (Olson & Kellum, 2003).

Furthermore, the healthier environment can bring money by lowering absenteeism and performance, the upfront costs remain relatively the same while the learning environment is substantially improved and operational costs are reduced on a long term, as well as Sustainable school buildings benefit the school district and community bottom lines. Economic benefits include reduced life cycle and operating and maintenance costs, such as Kings mead Primary School was completed in 2004 and open to pupils that September as green Design, the idea of design began on the basis of the partnership Ben Mir School and designer and authority where the results were start king ling. Kings mead Primary School falls in the top 10 percent of buildings in the current BUS dataset, making it one of the best school building. (Olson &Kellum, 2003) (Model building project - Kingsmead Primary School, 2006).

They provided the energy by orientation, daylight, natural ventilation, minimalizing the maintenance costs, and Cost savings on solar management enabled the architect to provide a winter garden for each classroom. These effectively act as (unheated) airlocks or thermal buffers between the classrooms and the playground, the quality of day lighting is good enough to encourage users to keep the lights off, and this approach to lighting seems refutes the conventional wisdom that classrooms should face south. The controllable top-lights in the deepest part of the classroom spaces was efficient, Staff say that the conditions in the building significantly contribute to their perceived productivity at work, because the good thermal comfort scores, attention to detail in the design (Model building project - Kingsmead Primary School, 2006).

Sustainable School Design and Education

Design of school buildings with sustainability is of great importance for sustainability and education, that appears in the Convention on the Rights of the Children, some of these criteria are the appropriate lighting which would ensure the convenience of the places for education, benefiting from daylight as we can, the sound comfort in the places, acoustic requirements, and convenience for hygiene by natural ventilation, air conditioning, energy efficiency, and green spaces (Tascıa, 2014).

Sustainable Schools and Student Performance

According to Olson &Kellum there are two factors that effecting building and student performance, those factors are day lighting and indoor air quality. day lighting in general aims to take the advantages and mostly use of natural light instead of artificial light, while indoor air quality refers to the chemical and biological impurities that can affect the student's and the entire school's staff health.

Two elements of sustainable building design that have attention, and have been shown to have a significant effect on student performance, are day lighting and indoor air quality (IAQ) (Olson & Kellum, 2003).

1- Day lighting and Student Performance

Day lighting can be produced in several ways beside windows, such as: skylights, baffles, clerestory structures, and roof monitors, all of these are supplying a diffuse light not a direct sunlight that adds heat. In addition these techniques can give a more attractive form for the building, beside of increasing the student's health and productivity. In fact, the "Study into the Effects of Light on Children of Elementary School Age: A Case of Daylight Robbery" which was conducted in Alberta , Canada, proved the effect of natural daylight on student performance and attendance, in which the students who had been taught in classrooms with natural daylight, they learned faster, tested higher, and fewer absences. In addition to that, this study showed by the designer architects that there had been cost reduction between 22-64 percent.(Kellum, 2003, p. 8).

Student performance data for over 21,000 students from three elementary school districts in Orange County, California, Seattle, Washington, and Fort Collins, Colorado was compared to the amount of daylight provided by each student’s classroom environment. Also, students in classrooms where windows could be opened progressed 7-8 percent faster than students with fixed window, and also found that students who had a well-designed skylight in there room, progressed 19-20 percent faster than those students without a skylight (HMG, 1999).

Another studies was investigated the energy costs and performance of student attending three daylight school, they found that regardless of the age of the building, the daylight schools have cost reductions of between 22to 64 percent that mean that mean save 40,000 per year, assuming energy costs increase by 5 percent per year, the savings on just this one school, over the next ten years, would exceed $500,000, more specifically, the students who were attending nondaylight schools by 5 to 14 percent the California Board for Energy Efficiency on the effect of day lighting on human performance. (Olson &Kellum, The Impact of Sustainable Buildings on.Educational Achievements in K-12 Schools, 2003)

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These results support the conclusion that lighting systems are not neutral and have non-visual effects on people who are exposed to them over long periods of time, due to along with a rising interest in “natural” and “healthy” environments, specifically increase interest in daylight in design schools (Olson &Kellum, the Impact of Sustainable Buildings on Educational Achievements in K-12 Schools, 2003).

2- Indoor Air Quality and Student Performance

Since students spend a huge time amount inside buildings in classrooms, it pulls the trigger to take the quality of indoor air more seriously, beside of the children sensitivity against polluted air. The consequences for not taking indoor air quality in consideration can lead to what is known as "Sick Building Syndrome" ([1]SBS), in which this term describe the buildings that affect the occupants' health and comfort that appear to be linked to the amount of time spent in the building. In other words, poor air quality can cause several symptoms, such as: headaches, shortness of breath, cough, sneezing, and eye, nose, and throat irritations or it could be worse, by spread of allergic reactions and expanding diseases. Eventually, poor indoor air quality has a significant effect on student's health, absenteeism, and their performance during school time (Kellum, 2003, pp. 9-10).

According to American lung association, there are problems related to poor indoor air quality including: higher relative air humidity, especially for volatile organic compounds, and bacteria. So it has to be a good environment, not too hot or too cold, in order these students can learn appropriately. There are two major problems affecting indoor air quality, those are heating, ventilation and air conditioning systems. These systems pump contaminates through school building again and again, which is a direct cause for mold and eventually affect the health of the students and contribute to the building bio-deterioration. So the efficiency of these mechanical and ventilation systems are needed to provide an adequate fresh air for all students and stuff, and reducing the collection of dirt, bacteria,

[1] "Sick Building Syndrome"

and moisture (Kellum, 2003, p. 10). As a result poor indoor air quality will affect the image of school and the relationship between administration and parents, besides of questioning the liability of this school among the other schools.
Sustainable design helps improve indoor air quality and helps to eliminate conditions related to SBS, Integrated design and construction helps address indoor air quality well before the site is even selected by highly efficient building systems that balance between indoor and outdoor air do create a healthy building environment. (Olson &Kellum, the Impact of Sustainable Buildings on Educational Achievements in K-12 Schools, 2003).

-<u>In the U.S green building council, The Centre of Green School emphasized the general characteristics are: (Green School, 2010).</u>

1-Conserves energy and natural resources.
2-Improves indoor air quality.
3-Removes toxic materials from places where children learn and play.
4-Employs day lighting strategies and improves classroom acoustics.
5-Decreases the burden on municipal water and wastewater treatment.
6-Encourages waste management efforts to benefit the local community and region.
7-Conserves fresh drinking water and helps manage storm water runoff.
8-Encourage recycling.
9-Promote habitats protection.
10-Reduced demand on local landfills.

These are the appropriate lighting organization which would ensure the convenience of the places for education, the quality and the density of the light, benefiting from daylight in the most rational manner, the sound comfort in the places, acoustic requirements, and convenience for hygiene, natural ventilation, air conditioning, energy efficiency, and green.

The performance of the building

The most important primary factors affecting the satisfaction of residents in the port and reflect its performance and consist of several secondary factors are thermal comfort, visual comfort, sound comfort (Mounir El Asmara, 2014).

1- Thermal Comfort

The temperature inside the building is more than outside the building that contributing to three factors; Emission of heat from the lights and electrical appliances; Admission heat from the outside through the walls, windows and roofs of the buildings and Heat convection by hot air from outside the building. (A. R. M. Nasir, 1998).

The purpose of measuring the thermal comfort of the school occupants is to assess general satisfaction with thermal performance and then to develop a plan for corrective action, that is measured climatic factors which air temperature, average radiant temperature, relative humidity that the amount of water vapor in the air and effect the temperature and air speed, as well as the personal factors include activity and clothing. In addition, there are also a factor that affects comfort, such as gender, body shape (fat, Dubois area) and races; it can be measured in a several methods such as seven-point ASHRAE scale, Bedford scale and the scale of Humphreys and Nicol. (A. R. M. Nasir, 1998)

To meet health needs, convert air to clean air through mechanical systems that support it, produce thermal comfort, and cool the building through thermal pressure on air by designing holes up and down to make airflow(Mechanical Ventilation, 2010).

Ideally, the classroom should be provided with a minimum of 13-15 cubic feet per minute (cfm) of outside air per person.

Many of experiment having done a study on 10-year-old children in which the average air temperatures were reduced from 23.6oC to 20oC and outdoor air supply rates were increased from 11 to 20.4 cfm per person for a week, that increasing fresh air and decreasing temperatures slightly can substantially improve children's schoolwork (Green School, 2010).

2- Acoustic Comfort

It Is the unwanted sound and causes discomfort, where inappropriate places reach 80 dB and affect the audio and non-instrumental effect, If it reaches 120 dB it can cause damage to the hearing bones and cause personal pain, permanent weakness of hearing, nausea and dizziness, According to American National Standard Institute (ANSI, 2002), the standard for acoustical performance in schools is ANSI/ASA S12.60, that is three background noise sources which are the building systems, exterior sound transmission and sound transmission from adjacent spaces, outside traffic, noise from HVAC and plumbing systems. (Olson &Kellum, 2003) (ParisaIzadpanahia)(A. R. M. Nasir, 1998)

To solve the noise problem must design two layers of windows and a good choice of fabric for the wall, In addition to the need for sound insulation for each room and the placement of sound tiles in the ceilings, some studies have shown that the development of spongy materials or green plants to absorb the sounds of a few frequencies very effective (Saadah, 2005).

3- Visual Comfort

Visual comfort is an emerging field of study, helps mental health and improve the productivity and performance of the passengers it is mean ensuring the quality of the light is just right - without introducing unintended consequences such as excessive glare or over heating risk, that measured by brightness, reflection, and type of light sources. (Tsikaloudaki, 1986)

Brightness is the sparkle in the field of vision is worth more than the usual light used by the eye, and result in inconvenience and discomfort, or that the vision and brightness of direct vision in the field, the bright objects reflect the light to the eye, and are measured by studying the following variables; The shape and size, the reflective surfaces, the level of lighting, the source, size and diversification of lighting, the number of sources of lighting, the lighting materials of the place to be lit, the location of the seat and the line of sight. (Ibrahim n.d, 1996) (A. R. M. Nasir, 1998)

The brightness is reduced by increasing the source of illumination in the area around the source of the brightness and the use of light pulses, in addition to the use of raw materials surrounding the light units such as paper and away from the metals and reflective materials, relatively the reflection is measured by studying the reflection ratios of walls, ceilings and surfaces in space (reflection factor), as well as the Type of light source measure by The quality of the lighting and the specific spectral line and its shape are studied. (Ibrahimn.d, 1996) (A. R. M. Nasir, 1998).

Methodology

In this the research includes two main ways:

1- Field study to Measuring the issues related to the comfort (thermal, visual and acoustic) of the school's users (students, teachers and other staff) through the research questionnaire, study the researcher used both the quantitative and qualitative methods (mixed methods) to collect the data in our research, to have a simple 3 pages questionnaire about the satisfaction of the students in the class room in term of comfort issues, in addition to the interviews with stakeholders and also observations by the researcher from school.

2- Simulation program to how improve the performance of the building by assessing the impact of proposed strategies on the building performance a simulation program (design builder program).

The researcher asked permission from the Ministry of Education and the school administration and the researcher took the approval to start collecting data.

For the purpose of this research, and in order to achieve the objectives, data was collected and used that assimilated of the engineering plans of the school (Appendix 1), photos of the school (Appendix 2) and general information about the school was gathered through communication with several government departments, including the Ministry of Public Works, the Directorate of Education and the Sahab Municipality, and then with the consultant office of the construction, and in the last one the researcher faced a lot of obstacle and difficulties and challenges to obtain the plans for the school.

-Current status in school building.

1 - Field study

- Population and samples

This research is for the occupants of the building (Rofaida Al-Eslameyeh School), so the population in this study is the occupants of the school (students, teachers and staff who work in it), the number of all students in the school is1190 students and the number of teachers and stuffs is 65.

1- From the population the researcher selected one teacher as a randomly sampling and the manager of the school (for the interviews). 2- The researcher divided the population (students for the questionnaire) used the stratified sampling method to choose the samples and then selected simple random sampling to choose students from each class room in different level and different orientation.

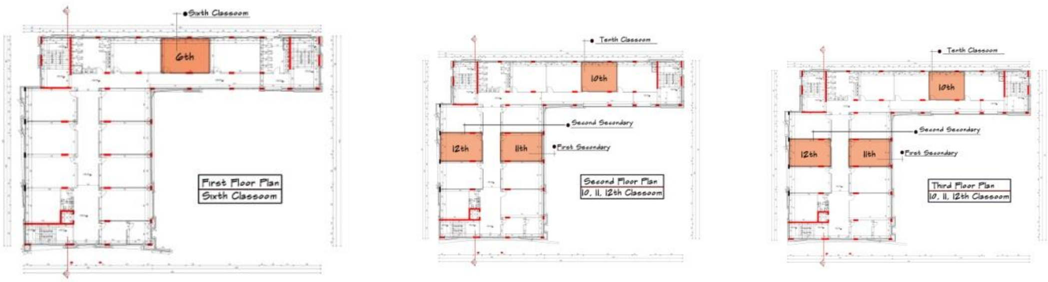


Figure 2: Selected class room in different level and different orientation

- Instruments that used in data gathering:

1. Interviews

The researcher conducted face to face two interviews with the school manager to collect more data about the school and one teacher.

Visiting the school on 4-4-2019 at 8:30 am to 1:30 pm to conduct interviews with the manager of school and the selected teacher.

And according to the above collected data the researcher also collected other information about the sustainable schools from internet websites and library (books and thesis that related in the same subject), and then the researcher began to analyzed the gathered data.

2. Observations

When the researcher visited the school the researcher observed school building and school yard throughout observe:

1. location of the school
2. The entrances (inside the school and outside).
3. Outdoor educational spaces (outdoor).
4. Movement systems.
5. Social participation.
6. Green structure.
7. Outdoor educational spaces (outdoor).

As will mentioned later in detailed.

3. The Questionnaire

The questionnaire was constructed for the students of the school, and based on the *likert scale* questions.

The questionnaire questions are16 questions divided to three sections:

1. Thermal comfort

2. Visual comfort.
3. Audio comfort.

From the collected data from the literature and from our background about the comfort environment in the classrooms in the schools, the researcher found the main factors to measure the thermal comfort:

1. Temperature.
2. Humidity.
3. Ventilation and Air movement.

The main factors to measure the visual comfort:

1. Lighting.

The main factors to measure the audio comfort:

1. Noise of (in and out) sounds.

Based on these factors the researcher prepared the questions, each set of questions measures one factor.

Questionnaire samples:

The researcher used the stratified sampling method to choose the samples and then selected simple random sampling to choose students from class room in deferent level and different orientation, to become the sample size 100 students for the questionnaire.

Note: according to the direction, there are three types of classrooms in the questionnaire, south, north and east classroom.

2 - Simulation program

The researcher will use the Design Builder simulation program to measure the effectiveness of the building from the data obtained from the questionnaire and interviews from the researcher, and work to change these data through the program such as; the type of windows used materials direction of the building and knowledge the effective of the extent of the building at the time.

Design Builder is a user-friendly modeling environment where you can work (and play) with virtual building models. It provides a range of environmental performance data such as: annual energy consumption, maximum summertime temperatures and HVAC component sizes.

Some typical uses are:

- Calculating building energy consumption.
- Evaluating façade options for overheating and visual appearance.
- Thermal simulation of naturally ventilated buildings.
- Day lighting - models lighting control systems and calculates savings in electric lighting.
- Visualization of site layouts and solar shading.
- Calculating heating and cooling equipment sizes.
- Communication aid at design meetings.
- An educational tool.

The current state of the building and its compatibility with the results of the questionnaires will be determined, and then some other options will be identified through which options that can improve the performance of the building, such as: shading device, lovers, insulation material.

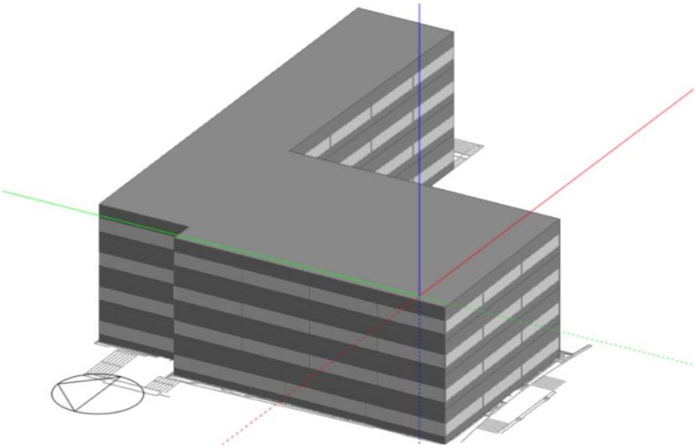


Figure 3: School Building in design builder program

Results and Discussion

1- Data collected from interviews with the manager of the school and teacher from the school

The average consumption of the school building is 1471.857 JD of electricity per month for the fans that used for cooling in summer and for lighting the building and to operate the equipment and appliances that used in the school, and the building consumes water at a rate of 390.55 JD per

each session for the WCs and other uses, the cooling devices (fans) and lighting devices (neon lighting) in the classrooms are controlled manually.
The school building does not use the solar thermal systems to heat the water and does not use PV systems. In WCs there aren't tools and parts to reduce of the water consumption. There is a very few plants and most of the areas are covered with asphalt.

2 -Data collected from researcher observations from the school

The site located in the center of neighborhood and it has good access, where it expected to cover the need of community in the future. There is a playground behind the building of the northern side is effective because it is attractive and there is access to it . no green zone in as much the high difference of levels and the green zone is not fully exploited, aside from high percentage of areas designed as parking serve 14 parking units, In addition that located in roads intersection with no enhance potential for pedestrians and cyclist despite of near from houses; Most students reach the school by car.

Orientation the building from solar gains depending on requirement by maximize south west facing glazing and minimize north facing glazing, the design provide shading device on south elevation the addition the orientation of the building provide the natural ventilation and natural light by l-shape design , no thermal insulation on building , on otherwise the building use inefficient energy mechanical appliance heating, cooling and lighting, because the design didn't provide the green energy resources.

Figure 4: Context

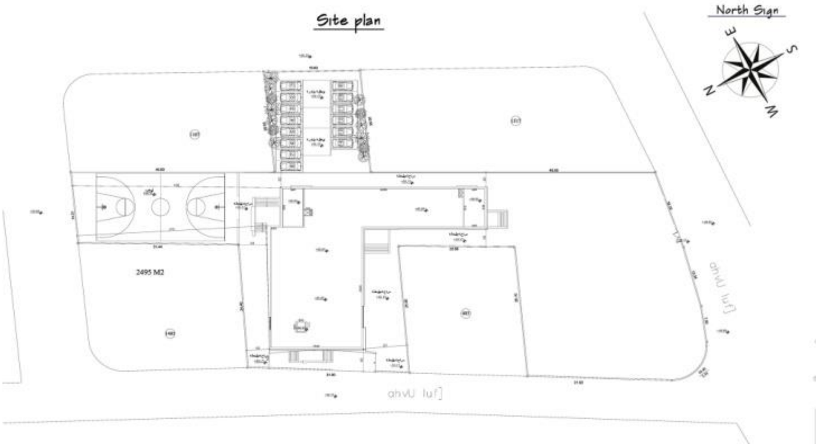


Figure 5: Site plan

Each classroom has 6 neon lighting units and two windows with a width of 1.80 cm and a height of 2 meters, made of aluminum and glass, and opened with a manual pull, There are no inside curtains or outside shelters on these windows.

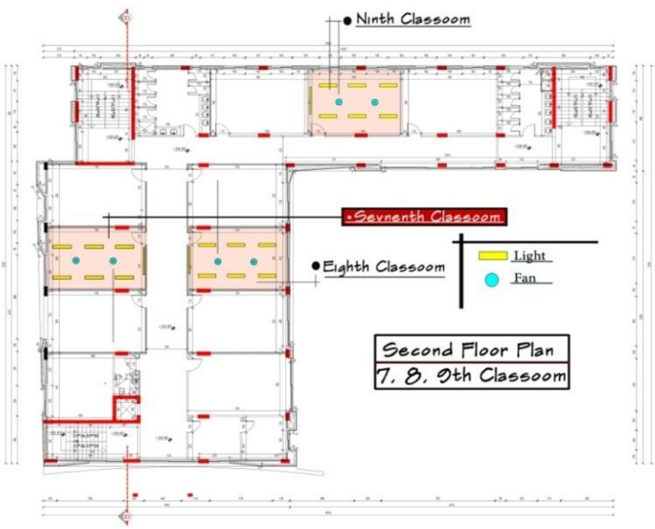


Figure 6: Selected Classroom

Design does not provide shelter for the squares; in the morning, students need to cover the sun in the south-east, from 10:30 am to 11:00 am. Students take a break, and it has been observed that a number of students use the wall as shelters, in addition there are no green spaces accessible on site and to the community, there are no gardens, For the building, indoor air quality provides a clean environment with natural ventilation in the case of open windows and manual ventilation, but with regard to thermal comfort, students have been shown to moderate moderation and take measures of passenger clothing where a child takes off the coat and suspension in the classroom. , The noise level of the building is characterized by a high level of dizziness, although the school is not fully occupied due to lack of soundproofing between classrooms and the lack of plant helps plants can help dissipate sound waves internally. The site contains water tank that use to additional supplies, but does not used to collect rainwater, the design doesn't provide efficient equipment and irrigation system .The building contains WCs units in each floor and each unit contains 6 bathrooms.

The site doesn't support the interaction the school with local community by the retaining wall and the high walls around the school , in addition the high width streets that doesn't provide pedestrian movement or pavement structure and the lack of public transport or bus stop serving the school; these factors weaken attention to workability, on otherwise the design neglect the private natural environment for students and wild life due to decrease the quality of life, for the landscape design does not contain the green zone and asphalt material surrounding the building without diversity of form and uses reduces the interaction with site, as well some feature Is ineffective and not interacted |in as much the design does not help to create a sustainable society and thought; such as the users do not interact with the theatre because it need protect from sun gains and shelters of green plants. And finally there isn't a waste recycle program in the school.

3- The questionnaire result

1- Thermal comfort; the result from the questionnaires as following.

- Temperature

80.2% of the students feel that the temperature inside their classroom is moderate, and 30.3% feel it is acceptable, and 58.8% of students do not prefer to change the temperature in the class, and 47.1% feel that the temperature is comfortable while 41.1% feel comfortable Somewhat, in addition to 76.5% of students feel a significant change in temperature during the day.

Some classroom because of the changing directions of the classrooms, the movement of the sun greatly affects this classroom, that's led to increases in the temperature s noticeably.

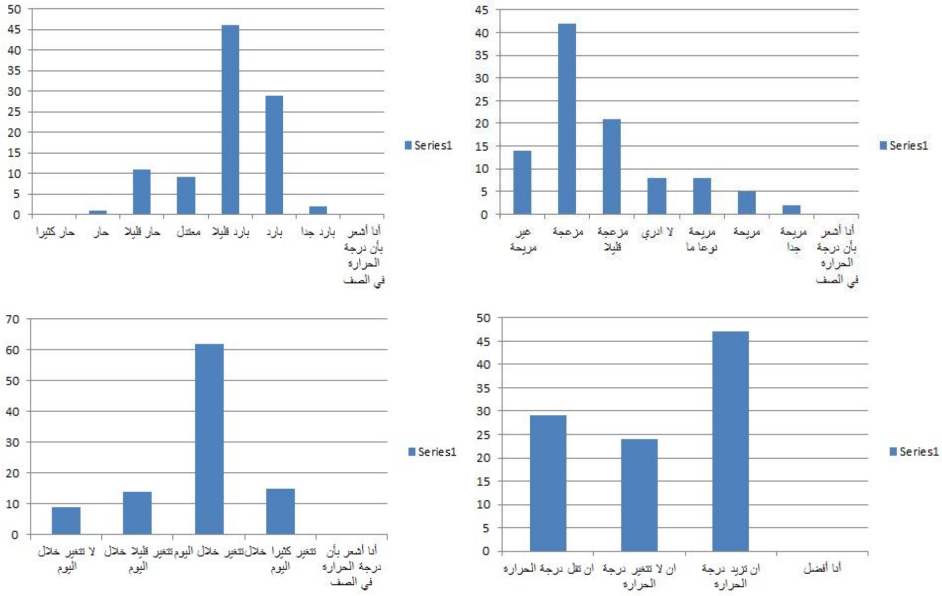


Figure 7: Temperature

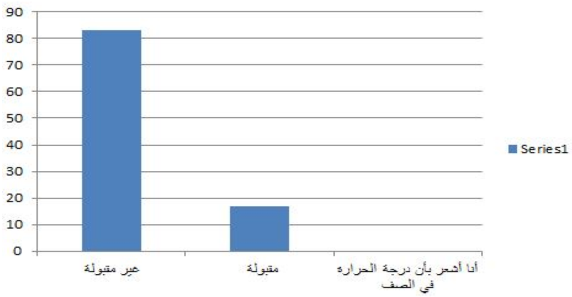


Figure 8: Result (Temperature)

- Air movement

41.2% of the students feel that the movement of air inside the classroom is still, and 52.9% feel that the air speed in the classroom is acceptable, while 76.5% prefer to increase the air speed.

In these rooms the pressure increased due to the lack of an air passing through these rooms and because the sun stays longer inside these classrooms.

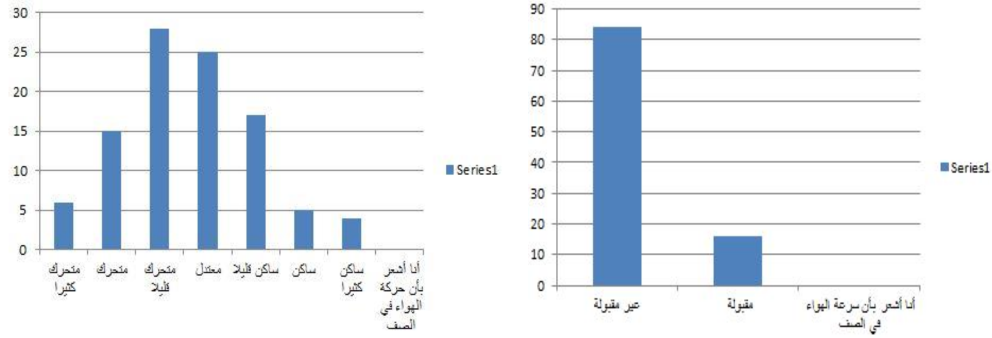


Figure 8: Air movement

- Humidity

94.1% of the students feel that the humidity in the classroom is moderate and appropriate, and 88.2% of students prefer to keep the humidity as it is and not change it.

Figure 9: Humidity

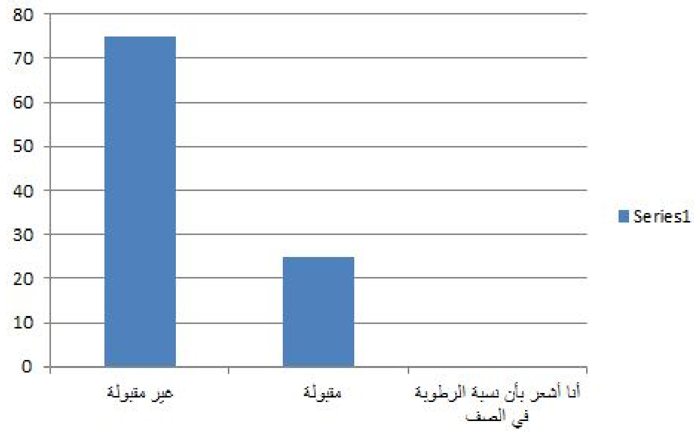


Figure 10: Result (Humidity)

- Visual comfort; the result from the questionnaires as following.

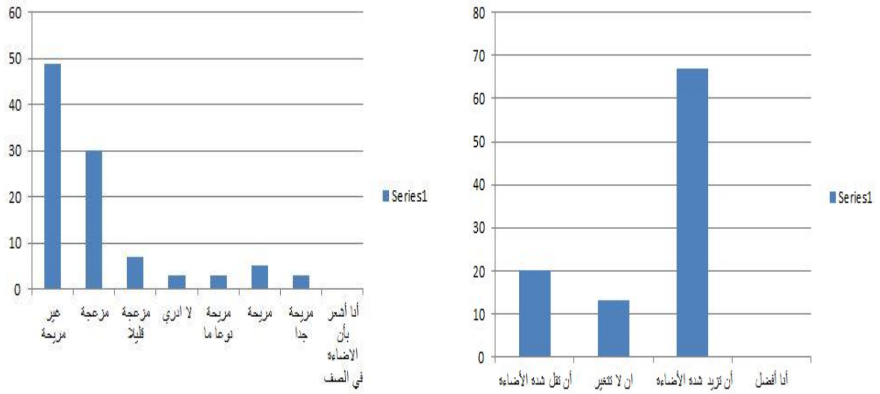


Figure 9: Visual comfort

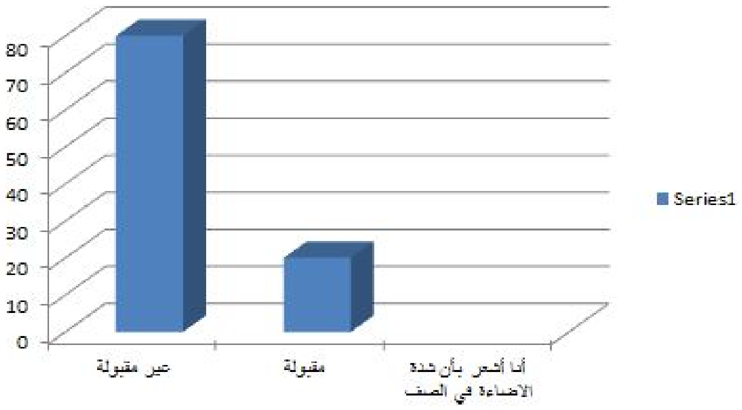


Figure 10: Result (Visualcomfort)

35% of the students feel that classroom lighting is somewhat comfortable, while the remaining percentages are between a little annoying 23.5% and annoying 17.6%. Also, 88.2% of the students feel that the light intensity is acceptable, but 58.8%.They preferred to decrease the light intensity while 35% preferred not to change.

These percentages came because the east classrooms are more exposed to the sun and heat for this reason increased the glow and heat and intensity of lighting in an annoying way.

- Acoustic comfort; the result from the questionnaires as following.

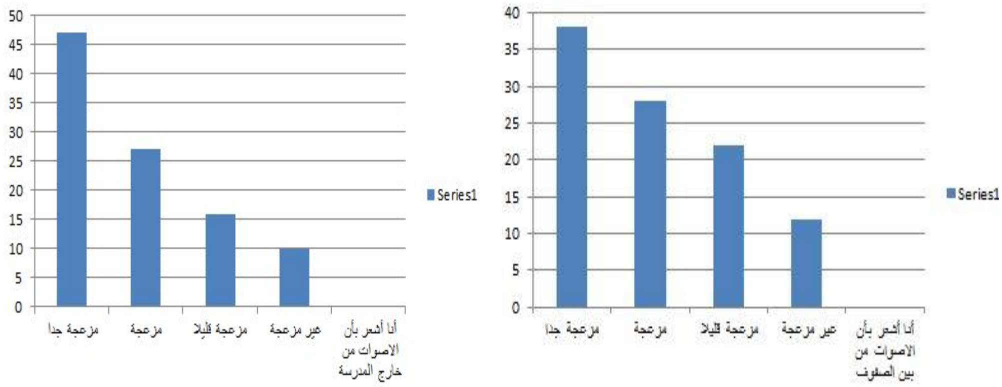


Figure 11: Acoustic comfort

35.3% of students feel that out-of-school sounds are annoying, and 35.3% of students feel it is a little annoying, and 41.2% feel that the sounds from the school yard or adjacent classrooms are a little annoying.

The results showed that the western classrooms were slightly better in terms of thermal comfort and air movement. This difference was due to the eastern orientation of the classrooms, the sun entering the classrooms and their longer stay in these rooms increased heat, glow and pressure. For explanation see figure (12) & (13).

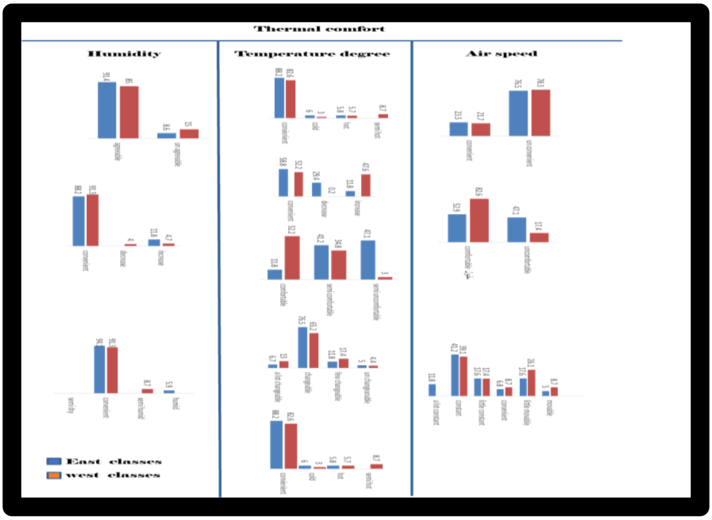


Figure 12: Thermal comfort result between east and west classroom

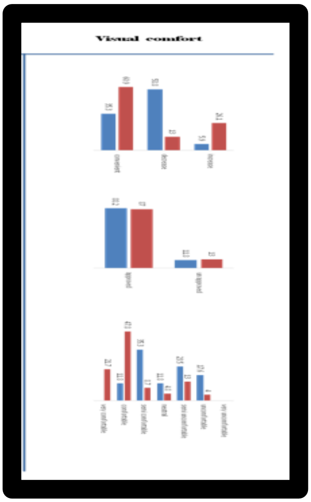


Figure 13: Visual & Acoustic comfort result between east and west classroom

- Simulation program results.

1- The current building

The current building was calculated during the period from 1 September to 1June, defined the building's consumption of energy and temperature.

-Temperature:

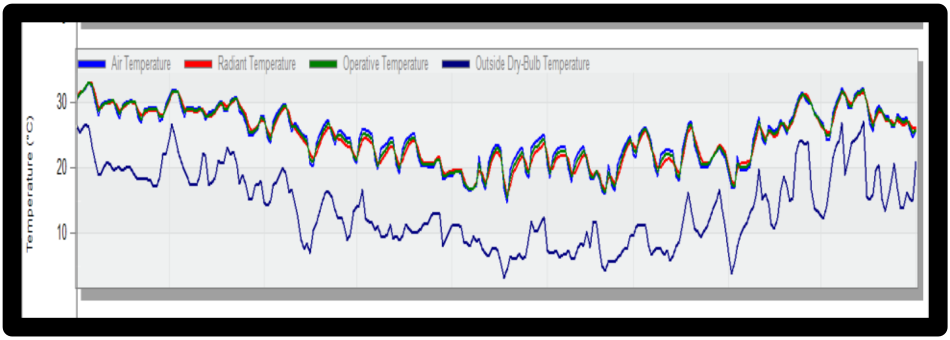


Figure 14: Temperature

Zone	Comfort Temperature (°C)	Steady-State Heat Loss (kW)	Design Capacity (kW)	Design Capacity (W/m2)	Glazing Gains (kW)	Wall Gains (kW)	Floor Gains (kW)	Roof and Ceiling G...	Ventilation Gains (...	Infiltration Gains (k...
Building 1 Total Design Heating Capacity = 449.280 (kW)										
Block 1 Total Design Heating Capacity = 105.650 (kW)										
Zone 1	17.67	84.52	**105.65**	138.8562	-14.985	-9.120	5.293	-2.177	-51.918	-11.611
Block 2 Total Design Heating Capacity = 109.250 (kW)										
Zone 1	17.35	87.40	**109.25**	143.4091	-15.145	-8.924	2.176	-1.884	-51.985	-11.641
Block 3 Total Design Heating Capacity = 111.800 (kW)										
Zone 1	17.17	89.44	**111.80**	146.7498	-15.157	-8.812	1.888	-3.716	-51.985	-11.656
Block 4 Total Design Heating Capacity = 122.580 (kW)										
Zone 1	16.50	98.06	**122.58**	160.9054	-14.514	-8.356	3.721	-15.260	-51.985	-11.671

-Heating design:

Block 2 Total Design Heating Capacity = 109.250 (kW)										
Zone 1	17.35	87.40	**109.25**	143.4091	-15.145	-8.924	2.176	-1.884	-51.985	-11.641

Figure 14: Heating design

-Cooling design:

Zone	Design Capacity (kW)	Design Flow Rate (m3/s)	Total Cooling Load (kW)	Sensible (kW)	Latent (kW)	Air Temperature (°C)	Humidity (%)	Time of Max Cooli...	Max Op Temp in Day (°C)	Floor Area (m2)	Volume (m3)
Building 1											
Block1:Zone1	106.89	6.5456	92.95	87.94	5.01	26.0	60.1	Jul 15:00	30.1	760.8	2662.9
Block2:Zone1	142.79	8.2143	124.16	110.36	13.80	26.0	55.6	Jul 15:00	32.7	761.8	2666.4
Block3:Zone1	154.69	8.8218	134.52	118.52	16.00	26.0	54.5	Jul 15:00	33.3	761.8	2666.4
Block4:Zone1	160.89	9.1429	139.91	122.83	17.08	26.0	53.9	Jul 15:00	33.8	761.8	2666.4
Totals	**565.26**	**32.7246**	**491.53**	**439.65**	**51.88**	**26.0**	**56.0**	**N/A**	**33.8**	**3046.3**	**10662.0**

Block2:Zone1	142.79	8.2143	124.16	110.36	13.80	26.0	55.6	Jul 15:00	32.7	761.8	2666.4

Figure 15: Cooling design.

The researcher have done simulation for the block 2 of heating and cooling design to know the active and the current ability to control the temperature in summer and winter.

In heating design:

-Design heating capacity =109.250KW

-Comfort temperature =17.35C

-Glazing gains = -15.145KW

-Wall gains= -8.924KW

In cooling design:

-Design capacity = 142.79 KW

-Total cooling load = 124.16 KW

-Air temperature = 26 C

-Humidity =55.6%

The heat loss comes from the glazed and from the wall in addition to external ventilation helps to lose 4 times the walls, and increase the insulation of walls and windows, by make air tight building.

2 - Alternative 1: triple glazed

-Temperature:

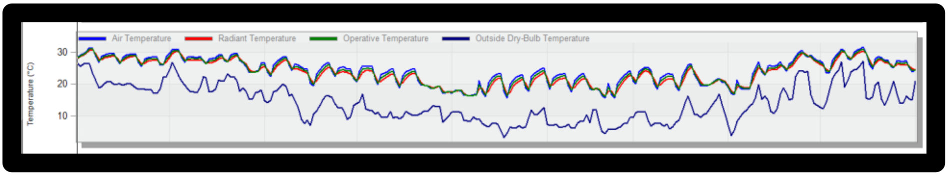


Figure 16: Temperature.

Zone	Comfort Temperature (°C)	Steady-State Heat Loss (kW)	Design Capacity (kW)	Design Capacity (W/m2)	Glazing Gains (kW)	Wall Gains (kW)	Floor Gains (kW)	Roof and Ceiling...	Ventilation Gains (...	Infiltration Gains (k...
Building 1 Total Design Heating Capacity = 413.290 (kW)										
Block 1 Total Design Heating Capacity = 97.750 (kW)										
Zone 1	18.19	78.20	**97.75**	128.4798	-6.773	-9.420	2.941	-1.422	-51.918	-11.611
Block 2 Total Design Heating Capacity = 99.740 (kW)										
Zone 1	18.01	79.79	**99.74**	130.9277	-6.754	-9.321	1.422	-1.517	-51.985	-11.641
Block 3 Total Design Heating Capacity = 102.120 (kW)										
Zone 1	17.84	81.69	**102.12**	134.0423	-6.699	-9.212	1.524	-3.667	-51.985	-11.656
Block 4 Total Design Heating Capacity = 113.680 (kW)										
Zone 1	17.08	90.95	**113.68**	149.2242	-6.359	-8.693	3.674	-15.913	-51.985	-11.671

-Heating design:

Block 2 Total Design Heating Capacity = 99.740 (kW)										
Zone 1	18.01	79.79	**99.74**	130.9277	-6.754	-9.321	1.422	-1.517	-51.985	-11.641

Figure 17: Heating design

Zone	Design Capacity (kW)	Design Flow Rate (m3/s)	Total Cooling Load (kW)	Sensible (kW)	Latent (kW)	Air Temperature (°C)	Humidity (%)	Time of Max Cool...	Max Op Temp in Day (°C)	Floor Area (m2)	Volume (m3)
Building 1											
Block1:Zone1	**96.45**	**6.1132**	83.87	82.13	1.74	26.0	61.8	Jul 14:00	28.9	760.8	2662.9
Block2:Zone1	**126.92**	**7.4501**	110.37	100.09	10.28	26.0	57.4	Jul 14:30	31.8	761.8	2666.4
Block3:Zone1	**139.78**	**8.0667**	121.55	108.37	13.18	26.0	55.9	Jul 14:00	32.5	761.8	2666.4
Block4:Zone1	**148.53**	**8.5124**	129.15	114.36	14.79	26.0	55.0	Jul 15:00	33.3	761.8	2666.4
Totals	**511.68**	**30.1425**	**444.94**	**404.96**	**39.99**	**26.0**	**57.5**	**N/A**	**33.3**	**3046.3**	**10662.0**

Block2:Zone1	126.92	7.4501	110.37	100.09	10.28	26.0	57.4	Jul 14:30	31.8	761.8	2666.4

-Cooling design:

Figure 18: Heating design

<u>In heating design:</u>

Design heating capacity =99.74KW

Comfort temperature =18.01C

<u>Glazing gains = -6.754 KW</u>

Wall gains= -9.321 KW

<u>In cooling design:</u>

Design capacity = 126.92 KW

Total cooling load = 110.37 KW

Air temperature = 26 C

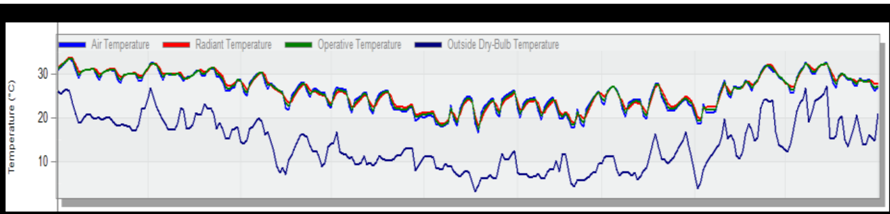
Humidity =57.4 %

The researcher assumed that the triple glazed window observed a decrease in readings such as design heating capacity and Glazing gains that mean the efficient thermal building increase.

In current building, glazing gains = -15.145KW

<u>Triple glazedbuilding, glazing gains = -6.754 KW</u>

3 - Alternative 2: insulation layers



-Temperature:

Figure 18: Temperature

Zone	Comfort Temperature (°C)	Steady-State Heat Loss (kW)	Design Capacity (kW)	Design Capacity (W/m2)	Glazing Gains (kW)	Wall Gains (kW)	Floor Gains (kW)	Roof and Ceiling ...	Ventilation Gains (...	Infiltration Gains (k...
Building 1 Total Design Heating Capacity = 416.590 (kW)										
Block 1 Total Design Heating Capacity = 98.270 (kW)										
Zone 1	18.20	78.61	**98.27**	129.1586	-15.484	-0.931	2.796	-1.468	-51.918	-11.611
Block 2 Total Design Heating Capacity = 100.550 (kW)										
Zone 1	18.01	80.44	**100.55**	131.9903	-15.804	-0.913	1.468	-1.569	-51.985	-11.641
Block 3 Total Design Heating Capacity = 103.110 (kW)										
Zone 1	17.81	82.49	**103.11**	135.3509	-15.815	-0.897	1.576	-3.715	-51.985	-11.656
Block 4 Total Design Heating Capacity = 114.660 (kW)										
Zone 1	17.04	91.73	**114.66**	150.5090	-15.063	-0.841	3.722	-15.891	-51.985	-11.671

Block 2 Total Design Heating Capacity = 100.550 (kW)										
Zone 1	18.01	80.44	**100.55**	131.9903	-15.804	-0.913	1.468	-1.569	-51.985	-11.641

-Heating design:

Figure 19: Temperature

Analysis | Summary

Zone	Design Capacity (kW)	Design Flow Rate (m3/s)	Total Cooling Load (kW)	Sensible (kW)	Latent (kW)	Air Temperature (°C)	Humidity (%)	Time of Max Cooli...	Max Op Temp in Day (°C)	Floor Area (m2)	Volume (m3)
- Building 1											
Block1:Zone1	104.99	6.4655	91.29	86.86	4.43	26.0	60.4	Jul 15:00	29.9	760.8	2662.9
Block2:Zone1	141.14	8.1328	122.73	109.26	13.47	26.0	55.8	Jul 15:00	32.6	761.8	2666.4
Block3:Zone1	153.96	8.7846	133.88	118.02	15.86	26.0	54.5	Jul 15:00	33.3	761.8	2666.4
Block4:Zone1	160.72	9.1342	139.75	122.72	17.04	26.0	53.9	Jul 15:00	33.8	761.8	2666.4
Totals	**560.80**	**32.5170**	**487.65**	**436.86**	**50.79**	**26.0**	**56.2**	**N/A**	**33.8**	**3046.3**	**10662.0**

Block2:Zone1	141.14	8.1328	122.73	109.26	13.47	26.0	55.8	Jul 15:00	32.6	761.8	2666.4

-Cooling design:

Figure 19: Cooling design

<u>In heating design:</u>

Design heating capacity =100.55KW

Comfort temperature =18.01C

Glazing gains = -15.815 KW

<u>Wall gains= -0.913 KW</u>

<u>In cooling design:</u>

Design capacity = 141.14 KW

Total cooling load = 122.73 KW

Air temperature = 26 C

Humidity =55.8 %

In the case of addition of insulation materials for walls, the loss of thermal gain or gain through the walls, this provides greater thermal comfort.

In current building, wall gains= -8.924KW

<u>In insulation building, wall gains= -0.913 KW</u>

4 - Alternative 3: louver

Steady-state | Summary

Zone	Comfort Temperature (°C)	Steady-State Heat Loss (kW)	Design Capacity (kW)	Design Capacity (W/m2)	Glazing Gains (kW)	Wall Gains (kW)	Floor Gains (kW)	Roof and Ceiling ...	Ventilation Gains (...	Infiltration Gains (k...
Building 1 Total Design Heating Capacity = 413.290 (kW)										
Block 1 Total Design Heating Capacity = 97.750 (kW)										
Zone 1	18.19	78.20	**97.75**	128.4798	-6.773	-9.420	2.941	-1.422	-51.918	-11.611
Block 2 Total Design Heating Capacity = 99.740 (kW)										
Zone 1	18.01	79.79	**99.74**	130.9277	-6.754	-9.321	1.422	-1.517	-51.985	-11.641
Block 3 Total Design Heating Capacity = 102.120 (kW)										
Zone 1	17.84	81.69	**102.12**	134.0423	-6.699	-9.212	1.524	-3.667	-51.985	-11.656
Block 4 Total Design Heating Capacity = 113.680 (kW)										
Zone 1	17.08	90.95	**113.68**	149.2242	-6.359	-8.693	3.674	-15.913	-51.985	-11.671

-Heating design:

Block 2 Total Design Heating Capacity = 99.740 (kW)										
Zone 1	18.01	79.79	**99.74**	130.9277	-6.754	-9.321	1.422	-1.517	-51.985	-11.641

Figure 20: Heating design

-Cooling design:

Analysis | Summary

Zone	Design Capacity (kW)	Design Flow Rate (m3/s)	Total Cooling Load (kW)	Sensible (kW)	Latent (kW)	Air Temperature (°C)	Humidity (%)	Time of Max Cool...	Max Op Temp in Day (°C)	Floor Area (m2)	Volume (m3)
Building 1											
Block1:Zone1	**101.32**	**6.3058**	88.11	84.72	3.39	26.0	61.0	Jul 14:00	28.9	760.8	2662.9
Block2:Zone1	**128.16**	**7.4996**	111.45	100.75	10.69	26.0	57.2	Jul 14:00	31.6	761.8	2666.4
Block3:Zone1	**140.44**	**8.0967**	122.13	108.78	13.35	26.0	55.8	Jul 14:00	32.3	761.8	2666.4
Block4:Zone1	**149.25**	**8.5463**	129.78	114.82	14.96	26.0	54.9	Jul 14:00	33.2	761.8	2666.4
Totals	**519.18**	**30.4484**	**451.46**	**409.07**	**42.39**	**26.0**	**57.3**	**N/A**	**33.2**	**3046.3**	**10662.0**

Block2:Zone1	128.16	7.4996	111.45	100.75	10.69	26.0	57.2	Jul 14:00	31.6	761.8	2666.4

Figure 21: Cooling design

<u>In heating design:</u>

Design heating capacity =99.740 KW

Comfort temperature =18.01C

Glazing gains = -6.74 KW

Wall gains= -9.321 KW

<u>In cooling design:</u>

Design capacity = 128.16 KW

Total cooling load = 111.45 KW
Air temperature = 26 C
Humidity =57.3%

5 - Alternative 4: all alterative above

Zone	Comfort Temperature (°C)	Steady-State Heat Loss (kW)	Design Capacity (kW)	Design Capacity (W/m2)	Glazing Gains (kW)	Wall Gains (kW)	Floor Gains (kW)	Roof and Ceiling ...	Ventilation Gains (...	Infiltration Gains (k...
Building 1 Total Design Heating Capacity = 378.070 (kW)										
Block 1 Total Design Heating Capacity = 89.950 (kW)										
Zone 1	18.80	71.96	**89.95**	118.2212	-7.016	-0.968	0.091	-0.537	-51.918	-11.611
Block 2 Total Design Heating Capacity = 90.370 (kW)										
Zone 1	18.78	72.30	**90.37**	118.6302	-7.078	-0.962	0.543	-1.177	-51.985	-11.641
Block 3 Total Design Heating Capacity = 92.700 (kW)										
Zone 1	18.59	74.16	**92.70**	121.6811	-7.019	-0.947	1.191	-3.746	-51.985	-11.656
Block 4 Total Design Heating Capacity = 105.050 (kW)										
Zone 1	17.70	84.04	**105.05**	137.8892	-6.616	-0.881	3.759	-16.645	-51.985	-11.671

-Heating design:

Figure 21: Heating design

-Cooling design:

Zone	Design Capacity (kW)	Design Flow Rate (m3/s)	Total Cooling Load (kW)	Sensible (kW)	Latent (kW)	Air Temperature (°C)	Humidity (%)	Time of Max Cooli...	Max Op Temp in Day (°C)	Floor Area (m2)	Volume (m3)
Building 1											
Block1:Zone1	**99.13**	**6.2164**	86.20	83.52	2.68	26.0	61.4	Jul 14:00	28.6	760.8	2662.9
Block2:Zone1	**126.02**	**7.3987**	109.58	99.40	10.18	26.0	57.5	Jul 14:00	31.5	761.8	2666.4
Block3:Zone1	**139.15**	**8.0331**	121.00	107.92	13.08	26.0	56.0	Jul 14:00	32.2	761.8	2666.4
Block4:Zone1	**148.44**	**8.5060**	129.08	114.28	14.81	26.0	55.0	Jul 14:00	33.1	761.8	2666.4
Totals	**512.74**	**30.1543**	**445.86**	**405.12**	**40.75**	**26.0**	**57.5**	**N/A**	**33.1**	**3046.3**	**10662.0**

Block 2 Total Design Heating Capacity = 90.370 (kW)									
Zone 1	18.78	72.30	**90.37**	118.6302	-7.078	-0.962	0.543	-1.177	-51.985	-11.641

Figure 21: Cooling design

<u>In heating design:</u>

Design heating capacity =90.3 KW
Comfort temperature =18.78C
Glazing gains = -7.07 KW
Wall gains= 0.962 KW

<u>In cooling design:</u>

Design capacity = 126.02 KW
Total cooling load = 109.58 KW
Air temperature = 26 C
Humidity =57.5 %

- Result in heating design

-The current building

Design heating capacity	109.25 KW
Comfort temperature	17.3 C
Glazing gains	-15.14 KW
Wall gains	-8.920 KW

-Simulation program result

	Design heating capacity	Comfort temperature	Glazing gains	Wall gains
Triple glazed	99.74 KW	18.01C	-6.754	-9.321 KW
Insulation layers	100.55 KW	18.01 C	-15.815	-0.913 KW
louver	99.74 KW	18.01 C	-6.754	-9.321 KW
all alterative above	90.3 KW	18.78C	-7.07 KW	0.962 KW

The current situation of the building indicates a high thermal loss of windows and walls(Glazing gains: -15.14 KW, Wall gains: -8.920 KW), some sort of eastern rows tend to rest thermal comfort (17.3 C), this was observed through questionnaires.

But when triple glass was used in the windows, the rate of loss was greatly reduced (from -15.14 KW to -6.754), so it was among the best choices for achieving thermal comfort in buildings, the comfort temperature been 18.01C. when the use of insulating materials in the walls, the loss of the loss of the largest

(From -8.920 KW to -0.913 KW) and became a degree of thermal comfort better.

The results started better when all the options were combined to achieve a sustainable building. The researcher noticed that the thermal loss rate of the windows and the walls is less (-7.07 KW, 0.962 KW), design heating capacity(90.3 KW) minimum number , and the building can maintain the temperature and achieve the thermal comfort and energy saving.

Of the results of the questionnaire shows that the eastern classes are the most comfortable thermal to enter the sun in the morning period and this is consistent with the results of the program about the temperature of comfort (17.3 C).

- Result in cooling design.

<u>The current building</u>

Design capacity	142.79KW
Total cooling load	124.16 KW
Air temperature	26 C
Humidity	55.6%

<u>Simulation program result</u>

	Design capacity	Total cooling load	Air temperature	Humidity
Triple glazed	126.92 KW	110.37 KW	26 C	57 %
Insulation layers	141.14 KW	122.73 KW	26 C	55.8%
louver	128.16	11.45 KW	26 C	57%
all alterative above	126.02 KW	109.58 KW	26 C	57.5 %

When using triple glazed, insulation for walls and louver the researcher notice a decrease each of Design capacity, Total cooling load and Humidity, this leads to a decrease in temperature and energy saving used.
But when all the options were used together, the results were the best as the building turned towards sustainability and thermal comfort; Design capacity (142.79KW -126.92 KW), Total cooling load (124.16 KW-122.73 KW), Humidity (55.6%- 57.5 %).

This is consistent with the fact that the eastern classes are comfortable thermally due to the sun entering only the morning period and good ventilation in them according to the results of the questionnaire.

Recommendations

Through the data that collected from the interviews with the principal and teacher, and through the observations of the researcher that took in the building of the school that shows many important sustainability issues that have not been used, although it is simple and easy to use and does not require expensive or difficult installation methods.

The following are the most important issues that the researcher has observed in the school environment and the proposed solutions and strategies to reach a sustainable building. As low as possible (divided by the axes of sustainability).

High Electricity Consumption; to reduce electricity consumption, the researcher recommend using several strategies; Exploitation of natural lighting. Take advantage of natural ventilation and make outdoor shading on the windows topped by solar cells to provide energy. Use curtains in classrooms to protect against annoying sun rays. Use led lamps. Use Daylight detectors switch on lights only when natural light levels are lower than a set level. Timed controls switch off lights after a set time of being switched on. Programmed controls switch lights on and off at set times in the day. Educating users by Make individuals responsible for switching off lights.

High energy consumption; to reduce this can be one of the alternative that have been applied to the building through the program and proved to be effective delivery of the building for thermal comfort and reduce the consumption of energy inside the building, and was the most important and most effective triple glazed for the windows and thermal insulation of the building and louvers on the facades or Combine them together to achieve their highest benefit.

The spaces in the school site are not exploited. All the spaces are covered with asphalt and most of them are parking. The most appropriate solution in this case is to design of the landscape in the school site and make plan of areas for growing the plants. There are no external shading to protect the students from the sun and rain. The solution is to put external shading, especially above the outdoor amphitheater; these shadings will be covered with solar cells.

The use of materials that do not last and consume a lot of energy in the extraction, manufacture and transfer. The solutions in this item has been changed materials and modified in the simulation program ... such as: use asphalt on the surface to increase insulation, Stone is also used in facades to increase insulation. Use double or triple glazed for windows. Use the stone in the elevations to increase the isolation.

The participation of parents and residents of the region should be undertaken by activities, initiatives and projects that call for sustainability. Finally, it is clear that the students are not aware of the importance of energy and to preserve it. So, we have to increase awareness among students and this through: Activities, projects and initiatives that support sustainability .Create green team of students, teachers, school administration, parents and community to be as a guide to sustainability education for student.

Conclusion

Many of studies proved that the student's satisfaction and their performance have strong relationship with the school environment by measuring the visual, hearing and thermal comfort. Second, the researcher observations to evaluate the performance of the building and surrounding environment in the design and construction, Third, through a simulation program (design builder) to evaluate the performance of the building structurally.

It has been shown through the second measurement method that the surrounding environment of the building needs to reduce the existing thermal islands phenomena, by the cultivation of fruit trees and creation shelters, and integrating the building with the local community.

Through the questionnaires the researcher find that the rest (thermal, visual and acoustic) and the student's satisfaction with the internal environment varies according to the location of the classroom, Western students were not satisfied enough for them not to enter the sun, while the eastern classes and the best and most satisfied Students entering the sun into it for a short period are sufficient to adjust their temperature to achieve thermal comfort.

As for the acoustic comfort was not achieved as a result of the votes coming from the ocean and the internal rows and squares. Visual comfort has not been achieved especially in the eastern classes because of the glare of the sun.

Through the program the researcher have made sustainable changes to the building to increase the effectiveness of the building and reduce the consumption of energy, where the researcher have modified the triple glazed and how effect on the loss and thermal gain, where both reduce and this led to maintain the internal temperature of the building, where was the most successful methods.

The second alternative was the addition of insulating materials where they were more effective in the heating design and prevent the loss of temperature of the building and provide the thermal comfort is also one of the most successful methods.

The third alternative was the addition of the Louvre on the facades to reduce thermal gain in summer and thermal loss in winter, but the biggest benefit was in the subject of visual comfort and reduces the glow resulting from the sun in the East elevation.

Finally, when combining these three options together we get a building oriented towards sustainability, comfortable and less energy consuming. And the environmental comfort optimization method, herein presented could be reflected in other building typologies, for example, housing developments, hospitals and government buildings such as ministries and municipalities for improving the design process as a whole.

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