بسم الله الرحمن الرحيم

Sudan University of Science and Technology.
College of Architecture and Planning.
Department of Architectural Design

Graduation Project Research

Elementary , Intermediate School for Boys and Teachers Housing
(Northern State - Dongola - Kodrokah village)

مدرسة إبتدائي ومتوسط وسكن للمعلمين
(الولاية الشمالية – دنقلا – قرية كدركة)

Name :
Abdalla Basheir Mohammed Basheir

Supervised by :
T. Mohamed Abdelmageed Al-fadil

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الآيـــة

قال تعالى :

ٱقۡرَأۡ بِٱسۡمِ رَبِّكَ ٱلَّذِي خَلَقَ ۝١ خَلَقَ ٱلۡإِنسَٰنَ مِنۡ عَلَقٍ ۝٢ ٱقۡرَأۡ وَرَبُّكَ ٱلۡأَكۡرَمُ ۝٣ ٱلَّذِي عَلَّمَ بِٱلۡقَلَمِ ۝٤ عَلَّمَ ٱلۡإِنسَٰنَ مَا لَمۡ يَعۡلَمۡ ۝٥

صدق الله العظيم
سورة العلق ، الآيات من ١ - ٥

الحديث النبوي

عن أبي هريرة - رضي الله عنه - قال: قال رسول الله - صلى الله عليه وسلم-: ((... ومَن سلك طريقًا يَلتمِس فيه عِلمًا، سهَّل الله له به طريقًا إلى الجنة.)) رواه مسلم برقم ٢٦٩٩ ،

Dedication

الحمد لله الذي لا يحيط بحمده حامد، ولا توفي قدره بليغ المحامد، سبحانه فلا يعبده حق عبادته عابد ولو قضى عمره قانتاً لله وهو راكعٌ أو ساجد. الحمد لله عظيم الشأن، واسع السلطان، مدبر الأكوان، في ملكه تسبح الأفلاك، وحول عرشه تسبح الأملاك ، وأحمده ربي الذي وفقني للوصول إلى هذه المرحلة.

"To my dear parents **(Negat and Basheir)**, who have always been my source of inspiration and strength, thank you for every moment of support and encouragement.

To my supporting brothers, **(Mohamed and Moaz) ,** thank you for every moment we spent together, and for every word of support and encouragement."

To my respected teacher **(Mohamed Abdel Majeed)**, without your wise guidance and valuable advice I would not have been able to reach this achievement."

Abstract .

This project focuses on designing an elementary and secondary school, along with a teacher's residence, in Northern Sudan, an area that lacks model schools and suffers from limited academic development. The aim is to enhance the quality of education in this region by providing much-needed educational facilities.

The methodology used involved gathering general information and conducting field studies on local needs and educational challenges. Comparative analysis of similar school models was carried out to optimize the distribution of primary and secondary activities within the school, focusing on the relationship between these activities and the movement flow. A space allocation schedule was created for each activity, and zoning techniques were applied to determine the optimal site for the school and teacher housing based on topographical and environmental considerations.

A significant aspect of the design is the emphasis on natural ventilation, incorporated throughout the project to ensure a healthy and comfortable environment for both students and teachers. The initial concept was developed with this focus, followed by further refinement of the design based on these principles.

Finally, structural solutions and advanced technical solutions were integrated to ensure the safety, energy efficiency, and environmental sustainability of the project.

The outcome is a comprehensive design that balances educational needs with teacher comfort, promoting a sustainable and well-organized learning environment. The project concludes with recommendations for governmental and collaborative support to implement this initiative, aimed at improving the region's education standards.

المستخلص

يركز هذا المشروع على تصميم مدرسة ابتدائية وثانوية، بالإضافة إلى سكن للمعلمين، في شمال السودان، وهي منطقة تفتقر إلى المدارس النموذجية وتعاني من محدودية التطور الأكاديمي. ويهدف المشروع إلى تحسين جودة التعليم في هذه المنطقة من خلال توفير المرافق التعليمية الضرورية.

اعتمدت المنهجية على جمع معلومات عامة وإجراء دراسات ميدانية حول الاحتياجات المحلية والتحديات التعليمية. وأُجري تحليل مقارن لنماذج مدارس مماثلة لتحسين توزيع أنشطة المرحلتين الابتدائية والثانوية داخل المدرسة، مع التركيز على العلاقة بين هذه الأنشطة وتدفق الحركة. ووُضع جدول لتوزيع المساحات لكل نشاط، وطُبقت تقنيات تقسيم المناطق لتحديد الموقع الأمثل للمدرسة وسكن المعلمين بناءً على اعتبارات طبوغرافية وبيئية.

ومن الجوانب المهمة في التصميم التركيز على التهوية الطبيعية، وهو ما تم دمجه في جميع مراحل المشروع لضمان بيئة صحية ومريحة للطلاب والمعلمين على حد سواء. وقد طُوّر المفهوم الأولي مع التركيز على هذا الجانب، تلاه مزيد من التحسين للتصميم بناءً على هذه المبادئ.

وأخيرًا، تم دمج الحلول الهيكلية والحلول التقنية المتقدمة لضمان السلامة وكفاءة الطاقة والاستدامة البيئية للمشروع.

النتيجة هي تصميم شامل يوازن بين الاحتياجات التعليمية وراحة المعلم، مما يعزز بيئة تعليمية مستدامة ومنظمة. ويختتم المشروع بتوصيات لدعم حكومي وتعاوني لتنفيذ هذه المبادرة، الهادفة إلى تحسين معايير التعليم في المنطقة.

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Chapter One
(Introduction)

- Project title.
- Definition of the project.
- The importance of the project.
- Financing party.
- Project objectives.

• Project title :

Elementary , Intermediate School for boys and Teachers Housing .

• Definition of the project :

It is an elementary and Intermediate school project; it aims to teach the child the basics of reading, writing and arithmetic, in addition to enhancing his basic knowledge in various subjects such as science, social studies, arts, etc. Elementary schools aim to develop students' personal and social skills by organizing appropriate activities and promoting the values of cooperation, respect and responsibility.

• The importance of the project:

The role of the school is not limited to science and study only:

a. Helping to build many social relationships.
b. Reducing social differences between students.
c. Development and progress of society.
d. Developing the student's talents and abilities.

• Financing party :

Ministry of Education.

• Nature of the project :

The project is an educational project.

• Project objectives :

General objectives :

- Providing a safe educational environment that encourages learning.
- Achieving educational quality through modern curricula and qualified teachers.
- Instilling social values such as cooperation and respect.
- Promoting the use of technology in education.
- Preparing students for the labor market and developing their practical skills.

Specific objectives :

- Improving students' academic achievement.
- Training and developing teachers' skills.
- Enhancing extracurricular and sports activities.
- Building partnerships with the local community.
- Supporting students psychologically and socially.
- Improving school resource management.
- Developing school facilities.

2

Chapter Two
(Data Collection)

- Basic project components.
- Project classifications.
- Design principles for schools.
- Similar models.

- **Basic project components :**

Schools consist mainly of classrooms, practical laboratories, offices for teachers, and general services for students and teachers, in addition to some recreational and social activities.

Main Activities

(2-1)

- **Project classifications :**
  - *Schools By type:*

- Government schools: Government and public budget funding.
- Private schools: Private entities and depend on funding for school-based schools.

  - *Schools By education:*

- Public schools: Extend basic or national education, and are formally taught by the Ministry.
- Boarding schools: Offer a globally recognized Irish curriculum such as the International Baccalaureate (IB), or classical, British, and other models.

  - *Schools By level of education:*

- Fundamental schools: Offer education for children from kindergarten through the end of sixth or seventh grade.
- Middle/preparatory: Offer ambitious education from seventh to ninth or tenth grade.
- Secondary schools: Offer education from tenth to twelfth grade (or whatever).

  - *Schools By specialization:*

- Comprehensive public schools: Offer educational programs in all specializations.
- Valid or conference schools: Original on vocational or technical education, such as crafts, mechanics, and the arts.
- Sports or cultural schools: Accept training in a specific sports or cultural field.

  - *Schools In terms of gender:*

- Sports schools: training course for both sexes.
- Schools for boys: for male students.
- Schools for girls: for female students.

  - *Schools In terms of special education:*

- Special educational schools: provide services for children with special needs.

Design principles for schools

1. In terms of planning :

a. Location :

The location, whether in a city, suburb or countryside, is what determines the minimum or maximum requirements needed to build a primary school and the percentage of use of the location in construction or for various services.

The location is what determines the minimum or maximum requirements needed to build a primary school and the percentage of use of the location in construction or for various services.

b. Site specific requirements :

- The general planning must take into account the orientation of the classrooms towards the north or west.
- The school site must overlook at least one street with a width of no less than 6 m.
- The location must be on private or secondary streets, so that the distance traveled by the child does not exceed 12 kilometers.
- It should be away from noise sources, factories and amusement parks that affect young children or the elderly.
- The site should be in the middle of services, hospitals and fire stations, and the surrounding landscape should be healthy and not cause any visual pollution.
- The distance between the school and the neighbor should not be less than 3 meters to prevent noise from reaching neighboring buildings.
- Build a fence of trees or any other material that does not obstruct the view.

c. Set location:

- Is it regional, designated to serve a large area with high density, and therefore its area must be proportionate to the number that the school will serve, or is it designated for a limited area with low population density, and therefore there is no need for a large area.

d. Surrounding conditions :

It includes several points :

- Noise, vibration and interference.
- Environmental pollutants such as factories and others that the area must be free of.

e. Site Requirements :

- Vehicle Requirements
- Maintenance equipment for the building so that there is no danger to the students' lives from collapse. Carry out the necessary repairs to the building periodically.

- Facilities, their availability and ease of delivery to the site.
- Miscellaneous Ambulance, Fire, Security.
- A sewage network as well as a drinking water reinforcement network. Urban planning of the site.

f. Vehicle parking:

Requirements to be observed:

- Parking for visitors, administration and student buses should be separated.
- The location of the parking spaces should not lead to conflict between the movement of cars and the pedestrian areas, to ensure public safety.
- Giving priority to school visitors' cars over administration and student cars, as they are clear and easy to use for those using them for the first time.

G. Criteria for selecting the location of entertainment facilities in the school's master plan:

- The relationship between its location and the neighboring buildings to avoid affecting these buildings with noise
- Soil stability and site topography
- The presence of adjacent wooded areas provides shade and oxygen and forms windbreaks.
- Choosing the right orientation to adjust the sun and wind movement.

2. School building :

- The entrance and several factors must be taken into account when choosing its location:
- The entrances should be expressive and in visible places that welcome the visitor, and a service entrance should be designated for supply vehicles to enter the warehouses to supply the tools and supplies necessary for the school.
- Avoid entrances located on main streets to ensure the general safety of children.
- It is better to have a separate entrance for teachers and another for students. In some designs, it may be better to have one entrance for teachers, students, and visitors.
- Doors must be able to be opened from the inside at any time, even after the school closes. Emergency exit signs must be placed to ensure that children can exit in the event of danger in the shortest possible time to avoid loss of life.

Planning requirements for school building :

- **First :**

The general orientation of the seasons is the north direction, and it is possible to deviate 25 degrees to the east or to the west of the north. If it is impossible to achieve this condition, other orientations can be permitted, with full provision of openings by means of sun breakers.

The maximum height (ground floor + 4 floors) is 18 m, taking into account building laws. The first floors are allocated to young first-year students. Services are placed so that they are close to the various elements of the building to achieve their purpose and ease of use.

- **Second :**

Educational spaces. The basic spaces necessary to accommodate the educational and pedagogical activities inferred from the analysis of current curricula were derived:

- *f. Classes :*

- It is suggested that the class capacity be 40 students.
- It is recommended that the student's share be 1.20 square meters.
- The classroom area is 48 square meters, or about 6.00-8.00%, and it is recommended that the classroom height not be less than
- About 3.0 meters, so the student's share of the classroom volume is 3.6 cubic meters.

- **Third :** Ventilation

Good ventilation in the classroom is a very important requirement for the health of students and to prevent the spread of epidemics among them. It is also important to create a good study environment.

- **Fourth:** Artificial lighting:

- lighting. In all cases, the classroom must be equipped with the necessary electrical supplies to fully illuminate it. Artificial lighting.
- To reduce the possibility of glare, care must be taken to avoid large changes in lighting within the visual field, so that the ratio between the intensity of the lighting of the object to be seen and the nearby surroundings and other surfaces in the visual field does not exceed 10 to 3 to 1 as a maximum.

- **Fifth:** Finishing materials:

The final surface of the walls must be able to withstand shocks, heavy use and continuous washing.

- Ceramic and brick are often unsightly despite their durability and low maintenance Plywood units can be used for walls.
- You should pay good attention to the materials of the partitions so that they do not allow sound to pass from one class to another. Also, the design that depends on the presence of warehouses between the classes is a good solution to reduce noise between the classes. The lower part of the classroom walls should be 1.80 - 2.00 meters high and made of a strong, solid material so that it is not affected by the tampering of the students. It is possible to maintain the cement whitewash painted with non-glossy lacquer.
- The room is equipped with blackout curtains to make it dark when using the projector.

- Flooring materials should be carefully selected so that they are easy to clean, can withstand constant washing, and do not produce any noise resulting from moving tables. Withstands hard work
- Light reflection: The colors of the classroom should be as light as possible, and it is preferable for the ceilings to be white to help
- It is not conductive to moisture and is not cold in winter.
- The walls should be in colours such as very light yellow, very light grey or very light pistachio.
- The colors of the furniture should match the colors of the classroom walls. It should be noted that the paints should not be shiny, so as to reduce the dazzle of the eye and so as not to affect the students' nerves.
- Using dark colors is a wrong idea (under the pretext that they do not show dirt)the lighting of the object to be seen and the nearby surroundings and other surfaces in the visual field does not exceed 10 to 3 to 1
  as a maximum

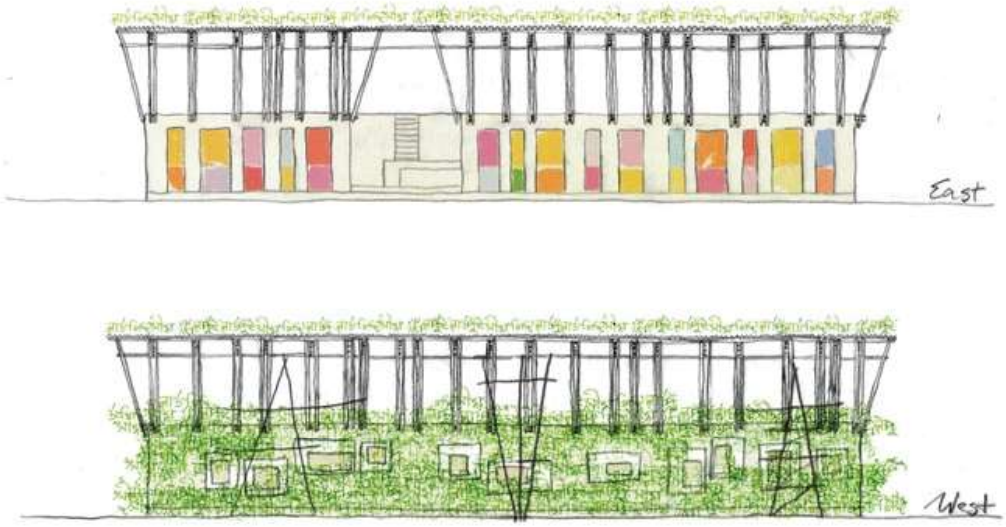
Similar models

A/ Global Model

- Earth Architecture: handmade school in Bangladesh

(2-2)

- This primary school in Rudrapur, a village in northwestern Bangladesh, was hand-built in four months by local architects, craftsmen, pupils, parents and teachers, using traditional building methods and materials but adapting them in new ways. The architects, Anna Eringer from Austria and Eike Roswaag from Germany, did their best to engage the skills of local craftsmen, helping them improve processes and learn new techniques that they could then use to improve the overall quality of rural housing.
- The philosophy of METI Modern Education and Training Institute is: Learning with joy. Teachers help children develop their own potential and use it in a creative and responsible way. The building reflects these ideas through materials, technologies and architectural design.
- The design solution used in this rural town may not be replicable in other parts of the Muslim world due to varying local conditions. However, new design solutions can emerge from in-depth knowledge of the local context and new construction methods. This provides a new and hopeful model for sustainable construction worldwide. The end result of this heroic volunteer effort is a building that creates beautiful, meaningful, and humane communal spaces for learning that enrich the lives of the children it serves.
- The construction method used is a historical floor building technique similar to the walls of a loaf of bread and is ideal for self-construction. The moist earth is mixed with straw and placed on the wall in layers. Each layer is about 50-70 cm high. After two days of drying, it is trimmed from the sides with a sharp trowel to obtain a uniform flat wall surface. After a second drying period, another layer can be added. The soil in this area is well suited for such construction and the stability of the mixture is improved by adding rice, straw and jute
- Earth construction: The most important technical improvement compared to traditional buildings is the introduction of a moisture-resistant course and a brick foundation. The traditional construction technique using very wet earth has been replaced by the "well" technique which is very similar to the traditional technique.
- The school building was built by experts and volunteers from Germany and Austria along with craftsmen, teachers, parents and students from Bangladesh during the period September to December 2005.
- The aim of the project is to improve existing construction techniques, to contribute to sustainability by utilizing local materials and labor and to enhance regional identity.



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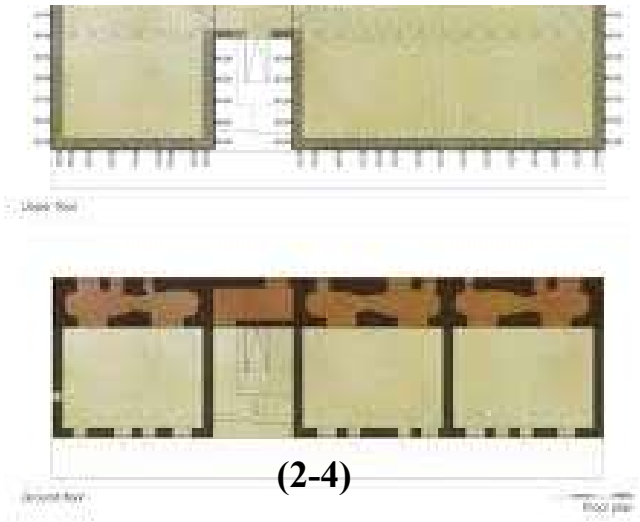

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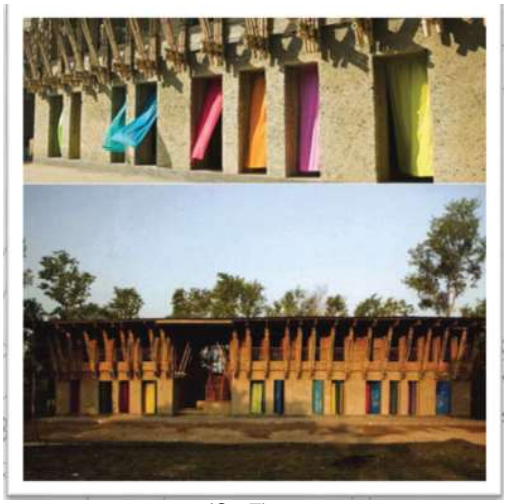


(2-5)

(2-6)

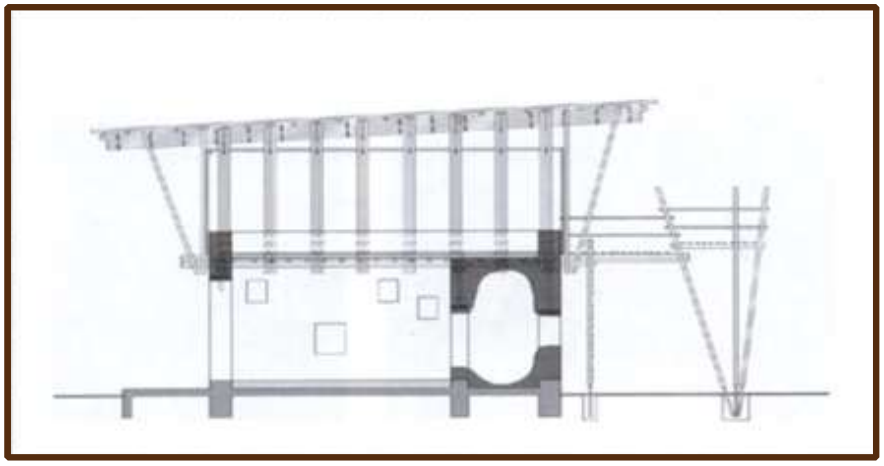
Study (criticism of the similar model) :

a. General introduction:

- This model is very good as it is located in a completely rural area. The architect used local building materials which made the project cost low and also kept up with the symbolic style of the people of the region and applied their symbolism and identity, which is what the desired project calls for.

b. Advantages of the model :

- Achieving the main function called for by the project in a simple manner that keeps pace with the identity of the region, while providing the appropriate environment for the function (natural ventilation and lighting).
- As for the structural system, the support for the ceilings was achieved by means of reed sticks, as they are called in the villages of northern Sudan, instead of concrete columns and beams, by means of connecting them.
- With the help of the same material, I made the structural connection strong to hold the zinc sheets in the roof. As shown in the following section: (2-7)



(2-7)

c. Disadvantages of the model:

- Not addressing the integration of civilization and modern design in any section of the project, as keeping pace with civilization, especially in educational projects, is a very important matter to improve the skills and abilities of children when learning, to improve their ideas for developing the future, and this is done by teaching them in modern and up-to-date ways, not the opposite.

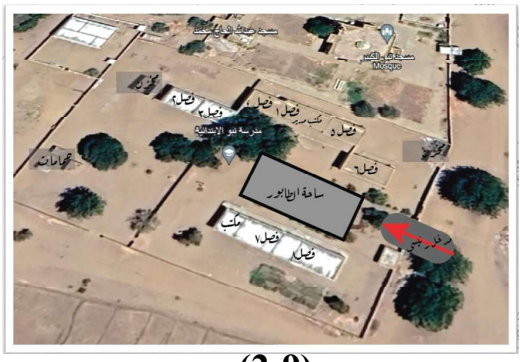
B/ Tabo Primary School

Location - Northern State / Al-Saleem / Tabo Village / About 30 km north of Dongola City

- School area: 5700 square meters
- School perimeter: 307 meters
- The school's surroundings: from the east and south, an agricultural area, from the west, Tabo Girls' School, from the north, Tabo Grand Mosque, the health center, and the mixed secondary schools.

(2-8)

- Number of classes: 8 classes
- The capacity of each class: 30 students only, with an average area of 70 square meters.
- Number of offices: 2
- Office capacity: 3 teachers / 30 square meters
- Area and capacity of the queue yard: 400 square meters, capacity for 240 students
- Structural systems: Foundation system (an old building system similar to load-bearing walls)
- Building materials: green bricks for walls, light zinc for roofs and cement tiles for floors.



(2-9)

(2-10)

Criticism of the school:

- The distribution of chapters is irregular, as there are some chapters that are very peripheral and difficult to monitor.
- And control it also away from the queue area
- Uneven distribution of desks in classrooms
- No labs - proces
- Services are very peripheral and out of reach from some classrooms.
- Classes are lined up side by side making noise to each other.
- There is no place to prepare and serve food inside the school.

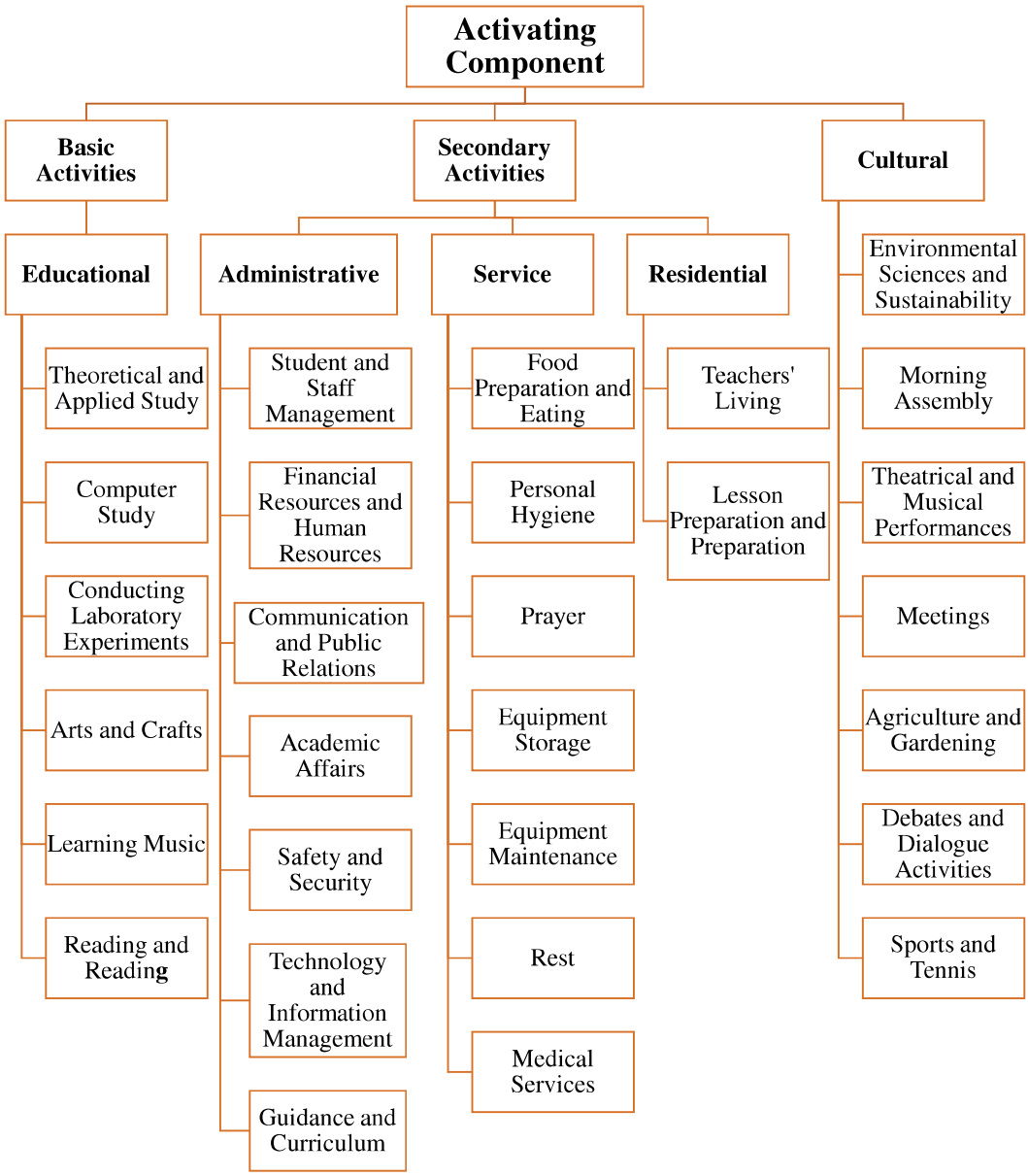
3

Chapter Three
(Project Analysis)

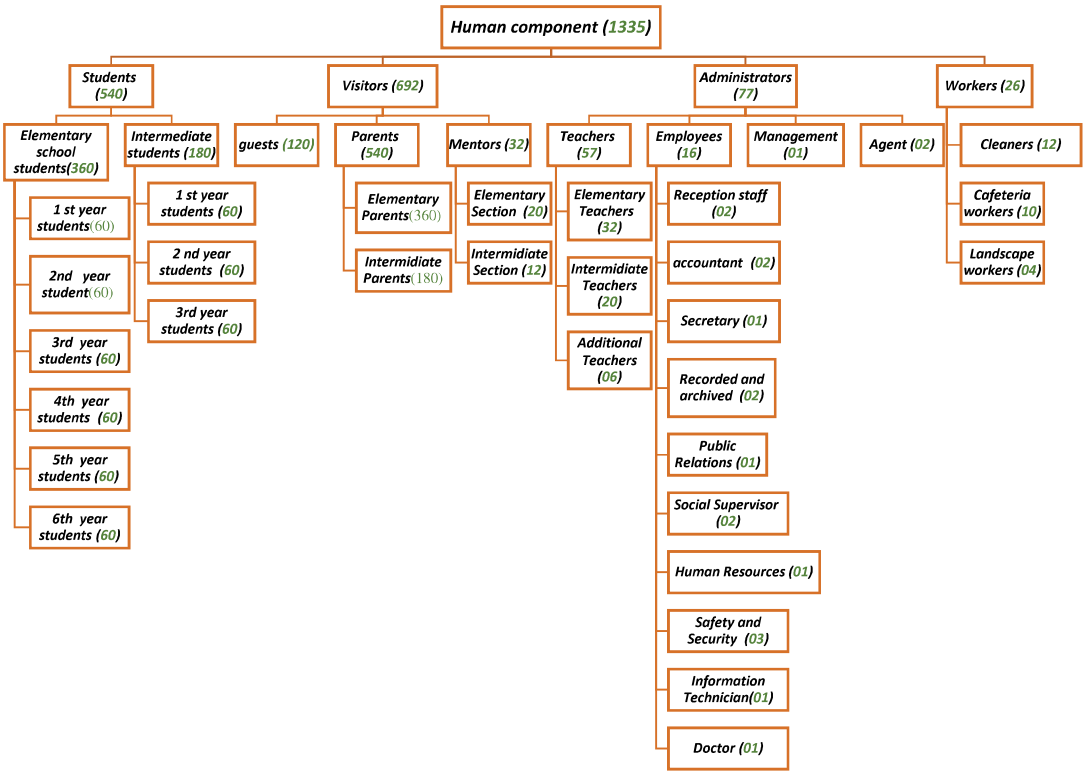
- Project components.
- General pyramid scheme.
- General bubble chart.
- General Movement Chart.
- Study of Spaces.
- Table of Spaces.
- Study the proposed sites.
- Site Preferabilities
- Indicators and Zoning.
- Table of indicators and Constraints.

1. Project Components

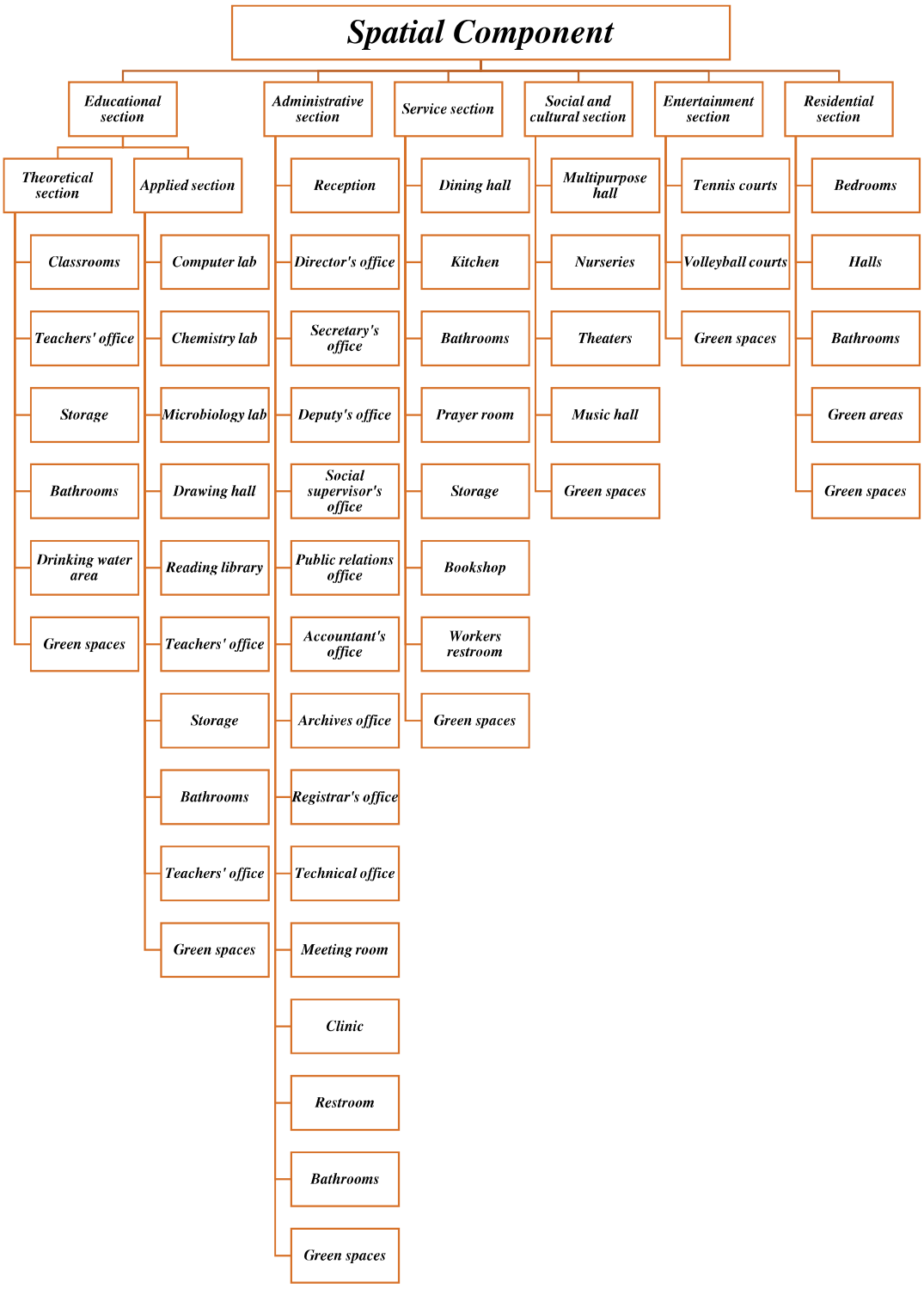
1. Activating component :



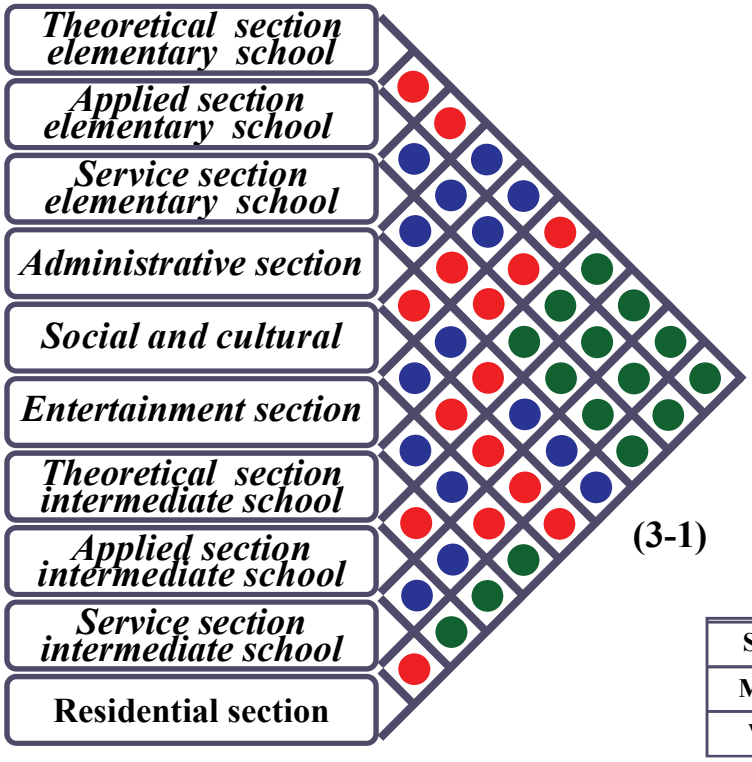
2. Human component



3. Spatial component



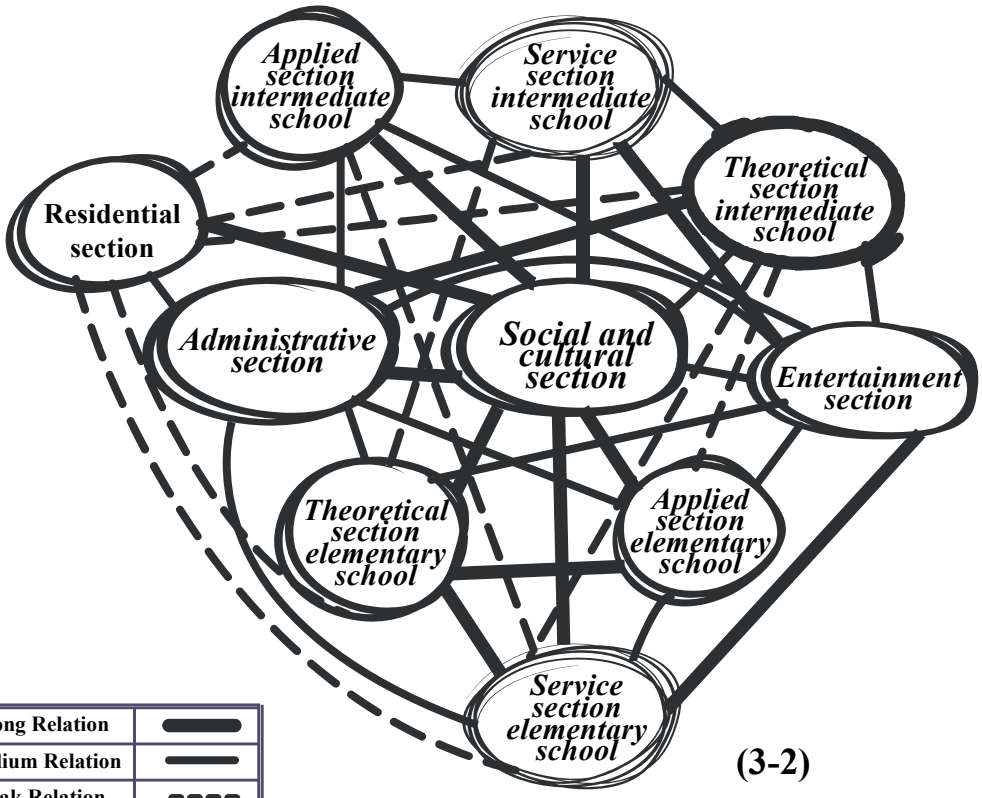
2. General pyramid scheme



(3-1)

Strong Relation	●
Medium Relation	●
Weak Relation	●

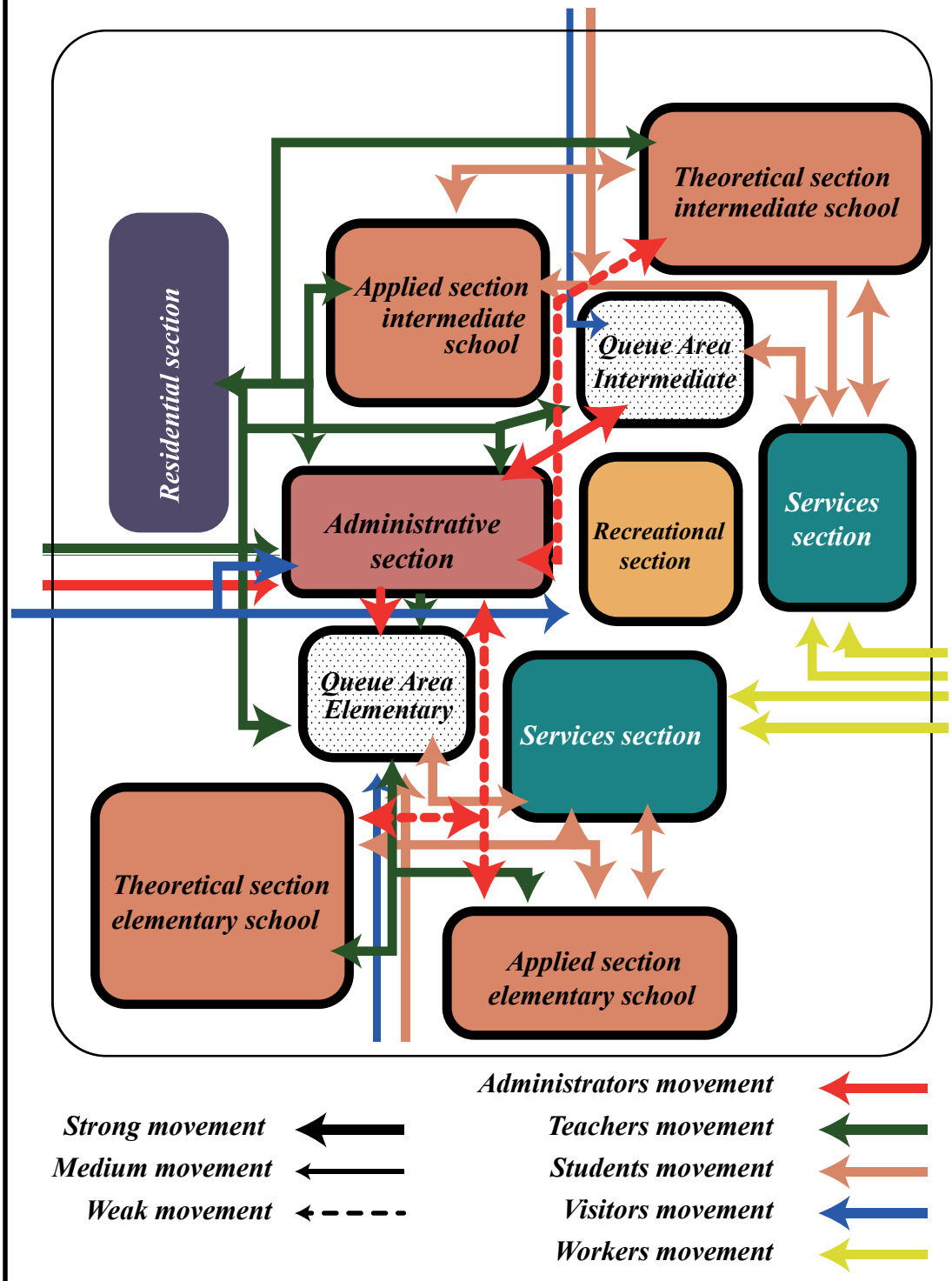
3. General bubble chart



Strong Relation	▬
Medium Relation	▬
Weak Relation	- - - -

(3-2)

4. General Movement Chart



(3-3)

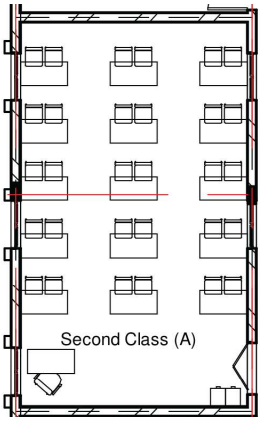
4. Study of Spaces

1. Classrooms :

Classroom Design Standards :

- Classroom design depends on several basic criteria that aim to provide a comfortable and effective learning environment. Here are some of the most important basics:

(3-4)



(3-5)

Space and dimensions

Ideal number of students The classroom space should be sufficient to accommodate the number of students comfortably without feeling crowded. The general rule is that the classroom should allow students space to move and sit comfortably.

Blackboard size

The blackboard space should be appropriate for the number of students, so that students throughout the classroom can easily see the writing on it.

Layout

It is best to distribute students in an arrangement that ensures a clear view of the board, with seats placed in rows or groups that suit the teaching style (direct or group).

Ventilation:

The classroom must have adequate ventilation to maintain fresh and healthy air, which positively affects students' concentration and performance.

Geographical orientation

It is preferable for the larger side of the classroom (which contains the windows) to be oriented towards the north or northwest, where the sun's rays are more moderate during the day, which helps improve natural ventilation and reduce exposure to direct sunlight.

Lighting

The classroom should have sufficient natural lighting through the windows. Natural light enhances mental activity and reduces visual stress.

Artificial lighting :

Artificial lighting should be appropriate for the classroom, so that it is not too bright or dim. It is preferable to use lighting that is evenly distributed throughout the classroom to avoid dark areas.

Aesthetic Design

Colors and Decor: It is preferable for the classroom to be decorated with comfortable and creative colors, such as calm colors that do not distract attention.

Decorations: Adding some decorations and paintings that encourage creativity and education can add a positive atmosphere inside the classroom.

(3-6)

Sizes and types of drawers in the classrooms

Schools platform

It is placed next to the board, and the distance between it and the first seat is 2-5 m (its length is 5 m, its width is 0.5 m, and its height is 25 m). It is made of wood and painted in a color that can withstand use. The platform may not be placed if there is no designated place for it or when saving on expenses.

(3-7)

Students' desks : there are two types of them.

A- Fixed type : (the seat and writing board are fixed together).

B- Non-fixed type: The seat is free-standing in the form of a chair and the writing board is in the form of a free-standing desk.

These seats are arranged in many positions and these positions are carefully implemented. The following pictures show examples of them.

(3-8)

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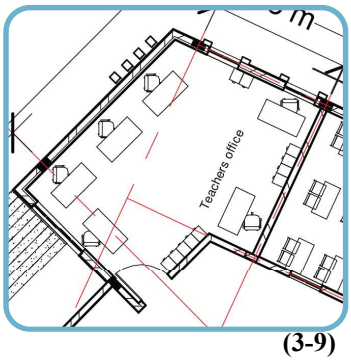
2. Offices :

Offices Design Standards :

The design of teachers' offices is an essential part of designing an educational environment, significantly impacting teachers' comfort and performance. Office design standards must take several aspects into account to provide a comfortable and effective work environment. Here are some key criteria to consider:



(3-9)

1. Space

The office space should be sufficient for the number of teachers working in it, and each teacher should have space to organize their tools and personal files.

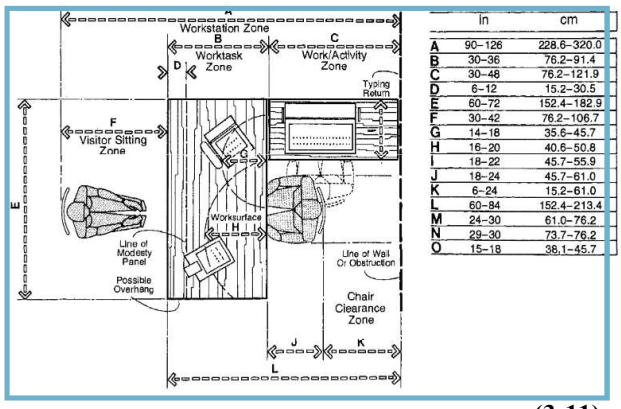
The recommended area for a single office typically ranges between 8-12 square meters, depending on the number of teachers and the type of activities they will be performing in the office.

(3-10)

2. Ventilation and Lighting

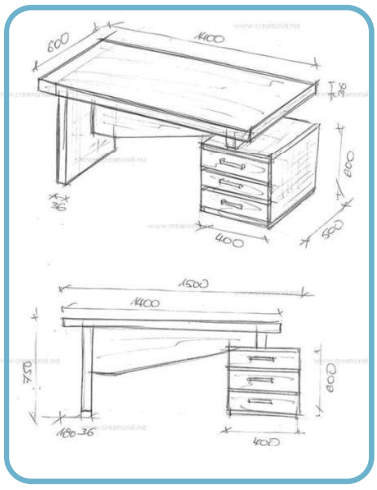
Natural ventilation is one of the most important factors affecting teacher comfort. Offices should be designed to provide good airflow, whether through windows or vents.

Lighting should be as natural as possible, with artificial lighting



	in	cm
A	90–126	228.6–320.0
B	30–36	76.2–91.4
C	30–48	76.2–121.9
D	6–12	15.2–30.5
E	60–72	152.4–182.9
F	30–42	76.2–106.7
G	14–18	35.6–45.7
H	16–20	40.6–50.8
I	18–22	45.7–55.9
J	18–24	45.7–61.0
K	6–24	15.2–61.0
L	60–84	152.4–213.4
M	24–30	61.0–76.2
N	29–30	73.7–76.2
O	15–18	38.1–45.7

(3-11)



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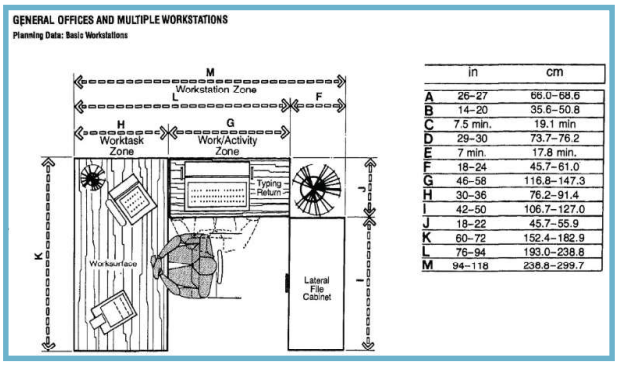


	in	cm
A	26–27	66.0–68.6
B	14–20	35.6–50.8
C	7.5 min.	19.1 min
D	29–30	73.7–76.2
E	7 min.	17.8 min.
F	18–24	45.7–61.0
G	46–58	116.8–147.3
H	30–36	76.2–91.4
I	42–50	106.7–127.0
J	18–22	45.7–55.9
K	60–72	152.4–182.9
L	76–94	193.0–238.8
M	94–118	238.8–299.7

(3-13)

that is gentle on the eyes and provides good illumination for reading and working.

It is preferable to place desks near windows to maximize the use of natural light, taking into account the orientation of windows to avoid direct glare.

3. Privacy

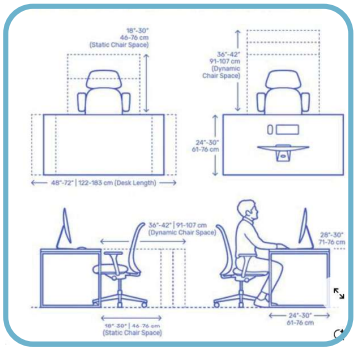
Offices should provide a degree of privacy for each teacher, whether through partition walls or surface design to give the teacher a personal workspace.

Open desks with adjustable partitions can be used to balance collaboration and privacy.

4. Comfort and Equipment

The chair should be comfortable, supportive, and height-adjustable. Provide tables or desks with sufficient space for computers, books, and papers, with a design that facilitates access to school supplies.

Storage spaces, whether cabinets or drawers, should be provided for teachers' files and supplies.



(3-14)

5. Safety

Furniture and equipment should be safe for teachers, with no sharp edges, and furniture should be securely secured to avoid accidents.

Nightlighting or additional lighting should be provided if work is needed after school hours.

6. Sustainability

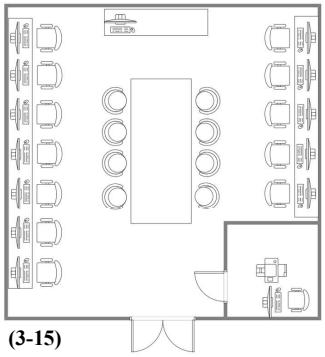
It is preferable to use environmentally friendly materials in furniture and office design, such as recycled wood or materials that consume less energy.

Provide energy-saving systems, such as LED lighting or natural ventilation systems, to help reduce energy consumption.

3. Computer Lab

1. Space

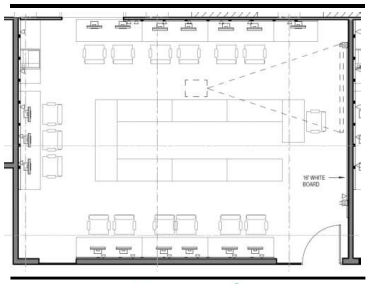
The space must be sufficient to accommodate the required number of devices, with sufficient space between tables to facilitate student and teacher movement.
The distance between each computer must be calculated to ensure each student has enough space to interact with the computer comfortably.
It is preferable to have at least 2 square meters of space per computer to ensure comfortable use.



(3-15)

2. Ventilation and Lighting

Good ventilation is crucial in computer labs, as electronic devices can cause overheating. Natural ventilation should be provided or an appropriate air conditioning system should be used.
Lighting should be balanced to provide adequate illumination for computer work and avoid reflections on the screen. It is preferable to use artificial lighting using LED technology, which saves energy and diffuses light evenly.
It is preferable to position windows so that natural light does not shine directly onto computer screens.



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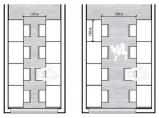
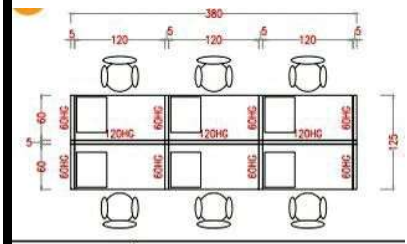
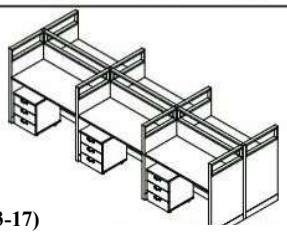


3. Planning and Space Distribution

Table Arrangement: It is preferable to arrange the tables in a way that allows each student to sit comfortably in front of a computer. Tables can be arranged in parallel rows or in a circular system to facilitate communication between the teacher and students.
A designated area can be provided in front of the teacher containing a computer and other educational tools, allowing the teacher to monitor and assist students while they use the devices.

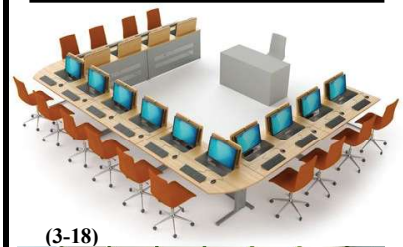




(3-17)

4. Equipment

Use scratch-resistant, easy-to-clean surfaces.
Provide comfortable seating that supports proper student posture.



(3-18)

(3-19)

6. General Spaces Table

Section Area m2	Total area m2	Area of one space m²	Number of spaces	Space Name	Section Name
2370	960	80	12	Classrooms	Theoretical section elementary school
	320	80	4	Outdoor Classroom	
	160	20	8	Teachers' office	
	36	9	4	Drinking water space	
	54	1.5	36	Bathrooms	
	200	50	4	Stores	
	640	320	2	Green Space	
1188	480	80	6	Classrooms	Theoretical section intermediate school
	160	80	2	Outdoor Classroom	
	80	20	4	Teachers' office	
	18	9	2	Drinking water space	
	30	1.5	20	Bathrooms	
	100	50	2	Stores	
	320	320	1	Green Space	
563.5	80	40	2	Computer lab	Applied section elementary school
	35	35	1	Chemistry lab	
	25	25	1	Microbiology lab	
	60	60	1	Drawing hall	
	60	60	1	Reading library	
	40	20	2	Teachers' office	
	13.5	1.5	9	Bathrooms	
	250	250	1	Green Space	
793.5	120	60	2	Computer lab	Applied section intermediate school
	55	55	1	Chemistry lab	
	55	55	1	Microbiology lab	
	80	80	1	Drawing hall	
	80	80	1	Reading library	
	40	20	2	Teachers' office	
	13.5	1.5	9	Bathrooms	
	350	350	1	Green Space	
1200.5	350	350	1	Dining hall	Service section elementary school
	70	70	1	Kitchen	
	35	35	1	Cocking store	
	150	150	1	Prayer room	
	37.5	1.5	25	Bathrooms	
	60	60	1	Ablutions	
	76	38	2	Storage	
	48	24	2	Workers restroom	
	24	24	1	Bookshop	
	350	350	1	Green Space	
856.5	200	200	1	Dining hall	Service section intermediate school
	65	65	1	Kitchen	
	25	25	1	Cocking store	
	150	150	1	Prayer room	
	22.5	1.5	15	Bathrooms	
	40	40	1	Ablutions	
	76	38	2	Storage	
	48	24	2	Workers restroom	
	30	30	1	Bookshop	
	200	200	1	Green Space	
567	50	50	1	Reception	Administrative section
	32	32	1	Director's office	
	9	9	1	Secretary's office	
	48	24	2	Deputy's office	
	48	24	2	Social supervisor's office	
	16	16	1	Public relations office	
	20	20	1	Accountant's office	
	42	42	1	Archives office	
	64	32	2	Registrar's office	
	16	16	1	Technical office	
	86	86	1	Meeting room	
	16	16	1	Clinic	
	96	48	2	Restroom	
	24	2	12	Bathrooms	
1994	800	400	2	Queue Area	Social and cultural section
	130	65	2	Theaters	
	18	18	1	Buses Parking	
	450	450	1	Multipurpose hall	
	500	250	2	Nurseries	
	96	48	2	Music hall	
1136	420	420	1	Tennis courts	Entertainment section
	324	162	2	Volleyball courts	
	32	32	1	Seating Aera	
	360	360	1	Green area	
2062.5	800	16	50	Bedrooms	Residential section
	375	25	15	Halls	
	112.5	2.5	45	Bathrooms	
	375	15	25	Kitchen	
	400	100	4	Green areas	
12731.5					Total sections Area

Built-up area	9843.5
Corridors Space 20%	1968.7
The Total built-up area	11812.2
Total Outdoor Area	2888
The entire project area	14700.2

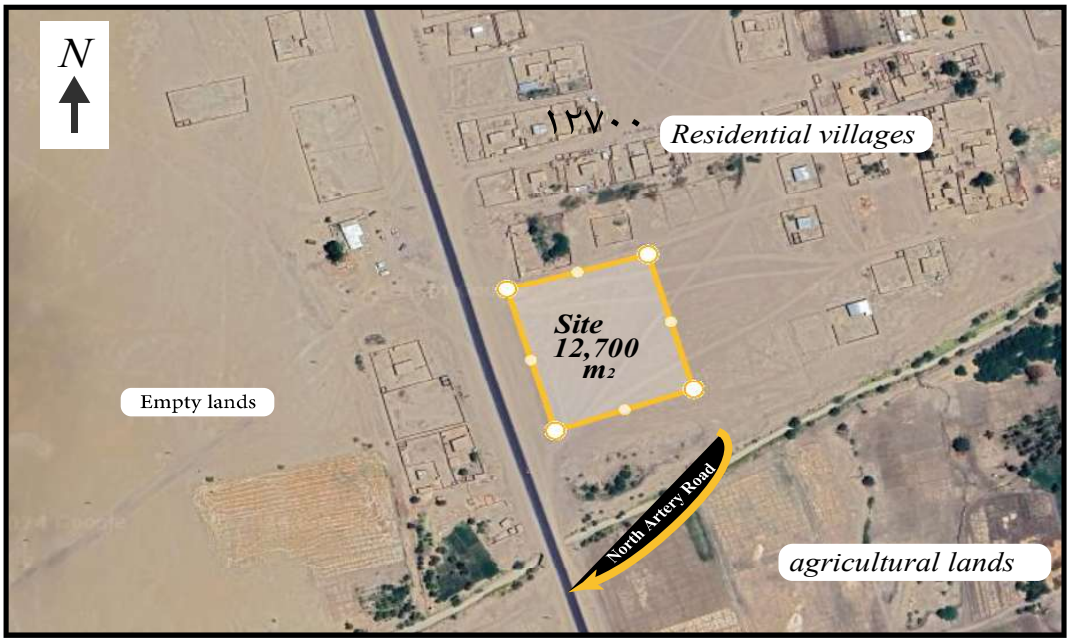
The total project area at coverage rate = 60%	19687

Table (3-1)

7. Study the proposed sites

First Site

- *Address: Dongola - Al-Sleem - North Artery Road - South Section*
- *Area: 12,700 Square Meters*
- *Adjacent areas: From the north residential villages, from the south agricultural lands, from the east residential villages.*

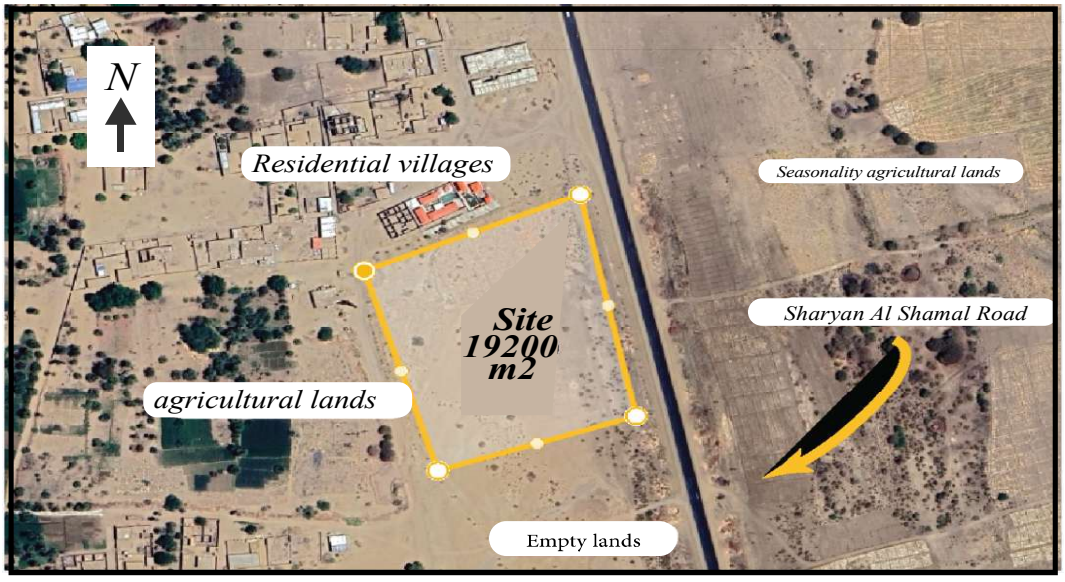


(3-20)

Second Site

- *Address: Dongola - Kadroka - Sharyan Al Shamal Road -*
- *South of Kadroka School.*
- *Area: 19,200 square meters*

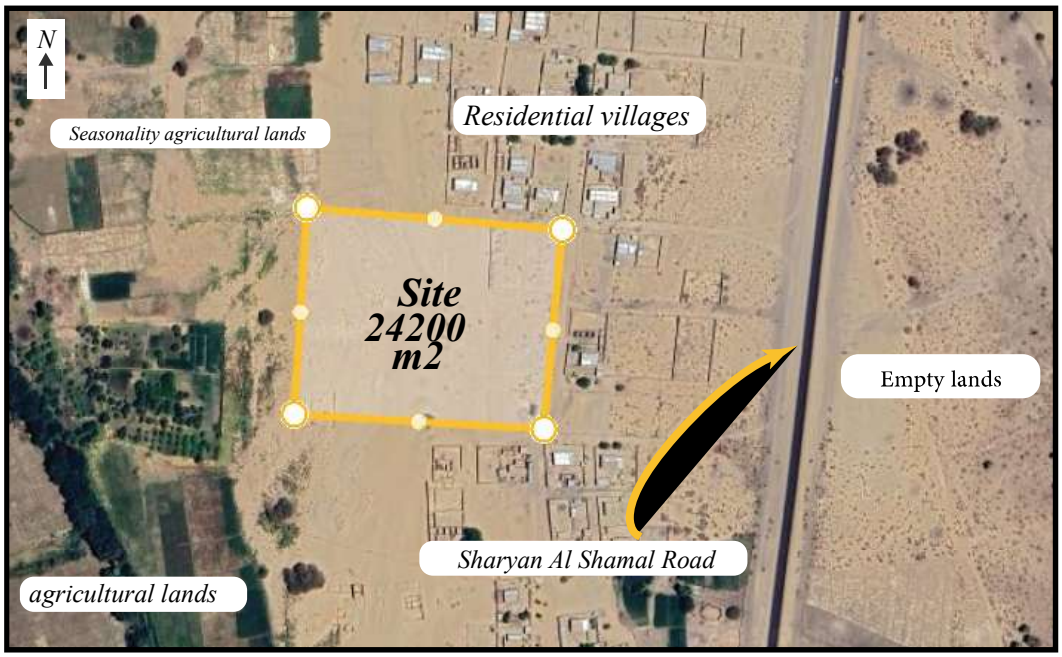
Adjacent areas: From the north residential villages, from the south vacant lands, from the east Sharyan Al Shamal Street, from the west residential villages.



(3-21)

Third Site

- *Address: Dongola - Kadroka - North Artery Road - South of*
- *Kadroka School.*
- *Area: 24200 square meters*
  Nearby areas: From the north, residential villages, then Kadroka Market, and the east and south, residential villages, and also from the east, North Artery Street, from the west, seasonal agricultural areas



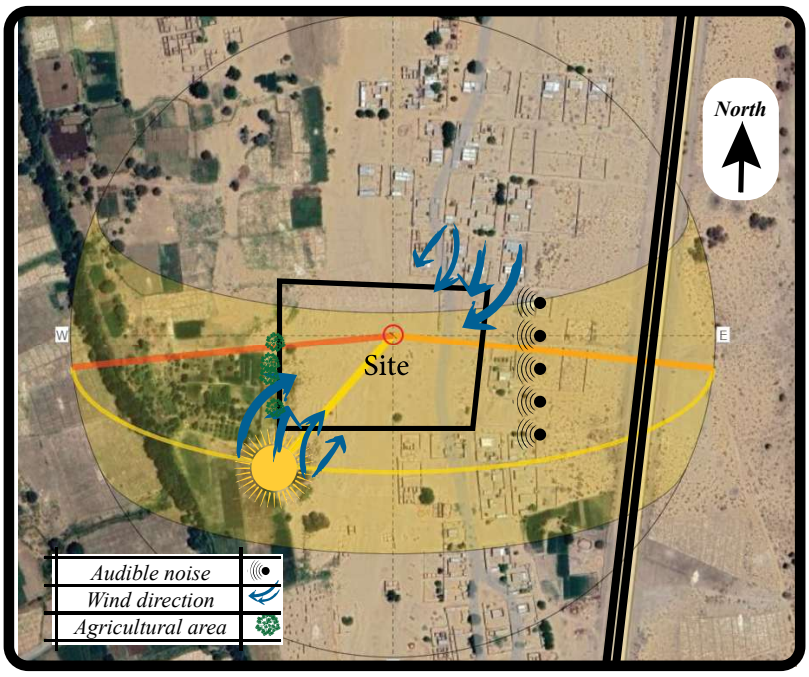
(3-22)

8. Site Preferabilities

Item	First Site	Second Site	Third Site
Accessibility	• It is about 9 kilometers away from Dongola City Bridge. • it is easily accessible from the villages of Imani, Al-Dom, Al-Hamid Narti, and Kadruka via the Shirian alshimal street. • It is closer to Dongola City, Al-Saleem, and Imani, and further from the northern villages.	• It is about 16.5 kilometers away from Dongola City Bridge, and is easily accessible from the villages of Imani, Al-Dom, Hamid Narti, and Kadruka via the North Artery Street. • It is considered to have a medium access distance, closer to the northern villages and Imani, and further from the villages adjacent to Dongola City and Al-Saleem.	• It is about 32 kilometers away from Dongola City Bridge, and is easily accessible from the villages of Biyoud, Al-Dom, Hamid Narti, and Tabo via the North Artery Street. • It is considered a relatively long distance away, closer to the northern villages and Tabo, and further than the villages adjacent to Dongola City and Al-Saleem.
20%	18%	15%	15%
Adjacent	• It is surrounded by residential villages from the north and east, which are considered quieter (more noisy than the neighboring villages) • It is surrounded by agricultural lands from the south and the road from the west.	• It is surrounded by one residential village from the west only (less noise impact on the neighboring village). • It is surrounded by agricultural lands from the south and north and the road from the east.	• One of its neighbors is the Kadrakah Market, which is considered the noisiest, as it contains blacksmith workshops. • The site is distinguished by its greater popularity, as it is located in an area with a relatively large population density.
20%	12%	10%	18%
Service Range	• In the short term, it serves about 8 villages east of the road, but on the western side there are no villages (empty areas) • In the long term, it serves the city of Dongola, Al-Saleem, and the island of Maqasir and the villages (Imani - Al-Dom - Hamid Narti - Tabo)	• In the short term, it serves about 15 villages west of the road, but there are no villages on the eastern side (empty areas). • In the long term, it serves the villages (Al-Sir - Mujarrab - Imani - Al-Dom - Hamed Narti - Tabu - Shaiqmar - Kadrakah - Kodi - Bayoud - Kaltos).	• In the short term it serves the villages of Kadrakah and Tabu located in the western part of the site, and on a larger scale it serves Hamid Narti, Al Dom, Kodi, Bayoud, Kaltos and more than 5 other villages.
20%	12%	14%	16%
Area	12,700 m²	19,200 m²	24,200 m²
20%	10%	15%	17%
Service supply	• `Public electricity: 11 kV coverage lines on the main road, the northern artery (directly west of the site). • Drinking water: Tanks Near Al-Tawhid Mosque, the northern and northeastern village of the site.	• Public Electricity: 11 kV coverage lines on the main road, Sharyan Al Shamal (directly east of the site) • Drinking Water: Tanks Near the small mosque of Al Dom village	• Public Electricity: 11 kV coverage lines on the main road, the northern artery (directly east of the site). • Drinking Water: Tanks Near the site. Where the hospital is
20%	12%	08%	12%
100%	64%	62%	78%

Table (3-2)

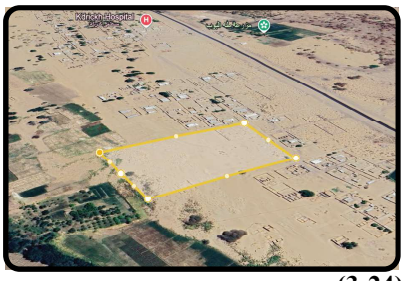
3-8. Study and analysis of the selected project site



(3-23)

1. Geographical location:

Geographical coordinates:



(3-24)

The site is located in the north of Sudan, near the North Artery Road.
Approximate coordinates of the site:
Latitude: 19.5° North
Longitude: 30.5° East
Relationship to neighboring areas:
The site is close to the city of Dongola (which is considered the center of the Northern State).
The area contains agricultural areas and pastures, which makes it useful in architectural planning for sustainable development.

2. Climate :

Temperatures:

The annual average temperature in the area is usually high in summer, with temperatures ranging from 35° to 45° Celsius.
Maximum temperatures may sometimes reach 50° Celsius in the summer months.
Minimum temperatures in winter may reach 10° Celsius.
Summer (May to September) is the hottest period, while winter (November to January) has more moderate temperatures.

Rainfall:

The annual average rainfall in the area ranges from 150 mm per year.
The rainy season usually starts from June to September, which is the season that witnesses an increase in rainfall.

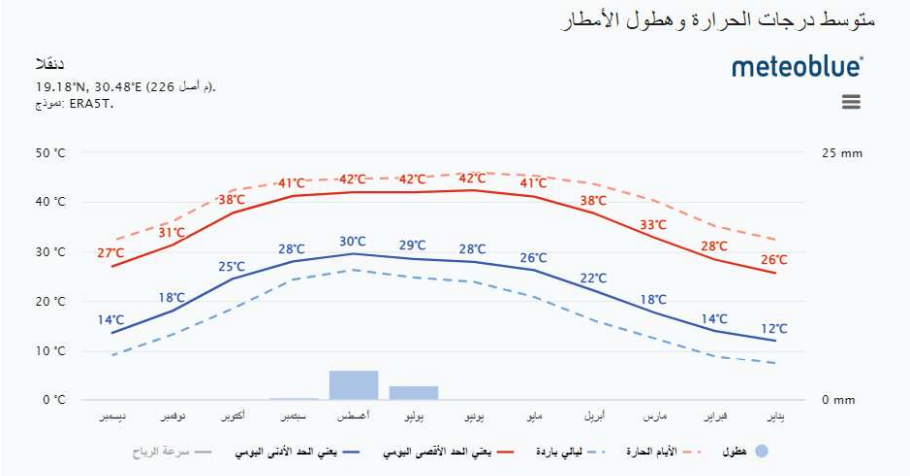
Rainfall:

The annual average rainfall in the area ranges from 150 mm per year.

The rainy season usually starts from June to September, which is the season that witnesses an increase in rainfall.

The amount of rainfall is low to moderate,

The annual Due to the limited rainfall in the region, long dry seasons can occur that may reach 9 months a year.



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(3-26)

Humidity:

The humidity in the region is low in the summer and reaches about 25%, while humidity is higher during the rainy season.

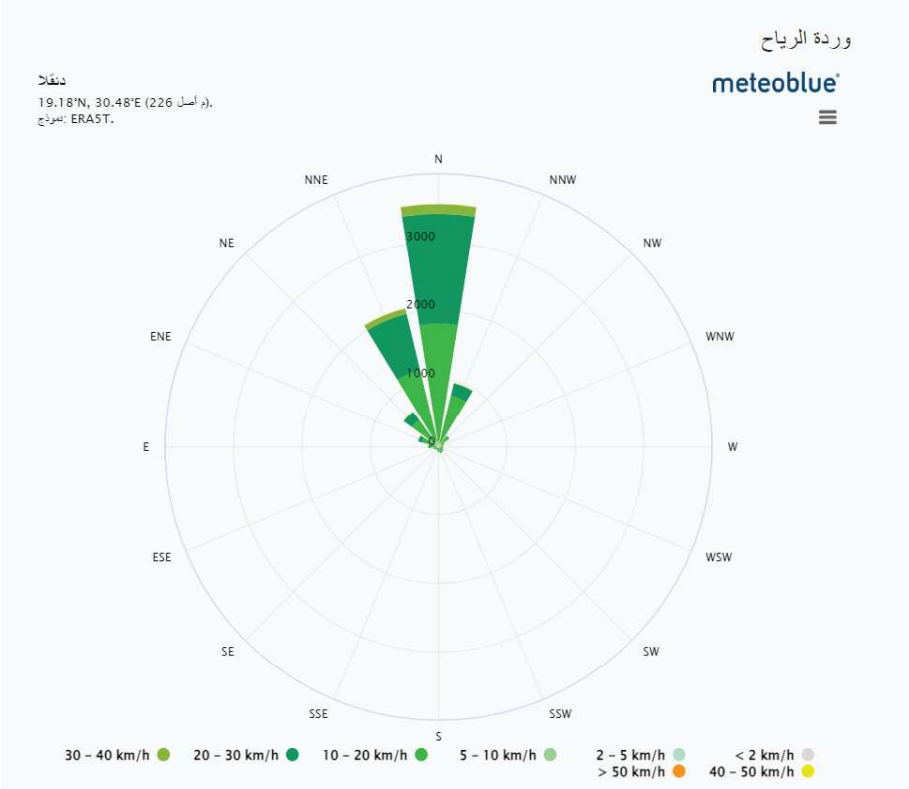
3. Wind :

Wind direction

The prevailing winds in the region are north-easterly and south-westerly winds. At certain times of the year, the region may be affected by seasonal sand-laden winds (meteor winds).

Wind speed:

The winds in the region are moderate to strong, and wind speeds sometimes reach 20-30 km/h. Winds may be stronger in the spring (from March to May).



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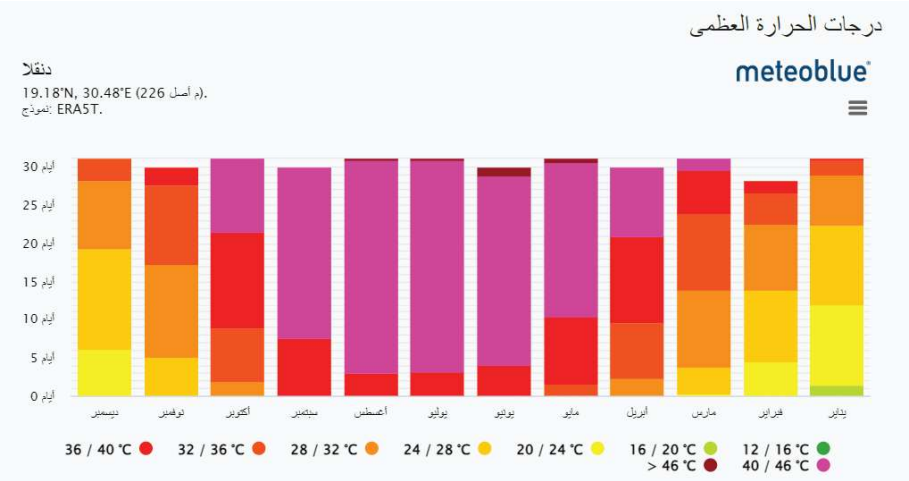


(3-29)

Architectural effects::

TWinds may affect the design of buildings, so protective walls must be installed or the natural operation of ventilation must be improved to reduce heat.

Natural ventilation is very important in hot regions as it contributes to mitigating the effect of extreme heat.

4. Soil :

Soil type :

The soil on the site varies between clay and sandy soil

Geological analysis:

The area is not prone to earthquakes, as it is considered a geologically stable area, Some areas with sandy soil may need to strengthen the foundations.

Groundwater depth:

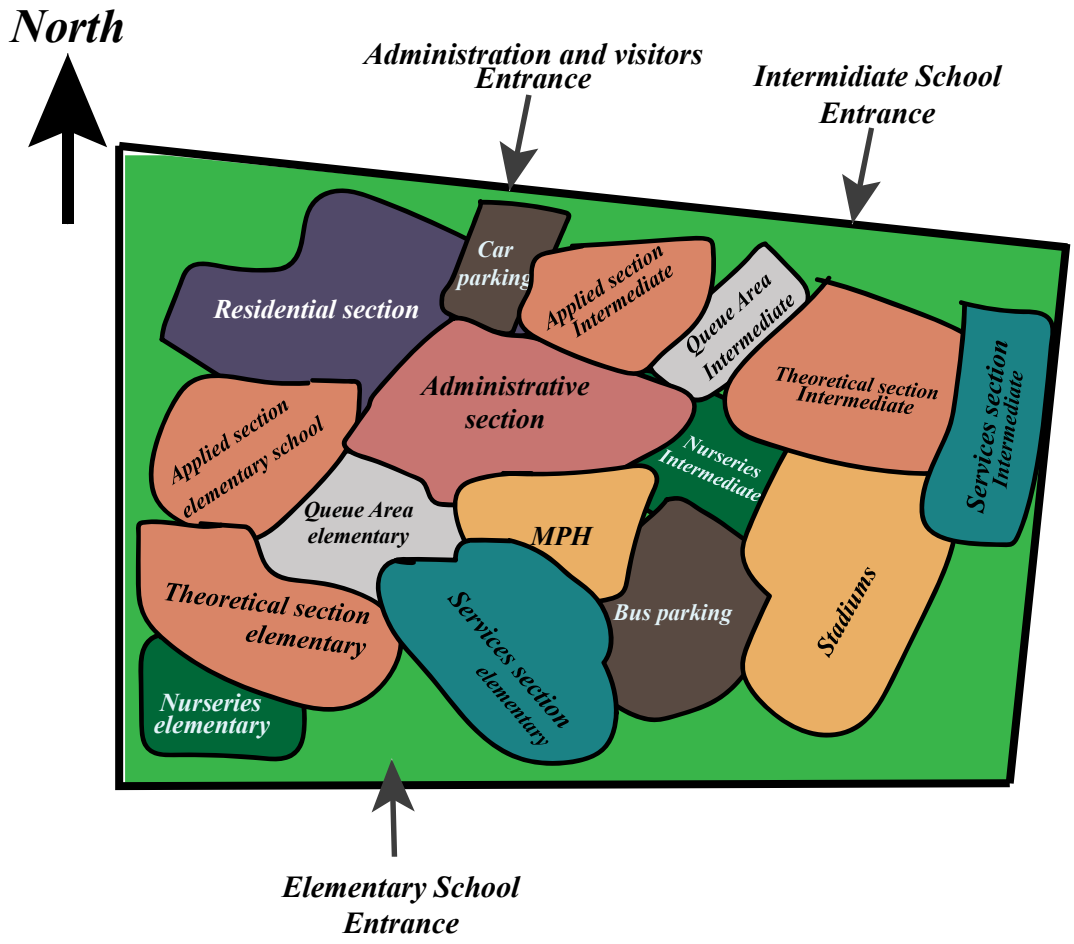
The depth of groundwater in the area varies, and may be between 10 to 20 meters in some places.

3-10 Table of indicators and Constraints

Field	Indicators	Constraints	Solutions
Climate	Extreme Heat	- High temperatures reaching up to 50°C in summer.	- Design buildings with heat-resistant materials such as fired brick or adobe.
	Low Rainfall	- 50-200 mm annually, rainy season from June to September.	- Design rainwater harvesting systems for irrigation and other uses.
	Low Humidity	- Humidity levels range from 15-25% throughout the year.	- Ensure good ventilation inside buildings using upper vents and large windows aligned with prevailing wind directions to minimize humidity effects.
Topography and Soil	Flat or Slightly Sloped Terrain	- The area is generally flat, but may have slight slopes affecting water drainage.	- Design an efficient drainage system and ensure stable building foundations.
	Sandy and Clayey Soil	- Sandy soil may be present in some areas, requiring stabilization.	- Use foundation reinforcement techniques such as deep foundations or concrete slabs in sandy areas.
Winds	Prevailing Wind Direction	- Winds from the northeast and southwest dominate the area.	- Orient buildings to utilize wind flow for natural ventilation and use wind barriers to protect buildings from sandstorms.
	Sandy Winds	- Sandstorms affect the area and can impact buildings.	- Use protected windows with mesh or slanted roofs to deflect winds away from buildings.
Natural Resources	Water Availability	- Limited water supply due to low rainfall.	- Design rainwater harvesting systems and store it for irrigation and other purposes.
	Solar Energy Potential	- High solar energy availability due to intense sunlight.	- Install solar panels on rooftops for electricity generation and water heating.
Sustainable Design	Energy Efficiency	- Design should minimize energy consumption.	- Use energy-efficient building materials and incorporate natural lighting through windows and skylights. Solar panels and wind energy can be used to supplement energy needs.
	Water Conservation	- Limited water availability requires careful usage.	- Design efficient water management systems such as rainwater harvesting, low-flow fixtures, and greywater recycling.
	Sustainable Materials	- Ensure building materials have low environmental impact.	- Use sustainable and locally sourced materials such as clay bricks, natural stones, and recycled materials to minimize the carbon footprint.

Table (3-3)

3-9 Indicators and Zoning



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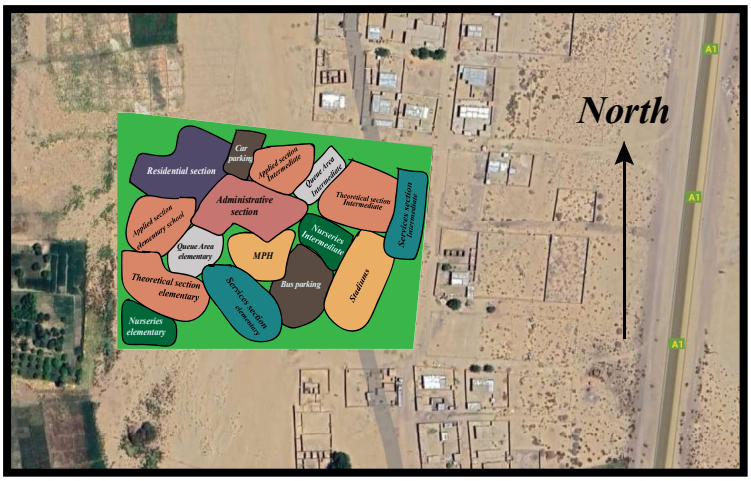

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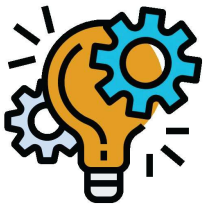


Chapter Four
(Project Design)

- Concept Design.
- Project development stages.
- Develop Design.

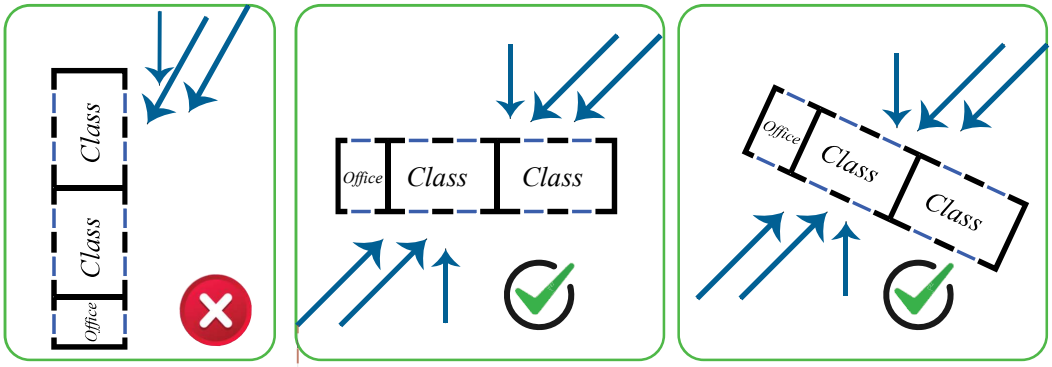
Concept Design

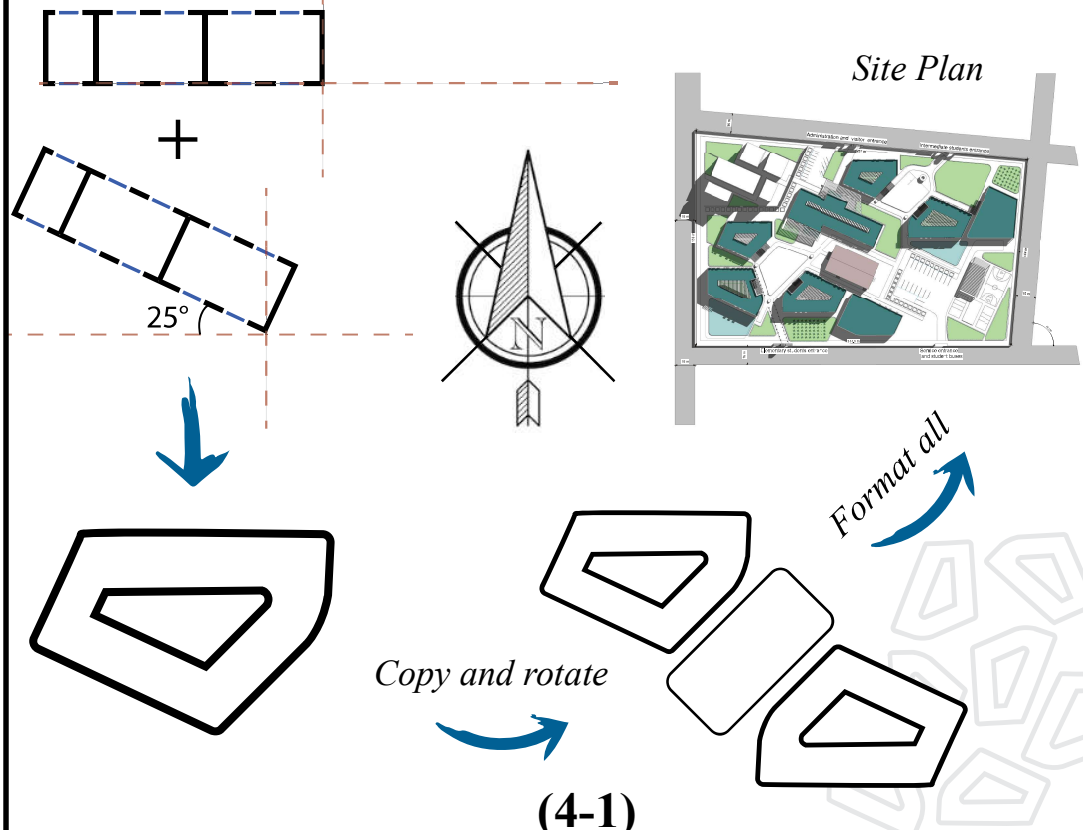
- *Design philosophy :*

"Building a bridge of science and education in the heart of the village, where tradition meets modern technology to inspire and empower future generations."

- *Design idea :*

My design concept for the project was based on the use of thoughtful functional solutions that combine the environmental and functional performance of the building. The classrooms, teachers' offices, laboratories, the entire administration department offices and other blocks were oriented towards the northeast and southwest directions in a way that takes into account natural ventilation and natural lighting. This orientation enabled us to make the most of the natural wind movement and introduce it into all spaces of the project.

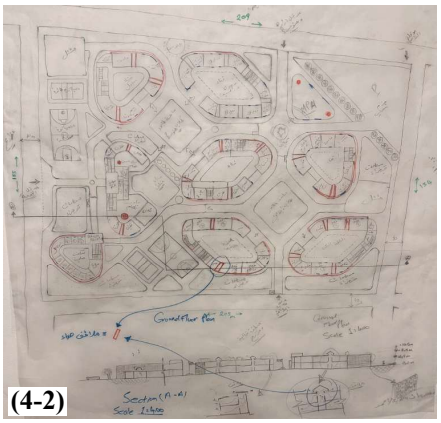


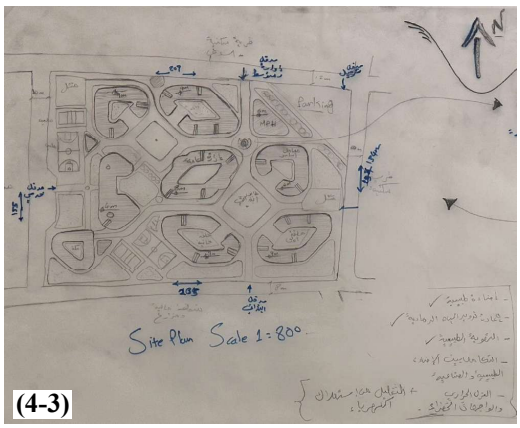


(4-1)

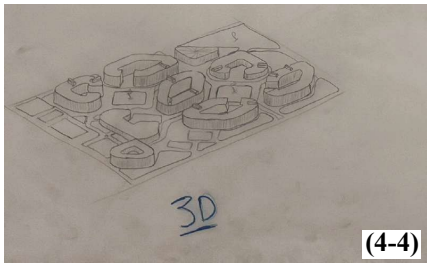
Project development stages

The pictures below show what the project looked like in the early stages of its philosophical formation, as there was no orientation of the blocks towards natural ventilation, nor was the distribution of movement paths considered in an optimal manner, and the distance between the sections was somewhat large.


(4-2)

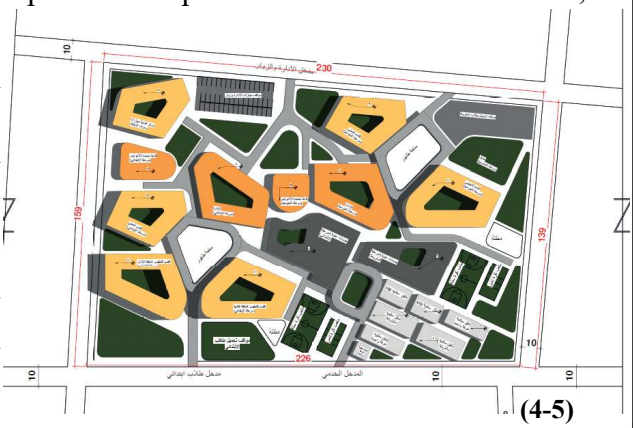


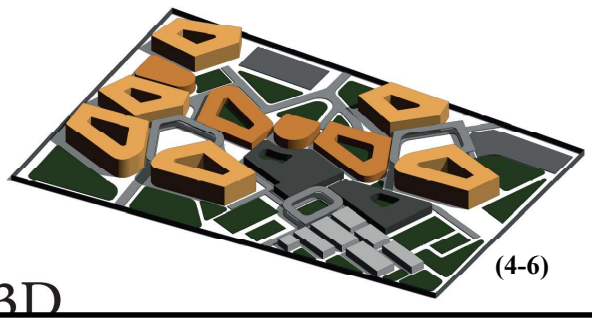
(4-3)



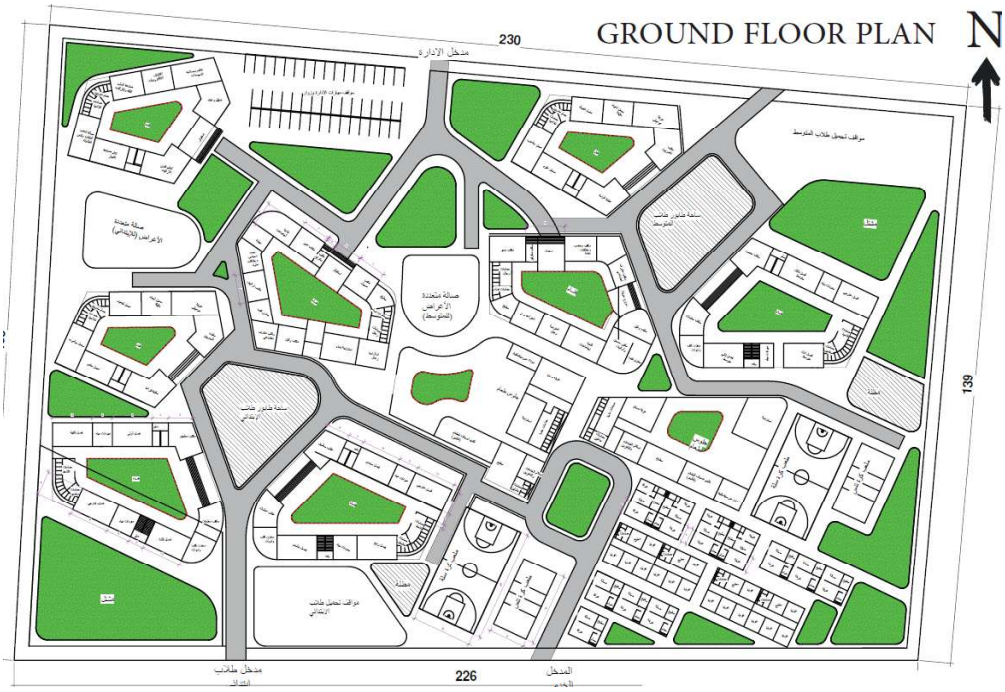
(4-4)

There were many problems, the spaces were in a shape that did not allow for natural ventilation, many curves that made it difficult to implement the function within the space, also there was a repetition of spaces between the two schools, for example the playgrounds, there was a playground for each school - a multi-purpose hall for each school, as well as an administration for each school and separate services for each school and parking lots for each school, this repetition created many problems including the problem of movement between the spaces and the lack of connection in the project and the complexity of the project instead of the opposite, the polluted environment and the failure to achieve any meaning of sustainability


(4-5)


(4-6)

3D



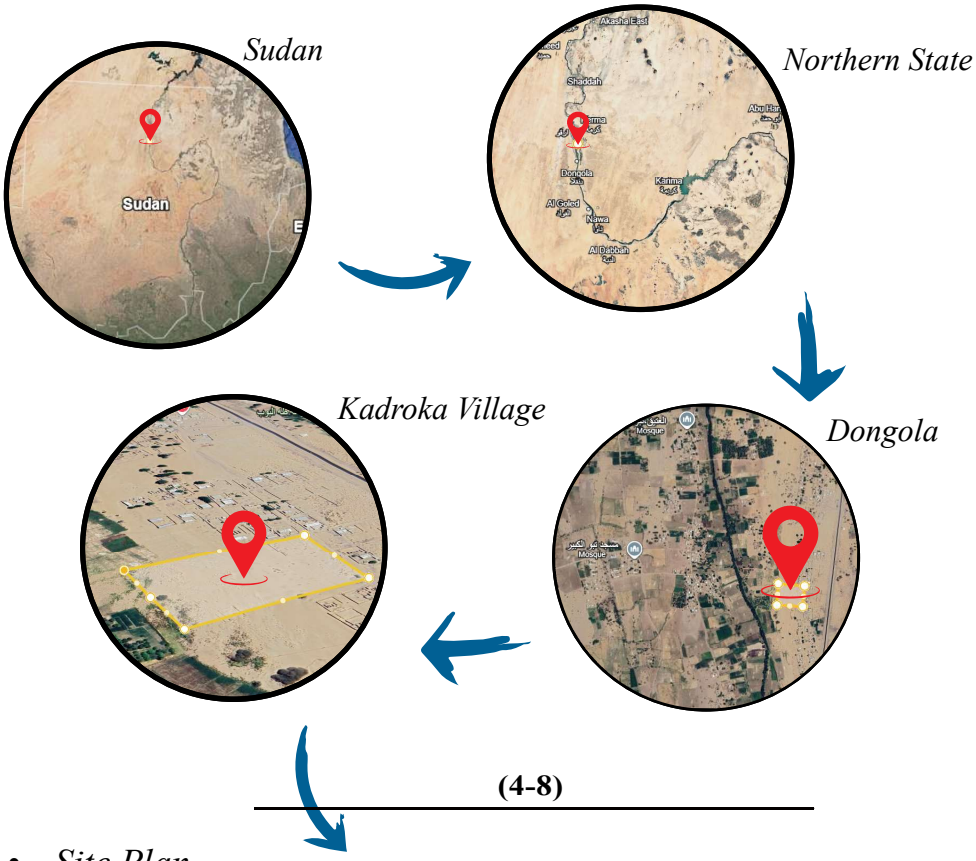
(4-7)

The design was developed, resolving the aforementioned problems, and integrating spaces as much as possible. Two separate administrative blocks, including one for each school, were merged, and the distance between departments was reduced. The additional space in the northwest was utilized to create a space for teachers' housing. The playgrounds and bus stops were combined into a single area to reduce distance. The separation between the school and parking areas, and the separation between the residential and administrative areas, were also scaled to reduce noise. The multipurpose hall was placed in the middle of the project to serve both schools.

The overall structure was reconfigured and improved, resolving the problems of the block structure and linking the forms. Integrated traffic corridors were created around all school spaces to facilitate student flow. In the public service areas, greater attention was paid to landscaping, providing shade and access paths to these areas. The two circles, the two schools, and the administration were discreetly combined to facilitate student control and monitoring.

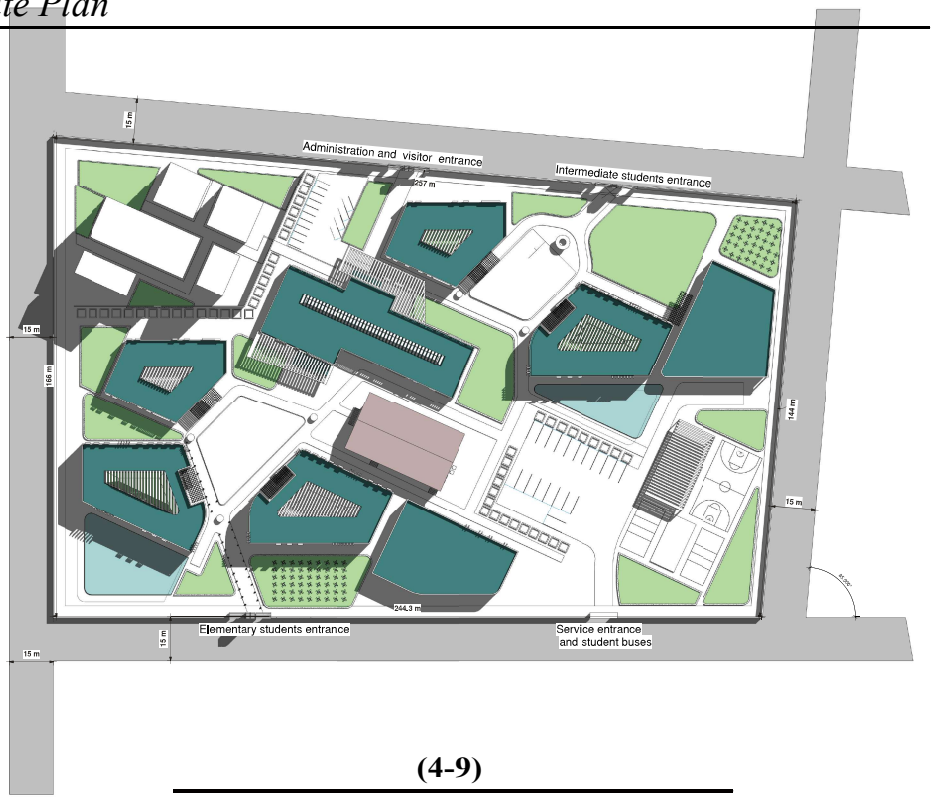
Develop Design

- *Location Plan*



(4-8)

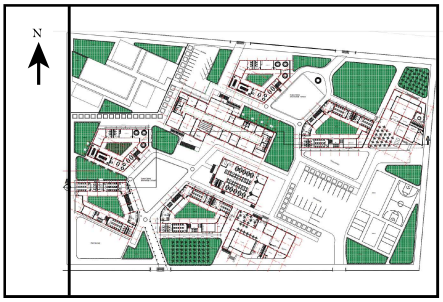
- *Site Plan*



(4-9)

- *Ground Floor Plan*

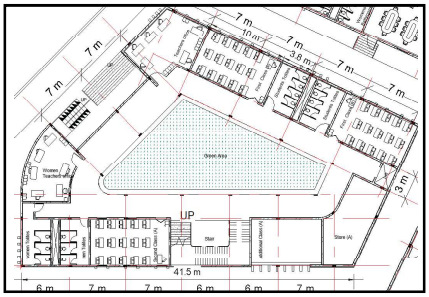
Focusing on ventilation of all chapters with natural ventilation - and to reach the form mentioned in the previous paper, the blocks (sections) were generally placed to serve each other



(4-10)

Design : (Theoretical section)

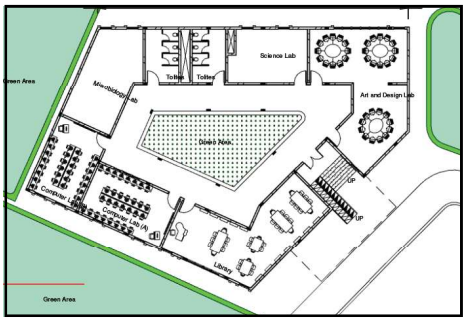
In general, the Theoretical section consists of classrooms, teachers' offices, bathrooms, a drinking area, a storeroom, and open green areas.
Classrooms and offices are positioned towards natural ventilation and the storeroom towards east and west.



(4-11)

Design : (Applied section)

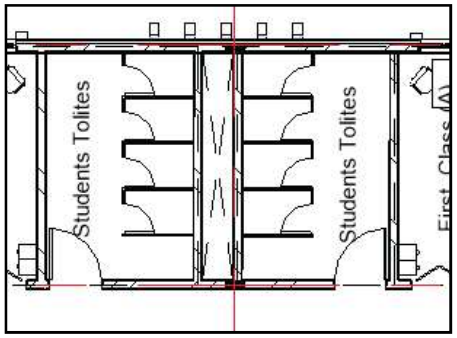
In general, the Theoretical section consists of classrooms, teachers' offices, bathrooms, a drinking area, a storeroom, and open green areas.
Classrooms and offices are positioned towards natural ventilation and the storeroom towards east and west.



(4-12)

Design : (Ducts)

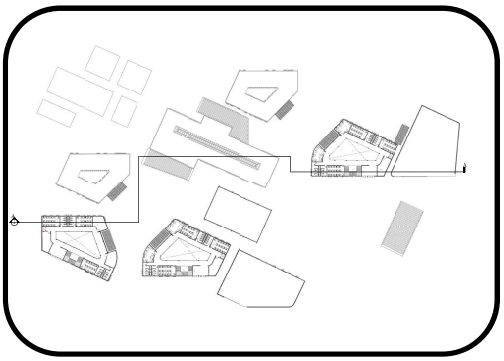
The distribution of bathrooms on the duct from two sides in some sections is bathrooms on one side and kitchen on the other side



(4-13)

- *First Floor Plan*

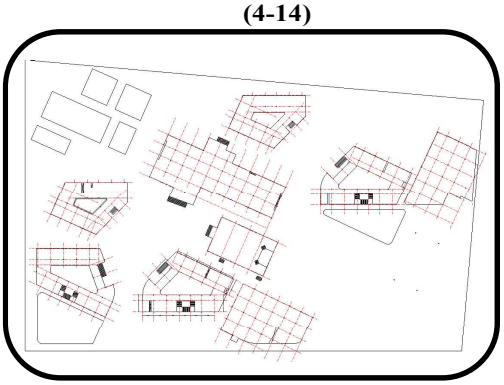
Since the school is two rivers, we added some classes on the upper floor, which are: For the elementary school: from each cycle, the fourth, fifth and sixth classes. For the middle school: one of the rivers was raised on the first floor (first, second and third classes).



(4-14)

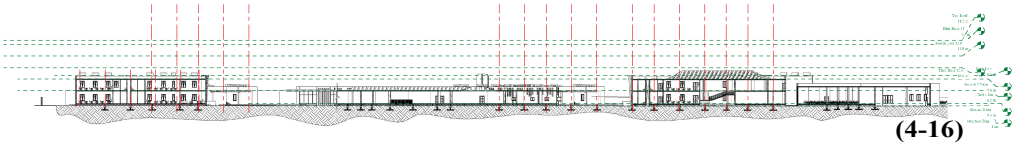
- *Grid And Stairs Sheet*

The structural system used in the project is the concrete structural frame system,With different seas, maximum 7 meters except for the multi-purpose hall located in the center of the project, which was designed with a Steel Truss‹



(4-15)

- *Section A-A*



(4-16)

- *Elevations and 3D Views*

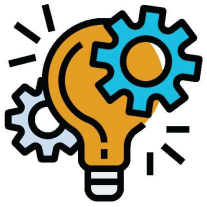
(4-17)

(4-19)

(4-18)

(4-20)

5



Chapter Five
(Technical Solutions)

- Finishes.
- Electricity and water supply.
- Sanitary and surface drainage.
- Waste Disposal Solutions.
- Sustainability.
- Air Conditioner System.
- Fire Fighting.

1. Finishes :

Walls Finishes	
W1	-3 Layers of white Pomastic paint
	- Cement sand (Plaster) 2.5cm thick .
	- D.P.C 3layer
	-A Wall 1 brick thick (20 cm)
	- Cement sand (Plaster) 2.5cm thick .
	- Thick white splash (5cm thick)
W2	-3 Layers of white Pomastic paint
	- Cement sand (Plaster) 2.5cm thick .
	-A Wall 1 brick thick (20 cm)
	- Cement sand (Plaster) 2.5cm thick .
	- Thick splash (5cm thick) (Gray colour)
W3	Layer of poly wood (3cm thick)
	Metal sheet mesh for fixing wood (5cm)
	Layer of poly wood (3cm thick)

Table (5-1)

Ceiling Finishes	
C1	Gypsum Bboards 60*60*2cm
	60*60 Metal Mesh (5cm Thick)
	Reinforced Concrete Slap 1:3:6 (15cm thick)
C2	Gypsum Bboards 60*60*2cm
	60*60 Mmetal Mmesh (5cm Thick)
	Sound Insulation layer (5cm)
	Reinforced Concrete Slap 1:3:6 (15cm thick)

Table (5-3)

Floors Finishes	
F1	-White Ceramic Tiles (90*90*2cm)
	C/S Mortor 1:6 (3cm Thick)
	D.P.C 3Layers.
	Plain Concrete Slap 1:3:6 (15cm thick)
	Hard Core 75cm.
	Natural Earth
F2	Interlocking wood flooring (220*20*4cm)
	C/S Mortor 1:6 (3cm Thick)
	D.P.C 3 layers.
	Plain Concrete Slap 1:3:6 (15cm thick)
	Hard Core 75cm.
	Natural Earth
F3	Artificial stone 7cm thick
	Sand Layer 5cm thick
	D.P.C 3 Layers
	Hard Core 16cm.
	Natural Earth
F4	Sand and Quartz mix layer 12cm thick
	D.P.C 3 layers
	Hard Core 16cm.
	Natural Earth
F5	Natural grass (5-10cm)
	Quartz sand (10cm) thick
	Gravel 20cm thick
	Natural Earth

Table (5-2)

Skirting Finishes	
S1	Epoxy 1 Layer
	C/S Mortor 1:6 (3cm Thick)
	-A Wall 1 brick thick (20 cm)
S2	Interlocking wood flooring (220*8*4cm)
	C/S Mortor 1:6 (3cm Thick)
	-A Wall 1 brick thick (20 cm)

Table (5-4)

Windows Scheduale			
Type	Width	Hight	Description
N1	1.2	1.8	Sliding Window
N2	0.9	1.2	Double Window Panel
N3	2.5	1.5	Sliding Window

Doors Scheduale			
Type	Width	Hight	Description
D1	1.3	2	Double Door
D2	2	2	Sliding Door
D3	0.9	1.8	Single Door

Table (5-5)

2. Electricity and water supply :

A. Water supply :

There are 540 Student in the School.

There are 36 teachers. , There are 20 employee , There are 10 worker. Amount of water required = Daily use water + Fire fighting water

From the water quantity table:

- A student in a school with a cafeteria and no gym needs 20 US gallons of water per day.

  540 x 20 = 10800 , 10800 x 3.8 = 41000 liters.

- Office work requires 15 US gallons per teacher.

  66 x 15 = 990, 990 x 3.8 = 3700 liters.

B. Electric supply :

On the northern artery road, 200 meters east of the site, there is an 11 km power supply line. A line is pulled from it to the site, then the electricity is fed into a transformer to reduce the voltage to 416 volts to accommodate all project activities. From the main control room, nine lines were pulled to supply all project blocks and create sub-control panels. The external lighting relies entirely on solar panels to provide energy savings.

Water supply code table

Code	Details
	"Main Water Supply pipe Type (PPR) Size (4 inches) Depth (1.2 M)"
	"Water Supply pipe Type (PPR) Size (2 inches) Depth (0.75 M)"
	"Water Supply pipe Type (PPR) Size (1 inches) Depth (0.75 M)"
	"Water Supply pipe Type (PPR) Size (0.5 inches) Depth (0.25 M)"
	Underground Water Tank (51.500 Liter)()
	Fire Extinguisher Tank (18000 Liter)
	Water Tanks 3types (10000 lit,7000 lit,5000 lit.
	Pump 2types (4 hp power . 1.5 hp power).
	Valve
	Non-return valve
	"• Spray Angle: Adjustable From 90 - 180 - 360 • Coverage Range (Spray Diameter) 8 M • Operating Pressure: 4 Bar. • Water Quantity: 30 Liters/Minute."
	"• Spray Angle: Adjustable From 90 - 180 - 360 • Coverage Range (Spray Diameter) 5 M • Operating Pressure: 2.5 Bar. • Water Quantity: 15 Liters/Minute."
	"• Spray Angle: Adjustable From 90 - 180 - 360 • Coverage Range (Spray Diameter) 3.6 M • Operating Pressure: 1.5 Bar. • Water Quantity: 8 Liters/Minute."
	Drip Spray (Graded Area)

Table (5-6)

Electricity supply code table

	Details
	33 KV Power Cable. (Aluminum - steel ACSR 300/50)
	415 V Power Cable. (Aluminum - NA2XS(F)2Y
	Manual Switch.
	Transformer
	Main Control Panel
	Control Panel.
	Solar Panel.
	Solar Lighting.

Table (5-7)

Solar System :

"Solar System Design for 30% Energy Dependency:

Project's Daily Energy Consumption:
Total estimated load: 216 kWh/day (administration, classrooms, labs).

Solar Energy Contribution (30%): Required from solar: 64.8 kWh/day.
System Capacity:
Peak sunlight in Sudan: ~6 hours/day.
Required capacity: 10.8 kW.
Number of Solar Panels: Using 400 W panels: 27 panels.
Space Requirements: Each panel needs ~2 m². Total area: 54 m²."

3. Sanitary and surface drainage :

Choose an Appropriate Sewer System: (Internal Sewer Network)

Each building should have:
Pipes for sanitary drainage (PVC) with diameters ranging 6 inches.
Separate lines for gray water (sinks, kitchens).

Sewerage Networks:

Six separate networks were constructed. Due to the project's vast size, very long lines were required, resulting in increased depth and, consequently, increased costs for pumping waste and disposing of it.
Long lines can also cause other problems in the long term.

Design Manholes:

Place manholes at :
Every 12 meters of pipe length.
Every change in pipe direction or at pipe intersections

Manholes Slope rate 1:40
Every 12 meters of pipe length.
Every change in pipe direction or at pipe intersections.

Design Septic Tank :

Required size = Daily consumption (m^3)×3 = 27.2 m2 ×3 = 81.6m3

Since the project was divided into two separate networks,
it means , any Septic Tank Size = 81.6 = 20.4m3 = 3.4*2*3m

A three-chamber tank for separating solids from treated water.

Each building : Has an independent internal sewer network. Connects to the nearest manhole.
Manholes : Located at key points for maintenance and flow management.

Sewage code table

Code	Details
	Main sewer pipe Pvc (diameter : 6 insh)
01	Manhole . (All sizes in table Below...)
	DownPipe. Pvc (diameter : 6 insh).
	Trunch - cover is made of stainless steel mesh. (Type A - Width : 35cm . Slope :1:100) (Type B - Width : 20cm . Slope :1:100)
	Drain Slope 1:100

Table (5-8)

Manholes Size table

	Mn no	Depth	Length	Width
Network 01	01	45	45	45
	02	63.75	75	45
	03	93.75	100	70
	04	123.75	100	75
	05	45	45	45
	06	62.5	75	45
	07	92.5	100	70
	08	122.5	100	75
	09	152.5	100	75
	10	162.5	100	75
Network 02	11	45	45	45
	12	66.5	75	45
	13	96.5	100	70
	14	126.5	100	75
	15	156.5	100	75
	16	45	45	45
	17	50	45	45
	18	80	75	57
	19	110	100	75
	20	140	100	75
	21	162.5	100	75
	22	178.5	100	75
	23	208.5	100	75
	24	45	45	45
	25	50	45	45
Network 03	26	45	45	45
	27	53.5	45	45
	28	83.5	75	57
	29	113.5	100	75
	30	143.5	100	75
	31	154.75	100	75
	32	184.75	100	75
	33	45	45	45
	34	53.75	45	45
	35	74.75	75	57
	36	92.25	100	70
	37	122.25	100	75
	38	45	45	45
	39	45	45	45
	40	66.25	75	45
	41	88.5	75	57
	42	106	100	75
	43	136	100	75
Network 04	44	45	45	45
	45	53.75	45	45
	46	72.5	75	57
	47	90	75	70
	48	106.25	100	75
	49	127.5	100	75
	50	149.25	100	75
	51	45	45	45
	52	51.25	45	45
	53	81.25	75	57
	54	111.25	100	75
	55	128	100	75
	59	45	45	45
	56	52.5	45	45
	57	82.5	75	57
	58	112.5	100	75

First Manhole Last Manhole

Table (5-9)

Pipe Material:
Use durable materials (PVC).
Pipe Slope 1 :40
Maintenance Access: Provide access points at regular intervals for cleaning.

(Sewage disposal well) Design:

Basic Dimensions: Shape: cylindrical - Diameter: 1 meters.
Walls: Constructed using perforated bricks to allow water seepage.
Gravel and rocks can be placed around the walls to enhance water absorption.
Pit Base: Left unpaved (no concrete) to allow water to percolate into the soil.
Covered with a layer of gravel or small rocks, 50 cm thick, to improve drainage.
Top Cover: Reinforced concrete cover with a maintenance opening (manhole).
Prevents surface water and insects from entering.

4. Waste Disposal Solutions:

01 The first level Small assembly points :

Each block (Classrooms, laboratories, management, services) contains small containers distributed according to the type of waste.
These containers were placed in strategic points:
At the entrances of classes and laboratories.
At the end of each corridor inside the blocks.
Next to eating and sitting areas.

02 The second level Medium collection stations :

More assembly points were provided for each group of blocks
These points are more well covered containers and distributed in places that are easy to reach by cleaners without

03 The third level The main Station :

All waste in a dedicated area is assembled on the end of the Sayan Blanc, away from educational and recreational activities. As shown in the drawing
This area was placed close to the school's service entrance to facilitate waste transport outside the site by municipal trucks or the recycling company.

Refuse disposal table

Code	Details
⊕	Small assembly points
●	Medium collection stations
■	Small assembly points
- - - - -	Transfer path from level 2 to level 3
▬	Garbage truck path

Table (5-10)

Waste collection mechanism betweenthe three levels

A

From the first level to the second level (internal collection for each block)

- **The method used:**
  Cleaners + small handcarts with dedicated containers
  Collection occurs twice a day (in the morning and before the end of the school day)
- **The process:**
  The small containers (located in classrooms, laboratories, and corridors) are emptied into larger containers dedicated to each block. , These large containers are placed in a central location in each block.

B

From the second level to the third level (transportation to the main station)

- **The method used:**
  A small electric cart (such as the carts used in stadiums and airports) , Transportation occurs once a day (after the end of the school day to avoid inconvenience).
- **The process:**
  The cleaners push the carts or drive the electric cart to collect waste from the intermediate collection points.
  It is transported to the main waste station.

C

From the second level to the third level (transportation to the main station)

- **The method used:**
  The method used:
  Municipal waste transport truck or a specialized company
  Collection takes place 3-4 times a week depending on the amount of waste.

5. Sustainability

Introduction:

As part of developing a sustainable school environment, the project focused on integrating various sustainability concepts. These practices aim to improve resource efficiency, preserve the environment, and enhance the quality of school life. Various sustainability strategies were implemented, including environmental, social, and economic sustainability, to achieve a balance between environmental conservation and providing a healthy and safe learning environment.

1. Environmental Sustainability:

Environmental sustainability revolves around reducing negative impacts on the natural environment and balancing the use and protection of natural resources. In this context, several effective environmental practices were implemented:

Using Natural Ventilation and Lighting Sources: The buildings were designed to optimize the use of natural light and ventilation. Large windows and open areas allowed natural light to enter classrooms and corridors, reducing the need for artificial lighting. Ventilation holes and natural ventilation strategies were also used to reduce the need for air conditioning systems, contributing to energy savings and reducing environmental impact.

School Tree Planting: Spaces within the school were designated for planting trees and plants, which not only contribute to improving the environment but also enhance air quality. Trees help reduce pollution, provide shade for students, and create a more aesthetically pleasing and healthy school environment.

Environmentally Friendly Waste Disposal: Environmentally friendly waste disposal strategies were adopted, where different types of waste (organic, plastic, and metal) are systematically separated. This process aims to reduce the environmental impact of waste through proper classification.

Waste Recycling: Waste recycling programs were established within the school. Recyclable materials, such as paper, plastic, and glass, are regularly collected and reused in the manufacture of new materials. This step contributes to reducing the amount of waste sent to landfills.

Sustainable Rainwater Disposal: The school system was designed to utilize rainwater by collecting and storing it for use in watering gardens and plants. This reduces freshwater consumption and improves the efficiency of water resource consumption within the school.

Use of Environmentally Friendly Materials: Environmentally friendly building materials were used throughout the construction process. For example, green bricks were chosen as one of the primary building materials. Green bricks are a natural thermal insulator, helping to reduce the need for air conditioning. It also provides natural warmth within the buildings, contributing to energy savings.

Use of local wood: Locally available wood was used for the canopies, reducing emissions associated with transporting materials. The use of local wood contributes to reducing environmental impact and enhances integration with the local environment.

Paving circulation paths with natural stones: Natural stones found in the area or village were chosen to pave circulation paths within the school. This choice enhances the sustainability of the project through the use of local materials, reducing energy consumption resulting from the manufacture and transportation of traditional materials.

2. Social Sustainability:

Social sustainability is related to achieving social justice and improving the quality of life of individuals within the school community. In this context, the following practices were adopted:

Separating sports activities from academic activities to avoid noise: Separate areas were designated for sports activities away from academic areas to avoid the negative effects of noise on students during lessons. This enhances concentration and contributes to a calm and safe learning environment.

3. Economic Sustainability:

Economic sustainability aims to achieve optimal use of resources and save costs in the long term. In this context, strategies were implemented, including:
Achieving energy savings and reducing operating costs: By utilizing natural lighting and ventilation, the need for electricity consumption was reduced, contributing to lower operating costs. These strategies save the school additional costs and contribute to improving long-term economic efficiency.

6. Air Condiotions:

First : For Classes Section :

Cooling Load calculation :

CL = Qsun+Qt+Qo+QL

CL ≡ *Cooling Load*
Qsun ≡ *Sun heat`.*
Qt ≡ *Heat transferred through surfaces.*
Qo ≡ *Users' body temperature*
QL ≡ *Lighting heat.*

Air Conditions & FireFighting table	
Code	Details
	Air Supply Diffuser (60*60cm)
	Air Return Diffuser (60*60cm)
	Air Supply Duct
	Air Return Duct
	Mechanical Equipment 17kw
	Split Units -Outdoor-
	Split Unit -indoor-
	Sirens. 45 dB loudness.
	Fire Sprinklers.
	hand powder extinguisher 25 Kilo
	Emergency Door1(w 1.5 H 2.2)m

Table (5-11)

(A) *Calculation Q.sun*

Q.sun =
Q.sun(Roof)+Q.sun(Wall) +Q.sun(Glass)
Q.sun(Roof) = A*U* Δt.sun *COs
Q.sun(Wall) = A*U* Δt.sun *COs
Q.sun(Glass) = A*Qs *CUs*T

Qsun ≡ *Amount of heat gained by Srface from the sun's rays.*
A ≡ *Total area calculated from architectural drawings)*
U ≡ *Heat transfer rate through construction materials.*
COs ≡ *the amount of absorption due to color .* Δ*t* ≡ *Extra heat due to sun rays.*
Qs ≡ *mount of direct solar heat through the glass.*
CUs ≡ *Curtain Performance Scale.* *T* ≡ *Transparency rate.*

Q.sun(Roof) = 0 - Ground Floor.
Q.sun(Wall) = 2(10*3.5)*1.15*3*0.3 = 72.4*
*Q.sun(Glass) = (3*1.2*1.5) * 78*0.25*0.70 = 73.5*

Total Q.sun = 146w

(B) *Calculation Qt*

Qt= ΣA*U*Δt

A ≡ *Area of external and internal surfaces.*
U ≡ *heat transfer rate through construction materials*
Δt≡ *A difference between the comfort degree and the design climate*

*Q.t ROOF =(10*6)*1.4*5 = 420.*
Q.t Walls =2(10*3)*1.2*(42-24) = 1296.*
Q.t Walls =2(6*3)*1.2*(5) = 270.*
*Q.t Floor =(10*6)*1.4*5 = 420.*
*Q.t Glass =(3*1.2*1.5)*6*(42-24)= 729.*

Total Q.t = 3135w

(C) *Calculation Qo*

Qo = nxQpxDf

n ≡ *Number of users.*
Qp ≡ *body temperature of the individual user according to the type of activity*
Df ≡ *coefficient of variation.*

Qo = 30x117x0.9 Total Qo = 3159w

(D) *Calculation Ql*

QL = AF X QLS × Df

AF ≡ *floor area of conditioned space.*
QLS ≡ *amount of lighting heat according to the type of building*
Df ≡ *coefficient of variation.*

QL = 60x40x0.9 Total Qo = 2160w

Total Cooling Load
= 146+3135+23550+3159+2160

= 32150w

chosing an air conditioning system.

For classrooms and offices, the split unit system is the most suitable system. We will use two units in each classroom. The capacity of each unit is 18,000. The details are shown in the table below.

Spilt units / Hi – wall								
Indoor unit 120*40*25 cm	Cooling load Btu/h	Heating load Btu/h	Air refining technology	Sound Pre. dB	controlling	Condensed water	Outdoor unit 90*60*40 cm	Energy kw.
Carrier 42QG18 	18,000	0.00	Dust filter Bact. filter	47	Remote-control 	Dropped	 Hori. dist 12 m Verti. dist 5 m	1.8

Table (5-12)

Second : For Classes Section :

Ⓐ Calculation Q.sun

Q.sun = Q.sun(Roof)+Q.sun(Wall) +Q.sun(Glass)

*Q.sun(Roof) = (33.5*20)*1.15*3*0.3 = 90.5*

Q.sun(Wall) = 2(33.5*4.5)*1.15*3*0.3 = 312*

*Q.sun(Glass) = (9*1.2*1.5) * 78*0.25*0.70* = 221

Total Q.sun = 623.5w

Ⓑ Calculation Qt

*Qt= ΣA*U*Δt*

*Q.t ROOF =(2*33.5*11)*1.4*5 = 469.*

Q.t Walls =2(33.5*4.5)*1.2*(42-24) = 6512.*

Q.t Walls =2(20*4.5)*1.2*(5) = 1080*

*Q.t Floor =(33.5*20)*1.4*5 = 4690.*

*Q.t Glass =(9*1.2*1.5)*6*(42-24)= 1750.*

Total Q.t = 14500w

Ⓒ Calculation Qo

Qo = nxQpxDf

Qo = 250x117x0.9 Total Qo = 26325w

Ⓓ Calculation Ql

QL = AF X QLS × Df

QL = 670x40x0.9

Total Qo = 24120w

Total Cooling Load = 623+14500+26325+24120

= 65568w

chosing an air conditioning system.

For a multi-purpose hall, we will use a central air conditioning system, distributing 17 diffusers with a capacity of 4,000 watts, and using two external units with a capacity of 35,000 watts each. More details in the table below.

Cassette unit						
Indoor unit 90*90*30 cm	Cooling load Btu/h	Heating load Btu/h	Air refining technology	controlling	Condensed water	Single outdoor unit 120*100*50 cm	Energy kw.
Carrier 40KMC 18 	35,000	0,000	Dust fil. Bact. fil.	Remote-control 	Dropped	 Hori. dist 20 m Verti. dist 10 m	2.4

Table (5-13)

7. Fire Fighting:

01 Fire classification

Expected fires in the seasons, MPH are Class (A) fires - combustible solids
Causative materials: paper, wood, ...
Extinguishing method:
Use water to extinguish the fire by cooling the material.
Use dry powder (ABC Powder Extinguisher) to prevent the spread of fire.
Use foam to isolate oxygen.

02 Determine fire severity.

Fires in these spaces are considered low-risk fires.
LIGHT HAZARD

03 Distribution of alarms and sirens

Sirens are distributed one at a time to serve every 80 square meters in low-risk fires. (45 dB loudness.)
Also, install manual alarm devices near the entrances as shown in the drawing.

04 Emergency exit design

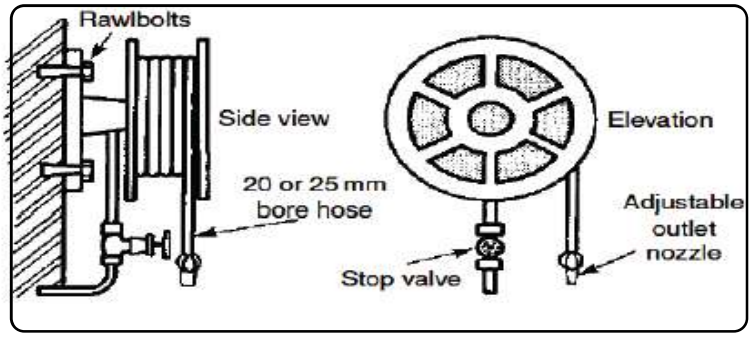
A number of emergency exits were designed for the multi-purpose hall as shown in the drawing. Door specifications: Opens outwards, works without a key, is labeled Emergency Exit, 1.5 meters width, 2.2 meters high.

05 Fire extinguishing

Place a hand powder extinguisher at each entrance.

(5-2)

Wet riser pipes :
A fixed network of extensions that is always full of water, starting from a pumping point from the building's water tanks and ending with fire nozzles or outlets distributed on each floor.



(5-1)

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Thank you for reading . . .