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Eco-Development Through Ecological Architecture: A Case Study of Trakya University

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ABSTRACT:
The issue of ecology is a pressing crisis that impacts all fields and demands attention. The solution lies in constructing buildings that honor nature and culture. To achieve this aim, we must prioritize ecologically-minded education emphasizing sustainability and the protection of ourselves, nature, and cultural values. This study delves into ecology and explores how to implement a sound ecological approach to address the need for more space at the Trakya Faculty of Architecture. The study assesses the ecological framework concerning environmental education, which is the primary objective of ecological development. With this in mind, the project design centers around a 780 m2 area south of the Trakya Faculty of Architecture. The proposed building is a two-story ecological structure with two studios, a work area on each floor, and wet spaces. The building will be constructed using a portable structure that can be disassembled and reassembled in the designated location, significantly contributing to the university's sustainability and ecological efforts.

Keywords: eco-development, eco-education, eco-building, Edirne

1. Introduction

Ecological awareness and relevant scientific knowledge are needed for the ecological transformation of society and production, which means ecological development (Lantitsou,2012). Ecological development is the development of human relations by each individual by his/her own culture (Kastoriadis, 1981). It expects production to be compatible with nature in line with the approaches of ecological science. This statement implies that the production should not surpass the ecological carrying capacity, which means that all countries must establish policies for ecological development. In doing so, the global trend can align with ecological expectations. This trend necessitates an education that promotes the conscious use of natural resources and encourages people to break free from consumption habits. Environmental education is vital in this process since it creates human potential to change lifestyles and consumption models (Vaiou, 2000). This process is referred to as the ecological education model, which integrates the principles of ecological development into the design of educational structures. Seeing the subjects taught in person in the field provides experience and permanent and adoptable knowledge transfer. The issue of ecology is a pressing crisis that impacts all fields and demands attention. The solution lies in constructing buildings that honor nature and culture. To achieve this aim, we must prioritize ecologically-minded education emphasizing

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sustainability and the protection of ourselves, nature, and cultural values. Because the construction of buildings in line with ecological design criteria will increase ecological awareness. With the increase in ecological awareness, the 2030 Sustainable Development Goal of affordable and clean energy will be approached. This study will also contribute to the gap in the literature.

Currently, developing energy-efficient building designs is a challenge not just in Turkey but globally. To address this issue, we have selected a 780 m2 plot in the northeastern area of the Faculty of Architecture at Trakya University in Edirne. We aim to contribute to the solution with our study. We have designed an eco-friendly structure using lightweight steel that can be disassembled and reassembled on the site, featuring two studios and a working space. This ecological structure will make a meaningful contribution to the University and the surrounding region. While understand the importance of evaluating real-world impact, which is vital in validating the effectiveness of eco-educational architecture.

2. Theoretical Background

2.1 Eco-development and ecological education

Current development plans challenge the balanced continuity of limited natural and living resources. This situation creates crises. Structural transformations are needed in managing crises (Kastoriadis, 1990); (Lantitsou,1998). Ecological development is required for structural transformation, and eco-development is an excellent strategy to solve emerging crises (Lantitsou, 2012); (Liakopoulos, et al. 2014). All countries are expected to support ecological development. Thus, rapid consumption will decrease, and the tendency towards using natural resources will increase (McMillan, (2003). The pivotal factor in achieving a sustainable future lies in environmental education. By imparting knowledge and awareness of ecological issues, individuals are better equipped to understand the moral implications of their actions. It is, therefore, imperative for every nation to take proactive steps toward creating a sustainable environment where both humanity and ecosystems can coexist harmoniously (Ghai and Vivian, 1992). To attain this objective, it is imperative to focus on ecological development. This entails nurturing individuals with a proclivity towards environmental education and promoting the establishment of sustainable ecological structures. To effectively strategize in this direction, setting up educational systems that offer comprehensive ecological education is essential. By imparting an ecological outlook to citizens, an education system can significantly contribute to fostering ecologically sustainable development and planning (Vaiou, 2000). The science of ecology and each country's culture will constitute this training's content. Perhaps we should give vernacular architecture as an example here, it can be defined as a local or regional type of construction made using the traditional materials and resources of the region where the building is located

Education plays a crucial role in fostering respect for life and nature, promoting the responsible use of natural resources, cultivating peaceful and just human relations, and improving the overall quality of life. Furthermore, it must facilitate ecological development and instill new values in individuals. To achieve this, there is a pressing need for educational structures that prioritize environmental education (Svek, et at. 2012). The educational structures designed with environmental approaches are crucial in conveying ecological knowledge to individuals. By seeing and living in an environment that is attuned to environmental awareness, people become more mindful of the impact of their actions on the environment. This approach helps to promote a sustainable future and is an essential component of contemporary academic education. In this direction, Eco-Building design principles are determined through literature studies.

2.2 Eco-design (ecological design)

When the multidisciplinary meaning of 'ecology', abbreviated as 'eco' in the literature, is investigated, German zoologist Ernst Haeckel defines the concept of "ecology" as follows: "It is a comprehensive branch of science that studies the relationship between the organism and the environment" (Frodin, 2001). The concept of ecology has gained importance among the study subjects of different disciplines and is starting to be used as “environmentally friendly”. In addition to characterizing the continuity of nature’s ecosystem cycle, the rapidly developing word “ecological” has become a field directly related to the good evaluation of natural resource potentials, the protection and sustainability of natural habitats, and sustainable urban development (Özkeresteci, 2009). Within this continuous transformation, “Ecological architecture” has reached an architecture that can establish healthy and harmonious relationships with its environment (Kavas, 2009). It is emphasized that ecological architecture is an important field in solving problems with the environment (Mchanglan,1969); (Yeang,1995); (Van Der Ryn, S. and Cowans,S. 1996); (Roaf, 2003); (Yeang, 2021); (Yunqi and Mieradili, 2023).

Ecological architecture supports designs that accept the environment as a whole, support the relationship of small units with the whole, support the relationship of social, cultural and ecological dimensions with each other, include the integration of the structure into the ecological cycle in all processes, prioritize environmental issues such as materials, energy and zero waste, aim to protect renewable resources and pass them on to the next generations, encourage ecological awareness in the user, and are humanistic and environmentally oriented (Kısa Ovalı and Tachir, 2018).

The general principles of ecological architecture can be listed as follows (Tönük, 2001);

•to minimize impairment of natural sources as regards the design and use of environment,
•to design in compliance with nature, to perform designs in compliance with climate conditions and topographical characteristics,
•to use recyclable materials,
•to consider ecological principles as regards vertical distribution just as horizontal distribution within the building,
•to allow for flexibility and variability criteria for design and have multi-functional spaces
•to have designs for the use of solar energy

Ecological design, which is approached with the expansions of the ecological concept, is evaluated under three main headings (Tönük, 2001);

1. Re-evaluation of old buildings
2. <u>Environmentally friendly-energy efficient designs</u>
3. Smart buildings using technology

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In this study, environmentally friendly energy efficient design is discussed and researched.

The oil empargo in 1973 (Fuller and Doggart, 1982) caused the questioning of the dependency on fossil fuels. This questioning produced the term "energy saving" (Owen, 1999). By the end of the 1970s, it was seen that the tendency towards low energy was increasing. This tendency provided the opportunity for environmentally friendly energy efficient design focusing on passive solar systems and active solar technologies. Environmentally friendly energy efficient design focused on the simple strategy of local forms and materials instead of different and flexible forms (Venturi, Scott Brown and Izenour, 1972). After the 1980s, the sustainable features of environmentally friendly energy efficient design approaches (Venturi, Scott Brown and Izenour,1972);

- Climate-sensitive architectural forms and building elements,
- Passive design strategies such as passive solar heating, good orientation, solar shading, spatial buffering or greenhouse effect,
- Optimized natural resources such as daylight, natural ventilation or solar radiation,
- Energy-efficient technologies and devices for heating, ventilation and control,
- Local, natural and low-embodied energy and materials

The concepts of environmental sensitivity and low energy have led to the emergence of the concept of sustainable architecture. Buildings have begun to be produced with this approach. The Trakya University Architecture Annex is an example of this approach.

2.3 Trakya university faculty of architecture additional building

Trakya University is in Edirne, a city on Turkey's border with Europe. Today, the university is a renowned educational institution, having separated from the universities in Çanakkale, Tekirdağ, and Kırklareli. Despite this, it maintains its identity as a regional university and has campuses in the city center and other districts. The Faculty of Architecture is one of the university's oldest departments, established in 1982. It was created by converting the Edirne State Engineering and Architecture Academy into a faculty affiliated with the rectorate. In 2013, the decision was made to establish a separate faculty for the Faculty of Engineering (Trakya Üniversitesi, 2024). The Faculty of Architecture, which continued its education on different campuses until 2012, later moved to its campus in the city's center, together with the Architecture, Landscape Architecture, and Interior Architecture departments (Figure 1).

Figure 1. Trakya University Macedonia Campus (Edited via satellite image.)

Trakya University Faculty of Architecture building was built as a military barracks structure (1877) and started to be used as a faculty of architecture building in 2013. The plan type is U-shaped and designed with an inner courtyard. It is a two-story building with the floors attached to three historical staircases. There are classrooms, workshops, and rooms for academic-administrative staff.

The current building, which incorporates the Architecture, Landscape, and Interior Architecture departments, spans an area of roughly 19,300 m2, with a seating capacity of 3,800 m2 and a closed area of 7,600 m2 spread across two floors. Due to the growing student population at the Faculty of Architecture, it has become challenging to accommodate everyone. To alleviate this issue, a new structure is required. The eco-structure design study, aimed at addressing this need, will serve as a vital solution for the current global challenges and the increasing number of students.

The campus comprises the Harbiye Barracks edifice and its surrounding grounds, which were established as a military institution in 1871. The structure, initially designed in a square configuration, was later expanded to include a southern annex featuring a central courtyard. The edifice is on a north-south sloping terrain, as depicted in Figure 2.

Figure 2. View of the building from past to present (From Past to Present Edirne, 2020).

In the northern section of the property, an aging steel warehouse was deemed unsafe and subsequently demolished to prevent any potential danger to students. The removal of an unsafe warehouse provides spatial opportunity and fertile ground for future research. Exploring how underused university spaces can be redesigned through ecological principles could lead to broader campus transformations. Perhaps adaptive reuse could become a standard method in educational green infrastructure.

If you face south towards the Selimiye Mosque, you will find a parking lot and the canteen's service area, which can be accessed through a separate entrance. It's important to note that while some of the land in this building block area is still under military control, the previously abandoned lodging building has been cleared, and no further construction is permitted.

In the academic year of 2023-24, the institution provided education to 1349 students across its three open departments (Trakya Üniversitesi, 2023). The institution also

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trains its own teaching staff, and its faculty continues to grow every year. Furthermore, the Urban and Regional Planning department affiliated with the faculty will soon begin admitting students, and this number is expected to increase significantly in the future. Due to the workshops that are integral to design education, the requirement for a more spacious environment compared to a lecture hall, and the growing significance of information systems in modern design education, it was determined that the current building's spatial provisions may fall short. A new building was conceived as a solution, replacing the old warehouse structure in the garden's northern section with a light steel construction system (Figure 3).

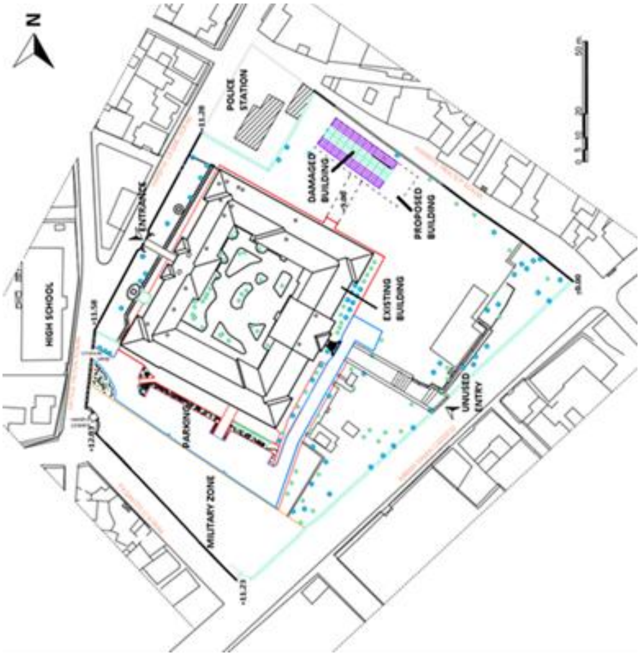

Figure 3. Situation of the Building on the Plot - Layout PlanL

3. Methods

The study investigates the significance of ecological concepts in development and construction. The research was conducted in two phases. In the first stage, relevant literature was researched to design an environmental structure. The literature review covered different disciplines to understand the relationship between eco-education, eco-development, and eco-structure. This helped establish the importance of ecological concepts. In the second stage, an eco-structure was designed using the Idecad program's Architectural add-on, allowing for detailed design and static calculations. The eco-structure aims to teach ecological knowledge through direct experience, utilizing theoretical and digital information (Table 1).

Table 1. Stages of study

Stages of the Study	
1. Theoretical information	2. Digital information
Researching relevant literature	Eco- structure
eco-education, eco-development and eco-building design	Ide CAD Steel and Architectural program
Supporting literature information with architectural digital program	

4. Results

When the study area is examined in terms of ecological design criteria;

1. Climate-sensitive architectural forms and building elements,

1.1. Suitability to the Topography

The work area is compatible with the topography. Design decisions were made by taking into account Edirne's climate conditions. No filling or excavation process was carried out that would damage the soil structure of the land. The design consists of lightweight structural design decisions that can be completely disassembled and assembled. In the layout plan, studio work areas were created to ensure that the workshops received constant light from the north and to take advantage of the shadow of the historical building in the southwest direction. The topography was planned by taking into account ecological sensitivity (Figure 3).

1.2. Protection of the Landscape

The structure was designed by evaluating the unused abandoned steel structure area in the faculty area and taking into account ecological criteria. Therefore, there was no decrease in the amount of green space with the construction. The structure was designed as 2 floors so as not to spread over the area. In line with this approach, the protection of the landscape was ensured (Figure 3,4,7).

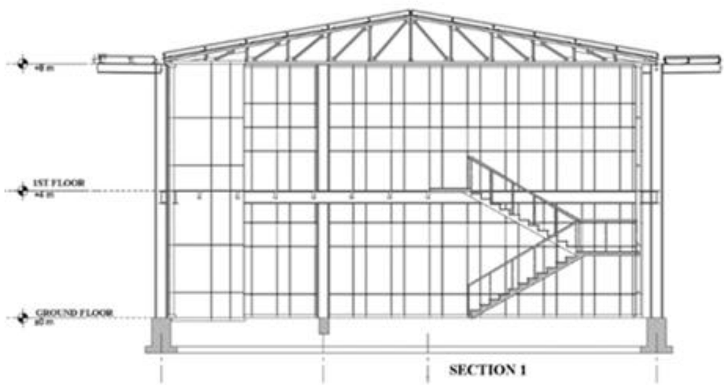

Figure 4. Structural Section view

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2.Passive design strategies such as passive solar heating, good orientation, solar shading, spatial buffering or greenhouse effect

2. 1. Direction Determination of the Building

A settlement plan was designed on the east-west axis to the extent that the topography allows. In this sense, the offices were planned in the south direction to provide maximum benefit. The workshops were designed taking the north direction into account. By creating an opening in the north-south axis, natural air flow was provided in the workshops, which were crowded spaces. In this respect, the criteria for passive energy conservation were taken into account in the design (Figure 5).

Figure 5. Ground floor with main building and surrounding

2.2. Building Form

Designed with a lightweight structure that can be assembled and disassembled, the structure was shaped as a cubic structure to easily comply with the standards. Our structure, which was shaped with this approach, was placed close to and parallel to the existing garden wall to reduce heat loss, creating a trombe wall effect against the wind coming from the north. The maximum heat gain of the structure was ensured by planning it on the southern facade with a transparent surface (Figure 5).

2.3. Building Envelope

In the building shell design of the sample area, it is seen that the area of the void surfaces is designed as 44.77%. (Figure 6. Calculation and drawing of full-empty on the facade) Since the shape of the building is narrow and long, it has a horizontal chimney effect and directs the wind coming from the north to the south. A hipped roof with a slope of 17% (approx. 10°) was designed in accordance with the climate conditions of Edirne. The use of green roofs in the climate of Edirne is not suitable (Nicholaus, 2024).

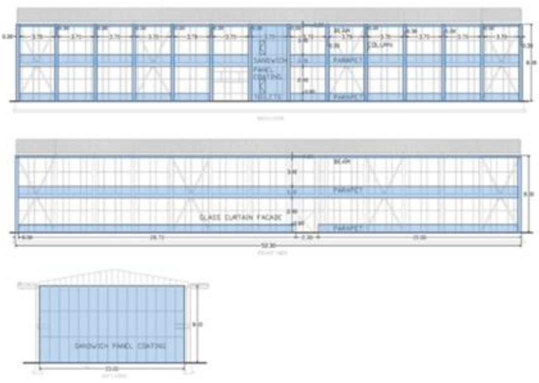

Figure 6. Drawing of full and empty areas on the facade (Northern facade on top, southern facade in the middle, western facade symmetrical with the east at the bottom)

The columns on the front facade extend outward, so they are not included in the occupancy calculation. The components that count as occupancy within the glass curtain wall are the parapets and beams at the ground and typical floor levels.

Calculation of occupancy areas on the front facade:

(28,7 + 21) x 0,8 = 39,76 m² ground floor parapets

52,3 x 1,2 = 62,76 m² first floor parapets and beam

52,3 x 0,2 = 10,46 m² upper beam

On the back view, since the columns are on the facade, 14 columns were used in the occupancy calculation. The other calculated areas were the entire facade, parapets, and beams in the section corresponding to the toilet spaces.

0,3 x 8 = 2,4 m² per column, 2,4 x 14 = 33,6 m² all columns

3,7 x 0,8 = 2,96 m² one parapet on the ground floor, 2,96 x 11 = 32,56 m² ground floor parapets

3,7 x 1,2 = 4,44 m² one parapet and beam on first floor, 4,44 x 12 = 53,28 m² first floor parapets

3,7 x 0,2 = 0,74 m² one part of roof beam, 0,74 x 13= 9,62 m² roof beam

3,7 x 8,0 = 29,6 m² façade on the wet areas

On the left and right façade, there is no glass, whole sandwich panel coating with the same size.

15 m width x 8 m height x 2 façade = 240 m²

Total occupancy on whole facades;

39,76+62,76+10,46+33,6+32,56+53,28+9,62+240= 482,04 m²

Total façade area;

15 x 8 x 2 = 240 m² (left and right facades); 52,3 x 8 x 2= 836,8 m² (front and back facades)

240+836,8 = 1076,8 m²;

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The total occupancy rate on whole facades: % 44,77

2.4. Space Between Buildings

The designed building is approximately 25 m away from the main mass. This decision ensures that the studios benefit from maximum shade and efficiently use the garden area between the two buildings (Figure 7).

Figure 7. Shadow size of the area on 21st Oct 11:15 am and 3:53 pm by the same view

2.5. Space Organization

The entrance to the rectangular building measures 15 meters by 52 meters and is situated asymmetrically. This design accommodates separate wet areas for girls, boys, and disabled students. These areas can be accessed through the upper arm of the double-armed staircase on the entrance axis. The BIM program (IdeCAD Steel and Architecture) created a carrier system that best suits architectural needs. This resulted in developing different workshop types on the ground floor, each tailored to the varying numbers of students in various departments. There are two workshops, one for 79 people and the other for 56 people, and two classrooms designed for seminars with a capacity of 85 people. These facilities are open to the corridor on the ground floor. The interior of the building was designed with an axis arrangement in mind, and the dividing walls are made of prefabricated materials that can be changed according to need. Additionally, the workshop for 56 people can be converted into a computer workshop when necessary (Figure 8).

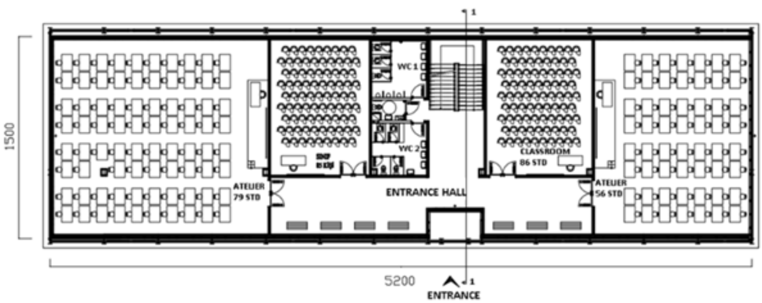

Figure 8. Ground Floor Plan

On the first floor, the workshops are uniformly sized and stacked on top of each other. However, faculty rooms facing the entrance have been added, with the hall in the center. This design has shortened the class units to accommodate 48 students. The rooms, accommodating up to 8 faculty members, are positioned to receive sunlight from the southwest direction and offer a view of the historical building and entrance. Our school values transparency in education, and direct access to faculty members is necessary for our approach. To facilitate this, the rooms are on the same corridor, providing quick and easy access to the classrooms and workshops where learning occurs (Figure 9).

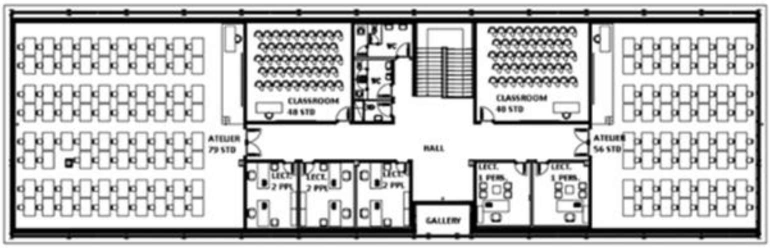

Figure 9. First Floor Plan

The design of the main entrance door on the front façade, with its wide eaves protecting from external weather conditions, is a nod to Turkish architecture. However, modern materials were used to ensure they meet current needs. The parapet height and size of the wings were carefully designed with ergonomics and application principles in mind to allow for natural airflow. Additionally, cross beams were strategically placed on specific axes in the long arms in the south and north directions to support the light steel columns and add a dynamic element to the façade tailored towards a younger user profile, as seen in Figure 10.

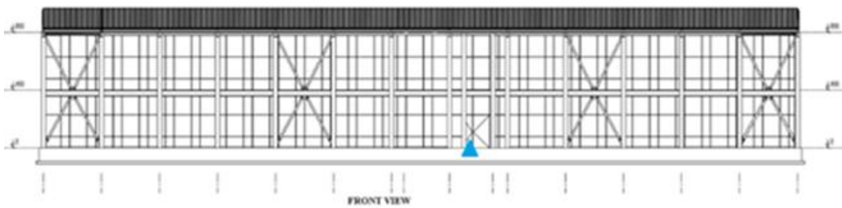

Figure 10. View from the historical building

In the design process, we carefully considered local regulations, historical environmental construction conditions, space requirements, and ecological structure features. Our goal was to create a building that seamlessly blended into the surrounding area without disrupting the silhouette of the Selimiye Mosque or exceeding the size of the current faculty building.

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On the ground floor of the existing building, located at +11.00 elevation, you can access the unused entrance to the east, which leads to a partial basement used as a warehouse. The proposed building's ground level is +9.00, and visitors can move between blocks through the garden exit door in the northeast direction. The main entrance door can be connected to the garden through the stairs on the walking path.

The existing historical building has a floor height of 4.50 m, including the ground and ordinary floors, with a total floor height of 9 m, excluding the roof construction. The proposed building's roof deck height is designed to be 8 m, ensuring it does not exceed the height of the historical building (Figure 4).

2.6. Material Selection and Plumbing

In line with the ecological studio design, steel was preferred as a carrier system to be able to pass through wide openings and wood was preferred as a coating on solid surfaces. Wood was used because it has low harmful chemical content, is completely recyclable and biodegradable, and has no negative effects on user health. Similarly, glass, a natural material, was used in the organization of open surfaces that constitute 44,7% of the facade. By leaving the structure and coating materials visible to users, ecological education was ensured in the ecological structure. The design did not include an approach for incorporating the water cycle.

3.Energy efficient technologies and devices for heating, ventilation and control (Active Method)

3.1. Solar Collectors

Solar panels measuring 1.75 m x 1.15 m were used on the roof. In case of being affected by the shadow of the main building, the solar panels are placed towards the ridge point of the roof (Figure 11).

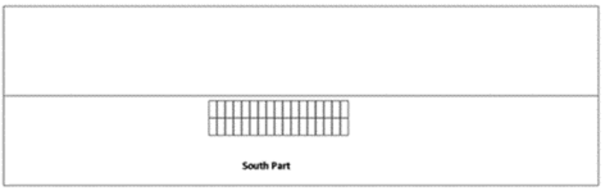

Figure 11. Solar panel on the roof facing South

3.2. Photovoltaic (PV)

In order to calculate the electricity consumption for each space, some assumptions had to be made:

1. Drawing Studios (79 and 56 people):

- Lighting: Students will use a drawing table, which requires constant lighting. Although natural light is at the maximum level for both studios, general lighting is needed for areas in the shade.
- Electronic devices: One faculty computer and projector in each studio.
- Seminar Halls (86 and 85 people):

• Lighting: General lighting will be needed in the seminar halls along with the use of projectors.

• Electronic devices: There will be a projector and a computer.

2. Toilets:

• Lighting can work for a certain period of time (with sensors).

3. Classrooms (48 people, 2 units):

Lighting: Although natural light is used to the maximum, lighting at full capacity will be needed.

• Electronic devices: Faculty computer and projector.
• Faculty Rooms (5 units, 2 people):
• Two computers and general lighting in each room.

4. Hall and Entrance Hall:

Lighting: Since the upper hall is illuminated from above, natural light can be used. The entrance hall on the ground floor will also need constant lighting (Table 2).

Below is a table with an estimate of electricity consumption for each location. Consumption is based on 8 hours of operation per day and 5 days of use per week.

Table 2. Electricity consumption for each location

Place	Area (m^2)	Devices	Lighting (kW)	Device Consumption (kW)	Daily Consumption (kWh)	Monthly Consumption (kWh)
Drawing Studio (79 people)	~150	1 computer, 1 projector	1.2	0.5	13.6	299.2
Drawing Studio (56 people)	~120	1 computer, 1 projector	1.0	0.5	12	264
Seminar Hall (86 people)	~120	1 computer, 1 projector	1.0	0.5	12	264
Seminar Hall (85 people)	~120	1 computer, 1 projector	1.0	0.5	12	264
Restrooms	~60	Motion sensor lighting (4 hours/day)	0.5	-	2	44
Classroom (48 people)	~100 (2 units)	1 computer, 1 projector	0.8 (each)	0.5	10.4 (each)	228.8 (each)
Faculty Offices	~15 (5 units)	2 computers	0.15 (each)	0.2	2.8 (each)	61.6 (each)
Hallway (Upper Floor)	~50	Overhead lighting, minimal light	0.2	-	1.6	35.2
Entrance Hall (Ground Floor)	~60	Continuous lighting	0.5	-	4	88

Total Monthly Consumption (kWh):
When the consumption of all venues is added up:
Drawing Studios: 299.2 + 264 = 563.2 kWh/month
Seminar Halls: 264 + 264 = 528 kWh/month
Toilets: 44 kWh/month
Classrooms: 228.8 + 228.8 = 457.6 kWh/month
Teaching Staff Rooms: 61.6 * 5 = 308 kWh/month

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Upper Floor Hall: 35.2 kWh/month
Entrance Hall: 88 kWh/month
Grand total: 563.2 + 528 + 44 + 457.6 + 308 + 35.2 + 88 = 2023 kWh/month

This is a general estimate that our 1560 m² school building will consume approximately 2023 kWh of electricity per month despite the use of natural light. This value may vary depending on the intensity of use of the building and energy-saving methods. To meet this consumption with solar panels, the daily energy requirement and the daily production amount of a panel have been calculated.

The educational building's daily energy needs, which are 2023 kWh monthly, are as follows:

2023 / 30 =67,43 kWh/day.

If the average sunshine duration of a modern solar panel (e.g. 400 W) in Edirne, Türkiye is assumed to be 5 hours per day (with a southerly inclination):

Daily production of one panel = 400 W x 5 hours = 2kWh/panel/day

Solar panels that can produce this amount are usually produced with monocrystalline cell technology. Monocrystalline panels consist of high-purity silicon crystals and thus provide higher efficiency and energy production. In addition to producing more energy by converting sunlight into electricity more effectively, they are resistant to harsh weather conditions with their aluminum frame and tempered glass surface. They also have a service life of 25 years or more with proper maintenance.

In Turkey, a 400 W monocrystalline solar panel measures approximately 1.15 m x 1.75 m and covers an area of 2 m².

Number of panels required to meet daily energy needs:

Number of panels needed= Daily energy requirement /

Daily production of one panel = 67,43 / 2=34 panels

Since the dimensions of one panel are approximately 2 m², the total area required for 34 panels is; 34 x 2=68 m².

Since the existing roof has a south-sloping area of 52 m x 7.86 m = 408.2 m², this area is more than enough for 34 panels. If the necessary gaps between the panels are taken into account, all panels can be easily placed. When the energy production of these panels is verified, the total monthly energy production of the 34 panels is:

Total energy production= 34 panels x 2kWh x 30 days = 3040 kWh / month

This amount is enough to meet the monthly consumption of 2023 kWh. In addition, the cost and payback period of the investment to be made must be calculated. In order to calculate the installation cost, unit panel prices and assembly costs must be taken into account. When examined and compared across manufacturing companies, on average:

- Cost of a panel (400 W): 200 USD.
- Total cost of 34 panels: 34 x 200 = 6800 USD (approx.)
- Total cost including inverter and installation costs: 10,000 - 12,000 USD

As of 2024, the unit price of electricity in residences and commercial buildings in Turkey is around 4,2 TL/kWh (on average; it may vary depending on local prices). At this price, the estimated annual electricity bill for the faculty building's monthly energy consumption of 2023 kWh is:

Monthly electricity bill = Monthly energy consumption x Unit price

2023 kWh x 4,2 TL = 8496 TL/month

8496 TL/month x 12 months = 101.952 TL /year

Total cost: 10,000 - 12,000 USD (including panel, inverter, mounting and fasteners). When this price is converted to TL: 10,000 USD × 35 TL/USD = 350,000 TL.

The payback period of the investment cost according to the amount of savings on the electricity bill can be calculated as;

350.000 TL /101.952 TL = 3,43 years. This period may be shortened further if there is an increase in electricity prices or if incentives are received.

5. Discussion

This structure is designed to serve as an educational tool for the students of the Faculty of Architecture, showcasing sustainable and ecological building design, as well as material and application details. The load-bearing system of the structure is left wholly exposed during both the construction and usage phases. Though the students are not currently utilizing the space, it will provide additional space for the faculty's needs, and the afforested area in the north and east will become more usable. Findings obtained by using eco-design criteria supported by the literature as a method with the IdeCAD Architectural and Steel program,

Materials and Resources:
Resource consumption in the design of steel structures is impacted by the amount of material used, as well as the size and complexity of the structure. The design of the rectangular annex building in question is relatively simple, with clear spaces. Steel columns and beams were used to create a sturdy and straightforward design. Using recycled steel and modular construction techniques minimizes resource consumption and waste. Steel columns were fashioned from 40 cm x 40 cm H profile (HE 400 A) material. These columns were then connected through steel beams with I profiles (IPE 400) of the same size. For the floor slabs, 24 cm I profile (IPE 240) type profiles were attached to the main beams, with trapezoidal sheet metal fixed onto these profiles. The floor was then achieved by pouring concrete over ribbed mesh reinforcement. Wet areas were finished with ceramic flooring, while PVC flooring was used in classrooms, workshops, and halls.

Energy Efficiency:
The building uses a curtain wall system with insulation to reduce heat loss and energy consumption, featuring glass on the expansive front and rear facades. At the same time, aluminum was employed on the less prominent side facades. This system also allows for ample natural light, reducing the need for artificial lighting. This system effectively curbs heat loss by incorporating insulation materials, resulting in notable energy savings. Additionally, properly applying the curtain wall system helps regulate airflow, preventing external air from seeping into the building while allowing ample natural light to permeate interior spaces. This energy-efficient approach reduces the need for artificial lighting and enhances overall user comfort.

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Fast and Flexible Construction:
The design prioritizes modularity and establishes a solid foundation for pre-production. This allows for seamless adaptability, quick assembly, and plan scalability. Furthermore, curtain wall systems are viable for integrating renewable energy technologies, such as solar panels and wind turbines.

Durability and Safety:
During the study, the installation to ensure a sturdy connection between the anchor rods in the raft foundation and the steel columns is carefully planned. The steel material employed is highly flexible, allowing for optimal force distribution, and its lightweight design significantly reduces the load during seismic activity, thereby enhancing the structure's earthquake resistance. Also, fire-resistant coatings and utilizing the steel material's inherent high-temperature resistance are incorporated to further strengthen the building's durability, given the significant number of individuals who will use it.

Zero Waste and Recycling:
The study focused on designing light steel structures with a zero-waste principle. The modular structure allowed for minimal construction waste. Using bolts and nuts enabled a completely disassembled and reassembled system, making it easy to reuse the primary carrier system even if moving to a new location.

6. Conclusions

The Faculty of Architecture building of Trakya University stands as a remarkable reminder of its time, featuring a distinct U-shaped design and an inner courtyard formation that showcases its architectural style. As we usher in a new era of environmental consciousness, established institutions must take innovative measures toward ecological awareness, knowledge transfer, and self-assured local growth. Prioritizing eco-development and education can help create an environment fostering active citizenship and sustainable living.

The Trakya Faculty of Architecture has proposed establishing an ecological structure, which includes constructing an "ecological structure configuration annex building" for students. This initiative aims to promote eco-development and enhance eco-awareness in the region. Once the infrastructure works are completed, the proposed workshops, classrooms, and offices will enable students to participate more actively in the concept of 'ecological structure.' By providing a hands-on experience in this field, students can enhance their professional education experience. This initiative will not only increase students' knowledge in the field of ecological structure but will also help them develop a deeper understanding of the importance of eco-friendliness, which will help them become responsible and sustainable architects in the future.

The eco-education building holds immense potential to foster ecological development in the broader region by serving as a hub for recognizing and studying the cultural environment of the Trakya Faculty of Architecture and the surrounding areas. By facilitating research, education, and community outreach programs, the building can catalyze sustainable development practices and promote a deeper understanding of the interdependence between human society and the natural world. The eco-education building aims to inspire a new generation of architects, scholars, and environmentalists to work towards a more harmonious and sustainable future for all through its innovative design and state-of-the-art facilities.

Supporting eco-design criteria with an architectural digital program enabled the eco-values of the building to be seen before being implemented in eco-building construction. The holistic use of literature and digital information helps to see preliminary information in the design and implementation of eco-buildings in line with sustainability and sustainability development goals. The structure implemented in this direction offers experience in eco-education.

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