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The Design of the Tourist Complex of Abali Resort, Optimized Based on the Angle of Sunlight

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Abstract

This study examines the design of a commercial and office center near the Abali ski resort, developed by a specialized team to meet the needs of athletes at the site. Given the cold and mountainous climate, the design emphasizes energy efficiency by incorporating a significant amount of glass in the facade to maximize the view. To regulate light and temperature, shading devices were considered. The design was analyzed for energy efficiency using Ladybug and Honeybee software, with simulations conducted to determine the optimal orientation of the shading devices. This research introduces a novel approach to optimizing shading devices using advanced simulation tools, tailored to the specific climatic conditions of the Abali resort.

Keywords

Tourist Complex, Angle of Sunlight, Energy Efficiency, Shading Devices, Commercial Center

1. Introduction

Architecture plays a significant role in shaping the tourism industry, as it has the power to captivate and inspire travelers from around the world. From iconic landmarks to modern marvels, the architectural landscape of a destination can greatly influence the number of visitors it attracts. In this blog, we will explore how architecture affects tourism and why it is an essential aspect of any travel experience [1]. Architecture always had a great significance in tourism. Most of the visible aspects of cultural landscape are architecture of the place which means that how visitors will perceive the destination and visually experience it depends largely on how appealing the architecture of the destination is. When talking about architecture in tourism, we are not mainly interested in theoretical knowledge of architecture, but in understanding the culture of the place, artistic flows and influences that created buildings as they are, to have visual experience and take memory back home. In the time of Grand Tours learning about architecture of Italy, or any other country for that matter, was a part of sophisticated education of young people of high society [2]. Admiring, understanding and learning about architecture as a part of education later became a trend in tourism. Branding and targeting unique architecture elements and sights as tourism attraction of a destination can attract more tourists [3] which in turn can bring financial and economic benefits to a host society. That means that architecture can also be a tourism product offered to potential visitors. In the past decade, a new trend has been noticed that large number of tourists are attracted not only to the old architecture sites, but to the new architectural hotspots which were triggered after opening of Gehry's Guggenheim Museum in Bilbao, and the phenomenon of creating such buildings was named Bilbao Effect. Therefore, research on architecture as an attraction element in tourism is necessary not only because of economical but also cultural and educational effects of tourism. Architecture has been recognized for its supporting role in the enhancement of the physical assets of destinations, which play a leading role in drawing tourists who identify and associate destinations with these architectural landmarks. While generating tourist expenditure is not the aim of most architects, many are increasingly aware that articulated and functional buildings become visitor attractions in their own right—an externality that requires valuing. However, the value assigned to iconic architecture is often restricted to the bricks-and-mortar construction, and the broader contributions a building can deliver to its stakeholders are largely ignored. This article explores the capacity for architecture to attract tourists and affect direct tourism spend through the examination of five cases, each of which has attempted to estimate their economic value to tourism. This article proposes a model for estimating the future value of iconic buildings and tests its application to the University of Technology Sydney, Gehry-designed, Dr Chau Chak Wing building. The implications of the framework and future research are discussed [4]. Designing a house to respond to the sun requires mindfulness and intentionality from beginning to end. A whole system approach is required, starting with good project goals and a cohesive design concept. Focusing on one aspect of the design (like sun shading) and thinking it has been nailed is not sufficient. A holistic approach to the entire design is necessary. All aspects of building design, from site design to building design to building construction, are involved. Starting early and being intentional in the big overall design moves (such as how spaces are located, sized, and oriented) will go a long way in making it easier to design a house to respond to the sun. Once the big design moves are figured out, the smaller essential considerations become a little easier to manage and account for. The building shape and room configurations affect how much light and heat can penetrate the house as well as which rooms will receive the most sunlight and heat gain. Locating certain less frequent rooms on the north face can open up views and sunlight to the south; great for passive solar design if shaded properly [5]. The aim of this research is to craft a picturesque tourist resort nestled in a mountainous setting, guided by the principles of solar orientation.

2. Methodology

This study examines the design of the tourist complex of Abali resort, optimized based on the angle of sunlight and analyzing green architectural design principles through the lens of "Lead." The U.S. Green Building Council (USGBC) was founded in 1993 to protect the environment by implementing the "LEED" approach within the American architectural framework. The "LEED" rating system exemplifies the council's endeavor to set a high benchmark for assessing green buildings. In 1998, the first edition of the LEED certification was launched. It has been updated several times over the years, and we now use its third version. While LEED certification is recognized as a national standard for assessing green buildings, it has also been adopted globally as a benchmark for the design, construction, and operation of environmentally friendly buildings. LEED serves as a guide and tool for issuing third-party certifications, aiming to enhance environmental performance, occupant well-being, and economic efficiency in building usage. This standard promotes innovation and technology worldwide. Additionally, it motivates clients and professionals to design, build, and manage more eco-friendly buildings. The scoring method for different types of LEED certifications is illustrated in **Figure 1** [6].

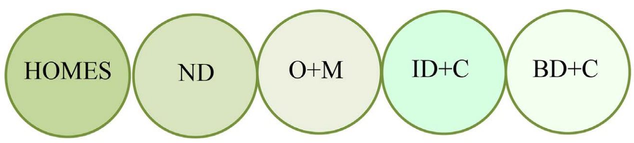

Figure 1. LEED certifications for different construction activities.

The aim of LEED certification is to evaluate a wide range of building types, spanning from new constructions and significant renovations to existing structures, commercial interiors, and core and shell constructions. The LEED checklist comprises five essential components, namely [7]:

1) Sustainable Sites
2) Water Efficiency
3) Energy and Atmosphere
4) Materials and Resources
5) Innovation in Design Process

If a project is structured and designed according to these six primary categories, or in simpler terms, if it aligns with LEED standards, it will yield a holistic outcome eligible for Silver, Gold, or Platinum certifications, contingent upon its commitment to environmental sustainability principles.

The sustainability of a site has a nuanced impact on contractors, yet it holds significant implications for owners and the engineering design team. Owners can earn up to 36 points in this category out of a total of 100, with most projects typically achieving around 75% of these points. Many of these points can be accessed without incurring additional initial construction costs. Key decisions, such as selecting brownfield redevelopment sites and promoting alternative transportation methods, are usually made by the owner. Even when a construction site is predetermined, the architectural and engineering teams still have numerous design opportunities to address green architecture challenges. These considerations can lead to reduced construction costs and favorable returns on operational expenses [8].

The criteria for site sustainability encompass several critical aspects. Site selection emphasizes avoiding unsuitable developments and mitigating the environmental impacts associated with construction activities. Urban density plays a pivotal role, prioritizing projects in urban areas with established infrastructure to conserve green spaces and protect habitats and natural resources. Revitalization efforts focus on areas affected by environmental harm, including the restoration of polluted sites where development is complicated by contamination.

Alternative transportation methods are essential for minimizing pollution and the land development impacts associated with automobile use, which includes reducing parking space requirements and encouraging shared facilities with neighboring buildings. Water preservation involves protecting existing natural resources and restoring degraded areas to create habitats and enhance onsite biodiversity. The use of indigenous vegetation is encouraged, as it supports the development of a natural ecosystem that requires minimal water and irrigation.

Surface water control is vital for preventing pollutants from entering natural waterways through effective management practices, including rainwater harvesting for irrigation. Addressing the urban heat island effect is another important consideration, as it seeks to reduce temperature differentials between developed and undeveloped areas, thereby lessening environmental impacts on both humans and wildlife. Finally, the minimization of light pollution is achieved by adhering to lighting guidelines that maintain appropriate illumination levels while preventing light spillage. This not only enhances access to the nighttime sky but also mitigates the adverse effects of development on nocturnal ecosystems.

The growing emphasis on sustainable building practices has prompted the development of various concepts aimed at enhancing water efficiency. Property owners can achieve a comprehensive improvement in building standards by implementing effective solutions that incur reasonable initial costs and yield a payback period of fewer than five years. Notably, reductions in water consumption within many residential structures are often linked to the necessity for water-cooled equipment. The criteria for water efficiency are as follows. Efficient water equipment for landscape maintenance is essential, with the goal of achieving a

50% reduction in water use by minimizing reliance on potable water for irrigation. This approach not only conserves resources but also aligns with broader sustainability goals.

Innovative solutions for wastewater management focus on reducing wastewater generation and the demand for potable water, thereby improving local water retention. Strategies include minimizing dependence on municipal drinking water for building sewage needs and utilizing surface water and rainwater for sewage conveyance and landscaping through the implementation of on-site treatment facilities.

Additionally, efforts to decrease overall water usage by 20 to 30 percent involve optimizing water consumption within buildings to alleviate pressure on municipal water distribution and sewage systems. This includes a thorough assessment of both drinking and non-drinking water needs within the premises, as well as the integration of high-performance appliances and fixtures. Furthermore, introducing metering mechanisms can empower users to monitor and reduce water wastage effectively [9].

The criteria for Energy and Atmosphere are as follows (**Table 1**):

Table 1. Energy and atmosphere.

17 points Possible	Energy and Atmosphere
necessary	Ensuring correct operation of building systems and elements
necessary	Minimal energy consumption in the building
necessary	CFC reduction in cooling, ventilation and air conditioning equipment
1 - 10	Optimizing energy consumption in the building
1	Renewable energy sources, 5 percent
1	Renewable energy sources, 10 percent
1	Renewable energy sources, 20 percent
1	More assurance of correct operation of building systems and elements
1	Prevent the destruction of the ozone layer
1	Measurement and audit of energy consumption in the building
1	Use of green energy

1) Setting a minimum energy standard for the fundamental building and system needs. Designing building envelopes and systems to optimize energy efficiency. Utilizing computer simulation models to evaluate energy efficiency and identify the most economically viable energy quantity relative to the base building.

2) Minimizing Energy Consumption in Buildings.

3) Reducing CFCs in cooling, ventilation, and air conditioning equipment.

4) Enhancing energy performance through design optimization presents valuable opportunities and encompasses:

a) Implementation of building codes and regulations

b) Efficient insulation for energy conservation

c) Integration of external shading mechanisms and solar shades on suitable building facades

d) Deployment of energy recuperation systems

e) Adoption of variable air volume ventilation systems

f) Installation of high-efficiency exhausts ventilation systems

g) Harnessing on-site renewable energy resources

5) Verifying the Precision of System Performance and Building Components (Ensuring that all critical building components and designed systems are installed and calibrated).

Materials: The materials and resources segment presents an opportunity for insurers to exert considerable influence on a project's outcome. Certain issues pertaining to contractors are influenced by the proportion of locally sourced materials purchased and their effectiveness in recycling materials and managing waste within the construction industry. Contractors should proactively seek out affordable local and indigenous resources. The initial contract should stipulate the contractor's commitment to utilizing recyclable materials in construction. The sustainable site criterion and its corresponding scores are outlined in **Table 2** [10].

Table 2. Materials and materials.

13 points Possible	Material
necessary	Storage and collection of recyclable materials
2	Reusing the building by maintaining the existing walls and floors
1	Reusing the building by maintaining the non-structural elements inside the building
2	Construction waste management
2	Reuse of materials and products used in the building
2	Use of recycled materials
2	Use of local materials and products
1	Use of materials and materials with a high renewal rate
1	The approved use of wood

3. Construction Waste and Debris Management

The management of construction waste and debris is an essential component of sustainable building practices. Effective strategies must be implemented to minimize the environmental impact of construction activities and to promote resource efficiency.

1) Storage and Collection of Recyclable Materials

A well-organized system for the storage and collection of recyclable materials is critical. Establishing designated areas for sorting materials at the construction site facilitates efficient recycling and reduces contamination of recyclable waste. Training workers in proper handling and segregation techniques can significantly enhance the recovery of materials.

2) Reuse of Buildings

Maintenance of Existing Walls and Floors

The preservation of existing walls and floors is a key strategy in reducing waste. By maintaining these structural elements, projects can minimize the demand for new materials and decrease the overall environmental footprint of construction activities.

3) Maintaining Non-structural Elements

Similarly, non-structural elements, such as interior fixtures and finishes, can often be reused in new projects. This approach not only conserves resources but also retains the character and functionality of existing spaces, reducing the need for extensive renovations.

4) Construction Waste Management

Effective construction waste management encompasses planning and ongoing evaluation of waste generation throughout the construction process. Developing a comprehensive waste management plan tailored to specific project requirements can significantly reduce the volume of waste produced.

5) Reuse of Materials and Products

The reuse of salvaged materials from deconstructed buildings contributes to a more sustainable construction cycle. Techniques such as deconstruction, as opposed to demolition, allow for valuable materials to be recovered and repurposed, reducing landfill contributions.

6) Use of Recycled Materials

Incorporating recycled materials into new construction projects is an effective strategy for minimizing waste. By using reclaimed aggregates, recycled plastics, and other repurposed materials, builders can significantly decrease their reliance on virgin resources.

7) Use of Local and Indigenous Materials

Utilizing local and indigenous materials not only supports local economies but also minimizes the carbon footprint associated with transportation. These materials often have characteristics well-suited to the local climate, further enhancing their sustainability.

8) Use of Materials with High Renewability Rates

Materials that are rapidly renewable, such as bamboo or cork, present viable alternatives to conventional building materials. These resources, when sourced responsibly, contribute to a more sustainable building environment.

9) Use of Certified Wood

Choosing wood certified by reputable organizations ensures sustainable harvesting practices. This commitment to responsible forestry helps combat deforestation and promotes ecological balance in construction practices.

10) Recycling Practices

Recycling is a process that involves the conservation and repurposing of used materials. By gathering and segregating construction waste, these materials can serve as raw inputs for the creation of new products, thus reducing the demand for virgin materials.

11) Waste Recycling Management

To facilitate effective recycling, it is crucial to provide training focused on gathering, categorizing, and segregating materials. Familiarity with recycling technology and practices is essential for reintegrating materials into the building lifecycle, particularly in regions like Iran, where the building lifecycle is estimated to span around 30 years. As a significant portion of urban structures deteriorates, the construction of new buildings is set to generate a considerable volume of construction waste.

12) Quality of Indoor Environment

Improving indoor environmental quality (IEQ) plays a pivotal role in enhancing the overall quality of life for building occupants. Many goals related to IEQ do not entail significant extra costs or yield easily measurable returns on investment. However, they contribute substantially to occupant health and well-being.

Enhanced daylighting, for example, is linked to improved health outcomes and increased productivity among employees. These benefits underscore the importance of integrating standards for indoor environmental quality in construction projects. The corresponding scores and metrics for these standards can be found in **Table 3** [6].

Table 3. Quality of interior space.

15 points Possible	The quality of the interior
necessary	Achieving the minimum desired indoor air quality
necessary	Controlling the amount of cigarette smoke released in the environment
1	Installation of carbon dioxide measurement systems in the exhaust air of the building
1	Effective ventilation
1	Indoor air quality management during construction
1	Indoor air quality management before operation
1	Using materials with low pollution levels—adhesives and sealants
1	Using materials with low pollution levels—paints and coatings
1	The use of materials with a low level of pollution—flooring
1	The use of materials with a low level of pollution—wooden products
1	Control of chemical and biological pollutants inside the building
1	Controllability of lighting systems
1	Controllability of ventilation and heating systems
1	Thermal comfort system design
1	Heat comfort system audit
1	Providing natural light and a suitable view for 75% of the spaces
1	Providing natural light and a suitable view for 90% of the spaces

Contractors play a role in shaping the construction management strategy both during and after the construction phase. It is the contractors' responsibility to acquire the most appropriate adhesives, sealants, paints, coatings, carpets, wood, and composites. These materials are outlined in the applicable standard.

4. Innovative Design Processes

Innovation in the design process usually entails teamwork among an architectural team, knowledgeable engineers, and a specialized lead expert. The criteria for innovation in the design process and the corresponding scores are depicted in Table 4.

Table 4. Innovation in the design process.

5 points Possible	Innovation in the design process
4	Innovation in the design process
1	Synchronized Design with Lead

Some notable points:

- Specific tasks aimed at reducing operational costs.
- Providing users with signage for sustainability education, using sustainable education solutions.
- Promoting green architecture and staff training.
- Clarifying design intentions for users through staff, graphic signs, informational boards, and tools that evolve over the building's lifespan.
- Material selection based on life cycle analysis.
- Improving acoustic performance.

5. Utilizing Professional Experts as Leads

Attending recognized and professional workshops focusing on LEED education is crucial for obtaining credits, approval, and official LEED certification for building design aligned with LEED green building standards (U.S. Green Building Council, 22-20).

Design Process

The reason for choosing the project site:

Damavand is a city in the Tehran Province and the capital of Damavand County. The Damavand Municipality was established in 1933. On September 15, 1931, Damavand and its surrounding areas were registered as national heritage sites in Iran under the registration number 56. Additionally, Damavand has been selected as a model tourist city in Iran.

Damavand is located along the route from Imam Zadeh Hashem Pass, which serves as a connection between Tehran and Amol, extending to the road linking Tehran with Firouzkouh and Sari. In the city center, covered with trees, the Tar River flows through. In the past, the river's floods have destroyed the city center multiple times. Tar Lake, one of the most beautiful freshwater lakes in Iran, is located nearby, and to reach it, one must pass through the Chenar-e Sharq area.

Other tourist attractions in Damavand include the Sheikh Shebli Tower and the Jameh Mosque of Damavand, both of which are ancient and historical landmarks. Additionally, natural attractions like the Abali Ski Resort, Tizab Waterfall, Ayneh Rood Waterfall, and Cheshmeh Ala Spring also draw visitors to the area.

The climate of the city is cold and suitable for a summer retreat. The highest temperature in the summer reaches 27˚C, while the lowest in winter drops to -20˚C. The average annual rainfall is

around 350 millimeters. Access to the city of Damavand is possible via the main Tehran-Qaemshahr road, with Damavand located just 1 kilometer from it, and the main Tehran-Amol Road, with Damavand situated 55 kilometers along this route. These are the primary access routes to the area. With an area of 188,000 hectares, Damavand County has the potential to allocate large plots of land for various uses.

6. Innovation Design Process

A design team, including architectural specialists, has been assembled to design a commercial-administrative complex in Abali, aimed at serving tourists in the Abali ski resort area. In addition to providing services to travelers, one of the team's primary concerns is energy optimization. Effective research and actions have been undertaken in this regard. The goal is not only to achieve mandatory energy savings but also to control lighting using shading devices (shaders). The dimensions and angles of these shaders have been precisely determined through software simulations.

7. Initial Concept

7.1. Use of Dense Volumes in Design

Based on this approach, empty spaces in the design should be minimized, and the building should expand vertically across multiple floors.

7.2. Utilization of Solar Heat (Active Solar Systems)

Therefore, the building's design should have an elongated form facing south to maximize the use of solar energy.

7.3. Use of Buffer Spaces for Energy Absorption and Distribution

Spaces such as greenhouses or terraces should be included in front of the units, featuring full-length south-facing windows. These areas will capture and distribute solar heat into the interior spaces.

7.4. Use of Buffer Spaces at Entrances

One factor that leads to the loss of thermal energy in a building is its entrances.

Therefore, an intermediate space with an automatic door should be incorporated. This setup ensures that individuals first enter a buffer zone before moving into the main space, which can effectively reduce energy loss.

8. Enclosing the Building's Facades on the Site

To reduce energy loss in the proposed design, three facades of the building should be enclosed. The site's topography should be utilized to shield the building using the surrounding mountains. To preserve the topography; the building must follow the natural slope of the land, resulting in a multi-story design.

Consequently, the roof areas will increase in the design. According to the studies, roofs are a significant factor in energy loss. Therefore, the design should incorporate the use of earth covering to conceal the roofs and prevent energy loss.

9. Creating Energy-Collecting Roofs

The use of sloped windows on the roofs pertains to areas where it is not possible to utilize solar energy from vertical facades. Therefore, in the proposed design, the end sections of the building, which are enclosed by mountains, will feature skylights to take advantage of solar energy and natural light.

10. Ensuring Thermal Comfort

Utilizing modern solar energy techniques with effective use of the site's potential can address shortcomings in thermal comfort. As was mentioned before, employing suitable materials (with high energy resistance), incorporating double-skin facades, and leveraging passive solar energy can successfully achieve thermal comfort.

10.1. User Comfort Conditions

Given the region's climatic characteristics and its cold weather, one key aspect of user comfort is achieving a balanced temperature by utilizing both natural and mechanical systems.

Additionally, ensuring the provision of adequate spatial amenities is crucial for user comfort.

What strategies and elements in design enhance the efficiency of natural energy use, reduce its waste, and preserve the environment? In response to this question, it can be stated that employing climate-responsive architectural solutions can be effective in reducing energy waste. Accordingly, the following: strategies are proposed.

10.2. Use of Dense Volumes in Design

Accordingly, empty spaces in the design should be minimized, and the building should expand vertically across multiple floors.

Utilization of Solar Heat (Active Solar Systems): Therefore, the building should be oriented with an elongated. shape facing south to maximize the use of solar energy (**Figure 2**).

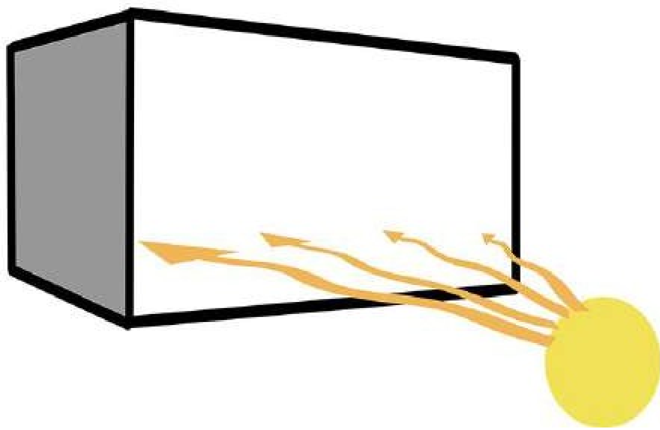

Figure 2. Utilization of solar heat.

11. Use of Buffer Spaces for Energy Absorption and Distribution

Accordingly, spaces such as greenhouses, but designed as terraces in front of the units, should be considered. These spaces should feature full-length south-facing windows to capture solar heat and distribute it into the interior spaces (**Figure 3**).

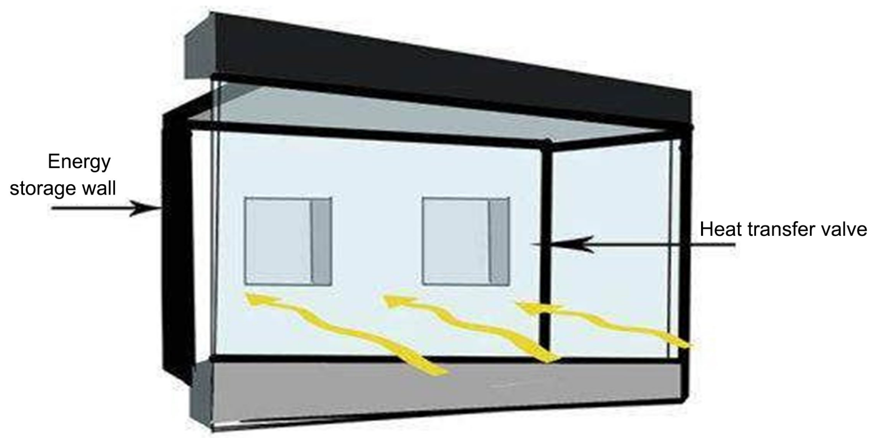

Figure 3. Use of buffer spaces for energy absorption and distribution.

12. Use of Buffer Spaces at Entrances

One factor that leads to the loss of thermal energy in a building is its entrances. Therefore, an intermediate space with an automatic door should be used. This setup ensures that individuals first enter a buffer zone before moving into the main space, which can effectively reduce energy loss (**Figure 4**).

13. Enclosing the Building on the Site

To reduce energy loss in the design, three facades of the building should be enclosed. Therefore, the site's topography should be utilized to shield the building using the surrounding mountains (Figure 5).

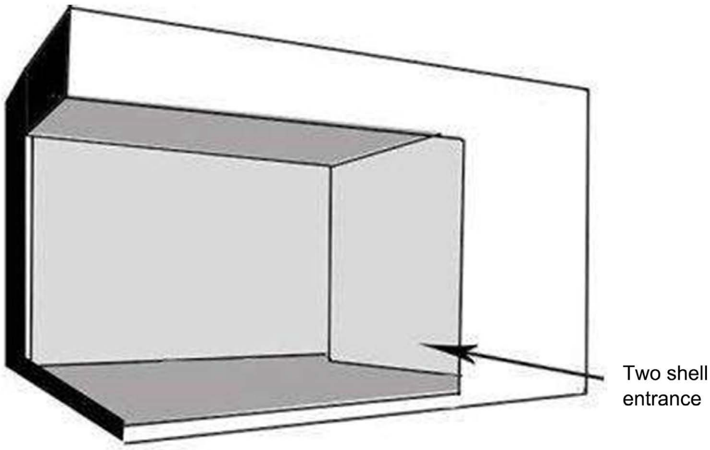

Figure 4. Use of buffer spaces at entrances.

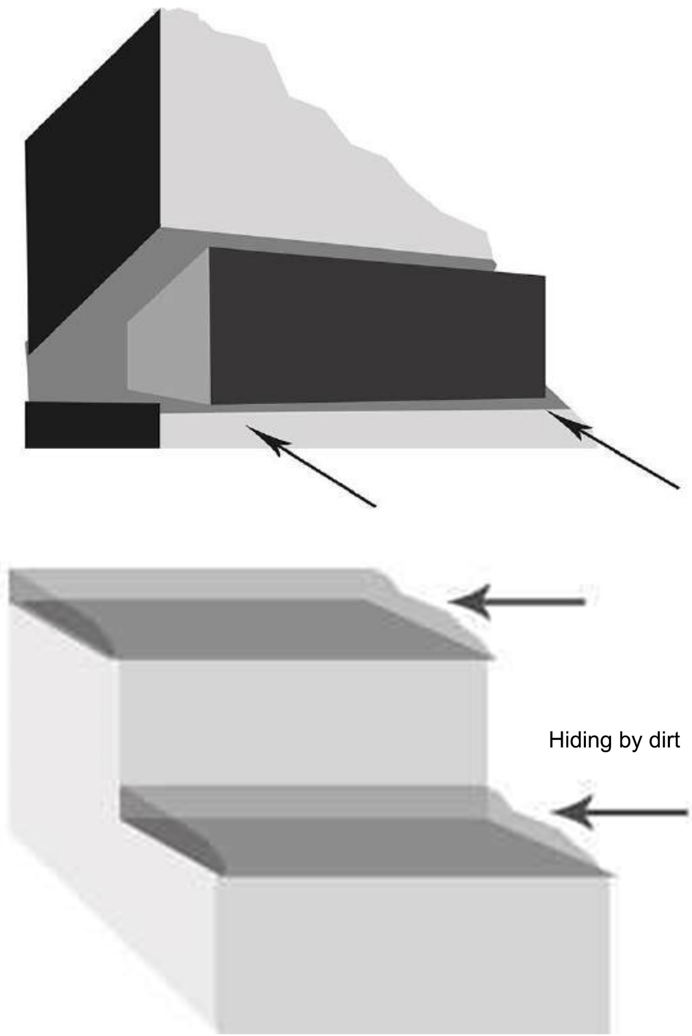

Figure 5. The building using the surrounding mountains.

14. To Preserve the Topography

The building must follow the slope of the land, resulting in a multi-story design. Consequently, the roof areas will increase in the design. According to studies, roofs are a significant factor in energy loss. Therefore, the design should incorporate covering the roofs with soil to prevent energy loss.

Creating Energy-Collecting Roofs

The use of sloped windows on the roofs is relevant for areas where utilizing solar energy from vertical facades is not feasible. Therefore, in the proposed design, skylights are used in the building's end sections, which are enclosed by mountains, to harness solar energy and natural light (Figure 6).

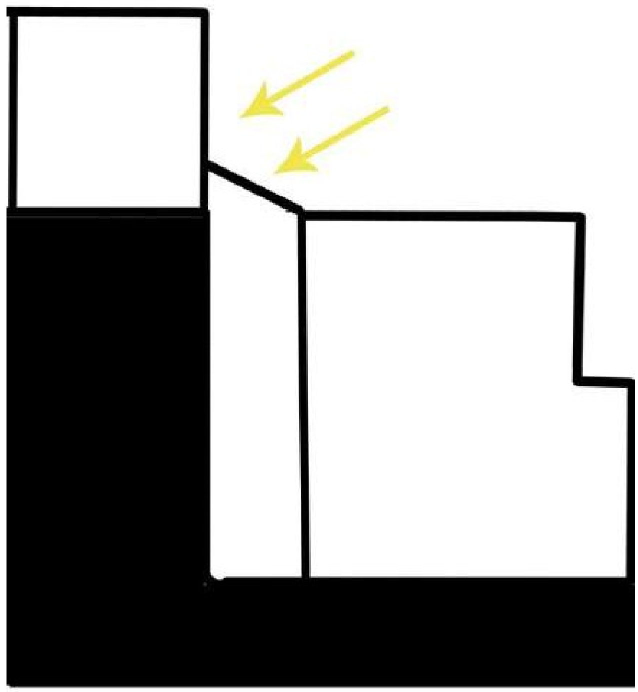

Figure 6. Creating Energy-Collecting roofs.

15. Innovative Climate-Responsive Architectural Methods

Complementing Traditional Methods

To effectively reduce energy consumption and achieve thermal comfort in the Abali mountain resort, the integration of innovative climate-responsive architectural methods with traditional techniques is crucial. Modern solar energy technologies, coupled with a comprehensive understanding of the site's unique characteristics, can address existing deficiencies in energy efficiency. Key strategies include the use of high-energy-resistance materials, the implementation of double-skin facades, and the effective harnessing of passive solar energy. These methods not only enhance thermal comfort but also contribute to the overall sustainability of the built environment.

16. User Comfort in the Abali Mountain Resort Conditions for User Comfort

In light of the region's climatic characteristics, particularly its cold weather, maintaining a balanced indoor temperature is vital for user comfort. This can be achieved through a combination of natural ventilation and mechanical heating systems, ensuring a consistently pleasant environment for occupants. Additionally, the provision of adequate spatial amenities—such as comfortable common areas, well-designed rooms, and access to outdoor spaces—is essential in promoting overall user satisfaction.

17. Principles for Attracting Tourists Designing for Tourism Appeal

To effectively attract tourists to the Abali mountain resort, the design must prioritize not only the creation of desirable accommodation spaces but also the integration of recreational and sports facilities that cater to diverse visitor interests. The physical program and required spatial standards should encompass a variety of amenities, including:

1) **Accommodation Spaces**: Comfortable lodging that meets modern standards and provides essential amenities.

2) **Recreational Facilities**: Areas for leisure activities, such as lounges, cafes, and wellness centers.

3) **Sports Facilities**: Infrastructure for skiing, hiking, and other outdoor pursuits, ensuring year-round engagement.

18. Introduction and Analysis of the Site

The dimensions of the site are 100 by 100 meters, resulting in a total area of 10,000 square meters (Figures 7-9).

Figure 7. Abali's strategic 10,000 sq meter site.

Figure 8. Zoomed-in view of Abali's 100 × 100 m site.

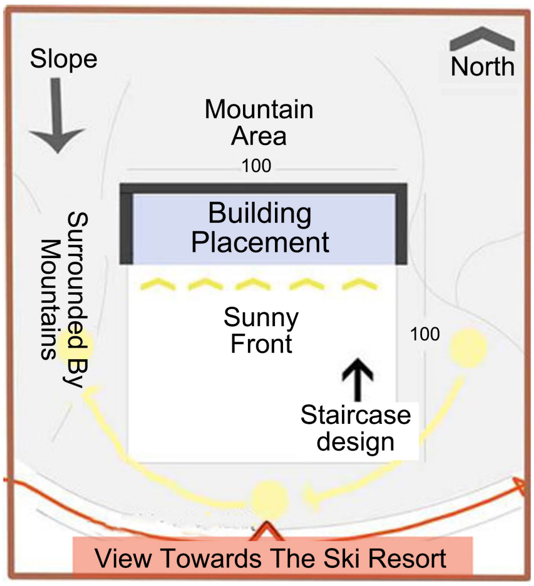

Figure 9. Landscape.

The image depicts a landscape plan for a potential building site nestled within a mountainous terrain. The central focus is a rectangular building placement outlined with dashed lines. Key features include (Figure 9).

- ***Slope***: *A downward slope is indicated on the left side of the image, suggesting a potential challenge for construction.*
- ***Mountain Area***: *The building is surrounded by mountains on three sides, creating a scenic and potentially isolated environment.*
- ***Sunny Front***: *The southern side of the building is designated as the "sunny front," suggesting it receives ample sunlight.*
- ***Staircase Design***: *A symbol of a staircase is present, indicating the need for stairs to access different levels of the building.*
- ***View Towards Ski Resort***: *A marker points towards the ski resort, highlighting a potential amenity or attraction in the vicinity* (Figure 9).

- ***Dimensions***: *The image includes numerical measurements of* 100, *likely representing distances or dimensions in meters or feet.*
- ***Orientation***: "*The North*" *is labeled at the top of the image, providing a sense of direction.*

19. Introduction to the Main Volume and Floor Plans

Ground Floor Plan: The ground floor of the commercial-administrative complex serves as a pivotal hub, incorporating a variety of essential spaces designed to enhance the visitor experience and facilitate operational efficiency (see **Figure 9**).

19.1. Key Spaces

1) Café: This central feature includes:
- Café Entrance
- Café Hall
- Café Kitchen

2) Ski School Facilities:
- Ski Classroom
- Ski Instructor Room
- Control Room

3) Exhibition Space:
- Exhibition Space Entrance

4) Sports Department Entrance:

5) Ice Skating Area:

6) Information Desk: A focal point for visitor inquiries and guidance.

7) Main Areas: The ground floor also accommodates several critical facilities, including:
- Main Lobby
- Main Entrance of the Complex
- Management Office
- Massage Room
- Emergency Medical Room
- Cinema Complex
- Reception
- Security Office
- Restrooms and Showers
- Sports Equipment Room
- Staff Room
- Retail Store
- Amphitheater
- Ticket Booth

19.2. Vertical Access

To ensure seamless movement throughout the ground floor, vertical access is facilitated by:

- Escalators
- Elevators

This thoughtfully designed ground floor plan not only supports the operational functions of the complex but also enhances user accessibility and comfort, setting a welcoming tone for all visitors (**Figure 10**).

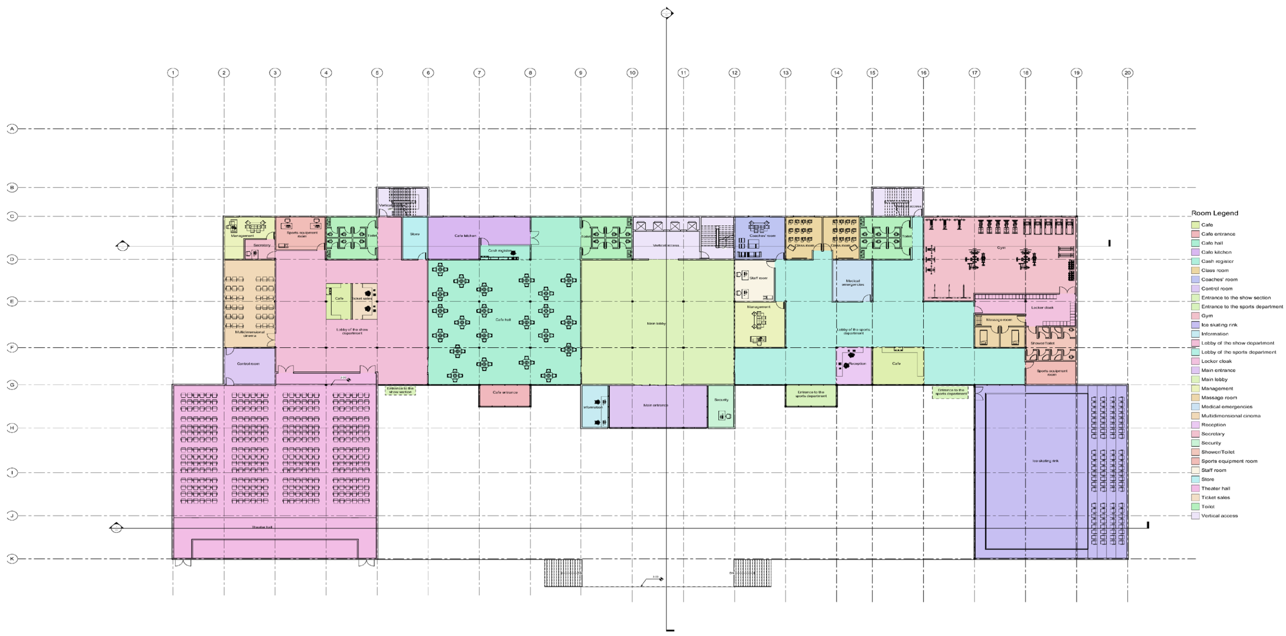

Figure 10. The main volume and floor plans.

20. Introduction to the First Floor of the Commercial-Administrative

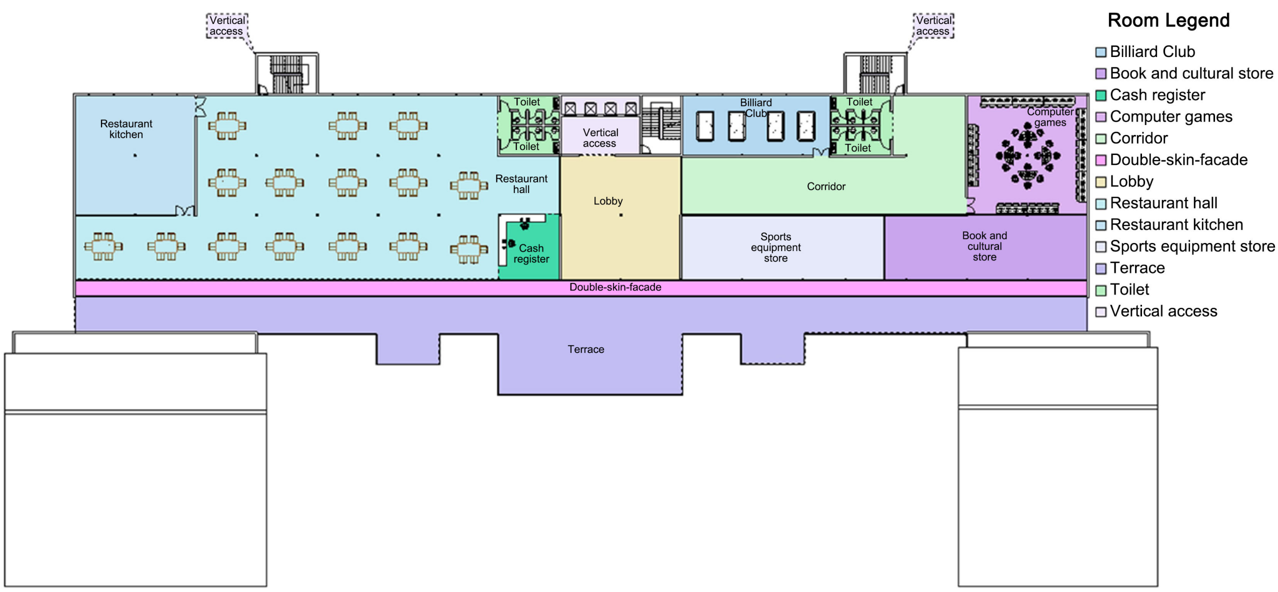

Figure 11. The first floor of the commercial-administrative.

The first floor of the commercial-administrative complex is designed to offer a diverse range of spaces that enhance leisure and social interactions among visitors (see Figure 11). This level complements the ground floor by providing additional amenities aimed at promoting engagement and comfort.

20.1. Key Spaces

1) **Billiard Club**: A dedicated area for recreation and socialization.

2) **Stationery and Book Shops**: Retail spaces catering to visitors' needs for supplies and leisure reading.

3) **Checkout Counter**: A centralized location for transactions related to the shops.

4) **Digital and Computer Games Area**: An interactive space designed for gaming enthusiasts of all ages.

5) **Corridor**: The primary circulation route connecting various areas on the floor.

6) **Space Between Façade Shells**: An architectural feature that enhances the aesthetic appeal and contributes to energy efficiency.

7) **Lobby**: A welcoming area that serves as a transition space between various functionalities.

8) **Restaurant Hall**: A spacious dining area offering a range of culinary options.

9) **Restaurant Kitchen**: Equipped to support the dining services efficiently.

10) **Sports Equipment Room**: Storage and rental space for sports gear.

11) **Terraces**: Outdoor spaces that provide opportunities for relaxation and social interaction.

12) **Restrooms**: Facilities conveniently located for visitor accessibility.

20.2. Vertical Access

Vertical circulation on this level is supported by:

Escalators: Facilitating easy movement between floors.

This carefully curated first floor plan not only enhances the visitor experience through diverse offerings but also integrates functionality and accessibility, fostering an inviting environment for all guests.

21. Introduction to the Fourth Floor of the Commercial-Administrative

The fourth floor of the commercial-administrative complex is designed to serve as a cultural and exhibition space, offering visitors a dynamic environment for art and creativity (see Figure 12). This level prioritizes the showcasing of artistic works and community engagement through thoughtfully planned areas.

21.1. Key Spaces

Corridor: The main circulation route, facilitating access to various areas on the floor.

Exhibition Space: A versatile area dedicated to hosting a range of exhibitions, events, and showcases, allowing for flexible configurations to accommodate different types of displays.

Gallery: An inviting space designed for the presentation of art collections and installations, encouraging exploration and appreciation of artistic expression.

Restrooms: Conveniently located facilities to ensure comfort for all visitors.

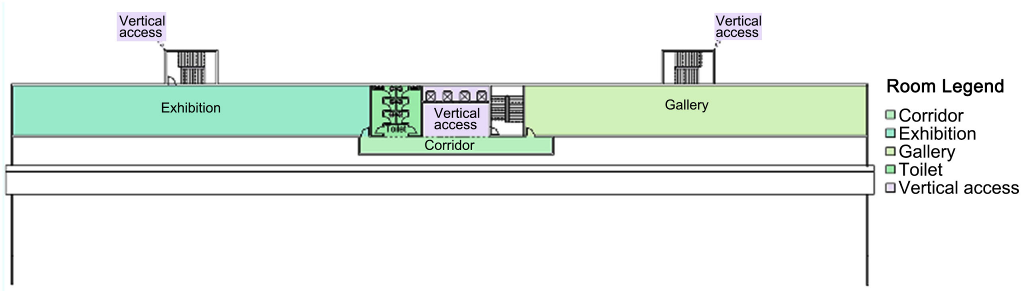

Figure 12. The fourth floor of the commercial-administrative.

21.2. Vertical Access

Vertical movement throughout the fourth floor is supported by:

Escalators: Providing efficient connectivity between floors.

Elevators: Ensuring accessibility for all users.

The fourth-floor plan not only enriches the cultural offerings of the complex but also enhances the overall visitor experience by promoting artistic engagement and community interaction.

22. Introduction to Basement Level

The presented floor plan showcases a multi-functional building characterized by a symmetrical layout and a clear division of spaces. The design emphasizes a central axis that bisects the structure, creating a sense of balance and order (Figure 13).

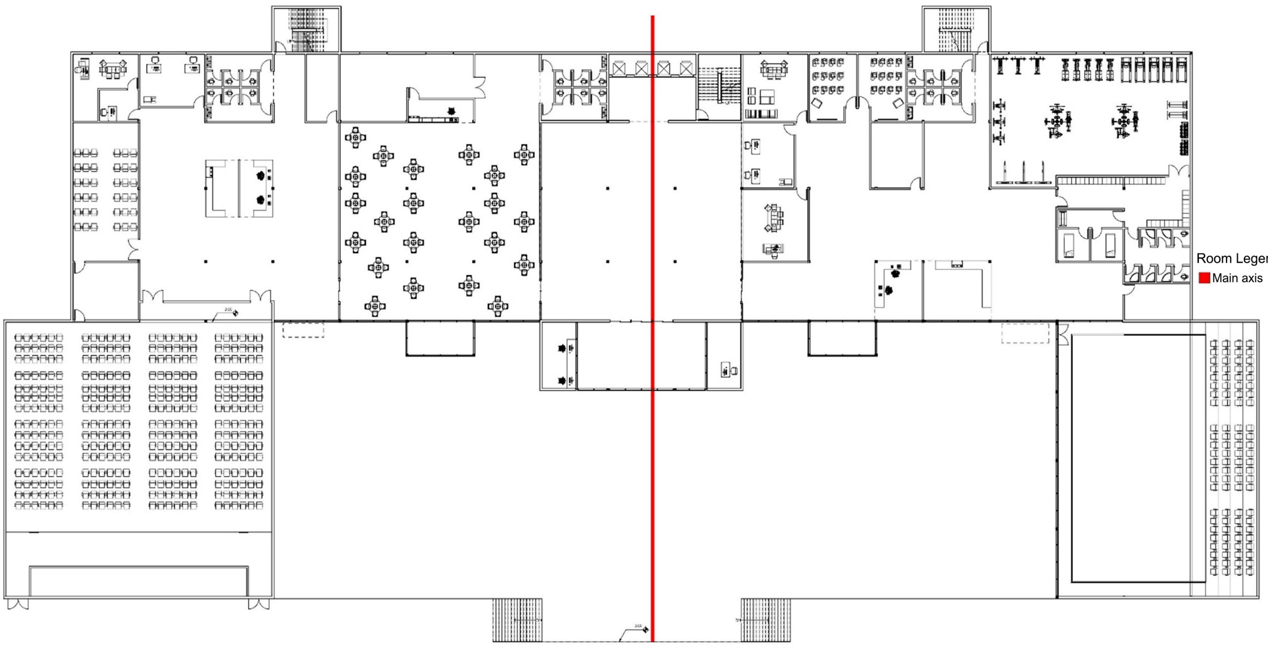

Figure 13. Basement level.

Key Features

- **Central Atrium:** A spacious atrium forms the heart of the building, occupying a significant portion of the floor area. This open space likely serves as a gathering area, providing natural light and ventilation.
- **Lecture Hall:** A large lecture hall dominates one side of the building, suggesting a focus on educational or assembly functions. The rows of seating indicate its primary purpose.
- **Classrooms:** Smaller, rectangular spaces are arranged around the atrium, likely designated as classrooms for various subjects.
- **Administrative Offices:** A cluster of offices is located on the opposite side of the building from the lecture hall, suggesting a clear separation between academic and administrative functions.
- **Support Spaces:** Additional rooms, such as a library, restrooms, and storage areas, are strategically placed throughout the plan to support the building's operations.
- **Outdoor Area:** A pool or recreational space is depicted outside, suggesting a potential for leisure or athletic activities.

Architectural Style and Design:

While the floor plan does not explicitly reveal a specific architectural style, it demonstrates a functional and efficient approach to design. The symmetrical layout and clear organization of spaces suggest a modernist influence, prioritizing practicality and clarity over ornate ornamentation.

23. Main Design Focus and Project Concept

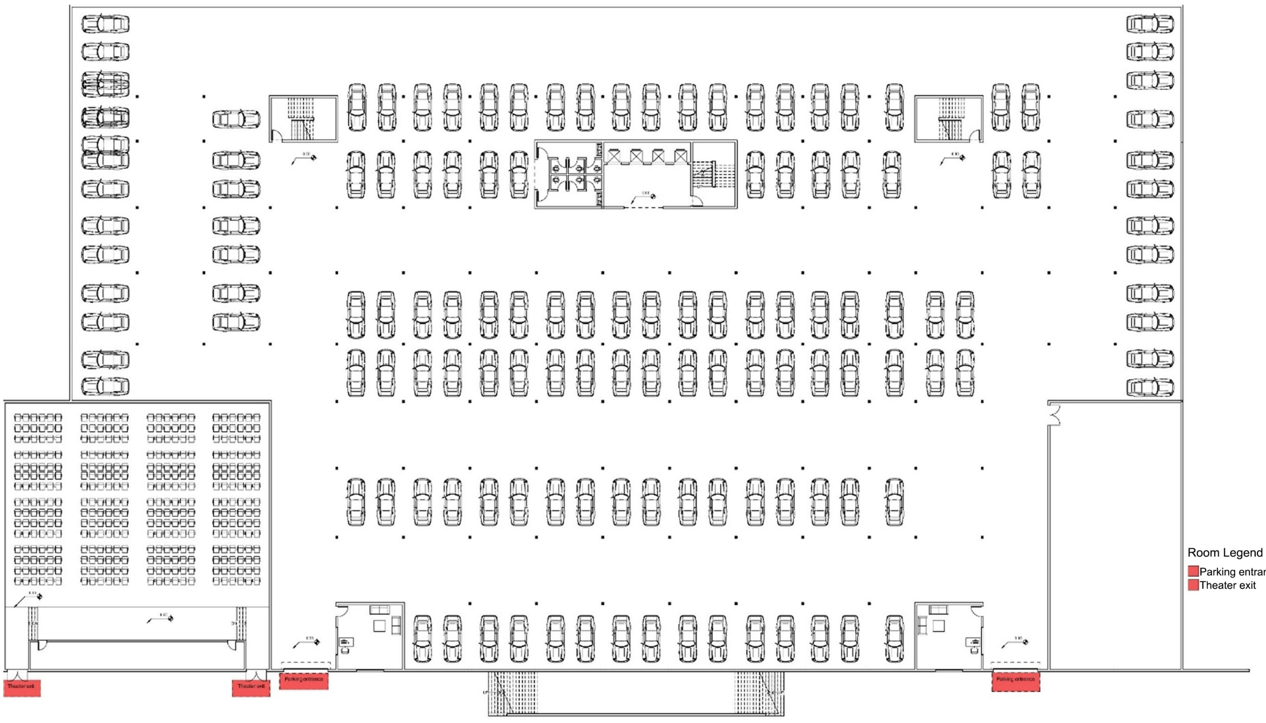

Figure 14. Main design focus and project concept.

The presented floor plan showcases a large-scale facility primarily dedicated to parking and storage. The design emphasizes a rectangular layout with a clear division of spaces (**Figure 14**).

Key Features

- **Extensive Parking Area:** The majority of the floor area is occupied by a vast parking lot, accommodating a significant number of vehicles.
- **Storage Areas:** Several smaller rooms or bays are located along one side of the building, likely designated for storage purposes, potentially for equipment, supplies, or inventory.
- **Office or Administrative Space:** A small, rectangular area is set apart from the parking and storage areas, possibly serving as an office or administrative space for managing the facility.
- **Entrance/Exit Points:** Multiple entrances and exits are indicated, suggesting a high volume of traffic and activity.

24. Eco-Friendly Alpine Office: A Modern, Energy-Efficient Hub for Athletes at Abali Ski Resort

Figure 15. Two-story building nestled against a snowy mountainside.

The image depicts a modern, two-story building nestled against a snowy mountainside. The structure is designed to harmonize with the surrounding natural environment while providing a functional and energy-efficient space for commercial and office purposes, particularly catering to the needs of athletes at the nearby Abali ski resort. The building's most striking feature is its extensive glass facade, which offers panoramic views of the mountain scenery. This design choice is in keeping with the study's emphasis on maximizing natural light and energy efficiency in the cold, mountainous climate. To mitigate the potential for excessive sunlight and heat gain, the design incorporates shading devices, such as overhangs or blinds, which can be adjusted to regulate light and temperature levels. The building's overall appearance is sleek and contemporary, with clean lines and a neutral color palette that complements the natural surroundings. The use of large windows creates a sense of openness and connection to the outdoors, while the solid walls and roof provide a sense of stability and protection against the elements.

In summary, the image showcases a well-designed and environmentally conscious building that is ideally suited for its location and intended use. The combination of natural light, energy-efficient features, and stunning views makes it a desirable destination for both athletes and visitors alike (**Figure 15**).

25. Optimizing Light and Energy: Advanced Shading Solutions Using Grasshopper and Plugins

In this project, the control of light and the associated energy was a key consideration, especially given the extensive use of terraces and glass openings. To effectively manage these elements, shading devices were selected as the primary solution. These devices were designed to optimize energy performance by allowing heat energy to enter the building during the winter while simultaneously reducing glare and light pollution. To achieve this balance, a simulation was necessary, focusing on two critical parameters: the angle and depth of the shading devices. To accurately capture the building's lighting characteristics, the Honeybee and Ladybug plugins within the Grasshopper platform were utilized for data extraction. With the relevant variables and lighting data in hand, a subsequent simulation using the Wallacei plugin was conducted to determine the optimal shading device configuration. This process was guided by key performance indicators, including Spatial Daylight Autonomy (sDA), Useful Daylight Illuminance (UDI), and Glare (GLR) indices, ensuring an efficient and effective design. Grasshopper is a powerful visual programming environment within the Rhino 3D software, widely used in architecture, engineering, and design for creating parametric models. It allows users to create complex forms and patterns through a node-based interface, where different components, or "nodes," are connected to define relationships and processes. Grasshopper's capabilities are significantly extended through the use of plugins, which add specialized tools and functionalities tailored to specific design needs. Some of the most popular plugins include:

25.1. Honeybee and Ladybug

These plugins are essential for environmental analysis, providing tools for day lighting, energy modeling, and thermal comfort analysis. They are especially useful in sustainable design, allowing users to simulate the impact of various environmental factors on building performance.

25.2. Wallace

This plugin is used for multi-objective optimization. It allows designers to explore and optimize complex design solutions based on multiple criteria, making it an invaluable tool for projects requiring finetuned performance across various parameters.

25.3. Simulation Methodology of Honeybee and Ladybug

To effectively manage light and energy in the design, shading devices were selected as the primary solution. These devices were designed to optimize energy performance by allowing heat energy to enter the building during the winter while simultaneously reducing glare and light pollution. To achieve this balance, a detailed simulation was necessary, focusing on two critical parameters: the angle and depth of the shading devices.

25.4. Tools and Plugins

The simulations were conducted using the Honeybee and Ladybug plugins within the Grasshopper platform. These tools are essential for environmental analysis, providing capabilities for daylighting, energy modeling, and thermal comfort analysis.

25.5. Simulation Process

Data Extraction: The relevant variables and lighting data were extracted using the Honeybee and Ladybug plugins. This included metrics such as Spatial Daylight Autonomy (sDA), Useful Daylight Illuminance (UDI), and Glare (GLR) indices.

25.6. Optimization

With the extracted data, a subsequent simulation using the Wallacei plugin was conducted to determine the optimal shading device configuration. Wallacei is used for multi-objective optimization, allowing the exploration and optimization of complex design solutions based on multiple criteria.

25.7. Performance Indicators

Spatial Daylight Autonomy (sDA): Measures the percentage of floor area that receives sufficient daylight during standard operating hours over a year.

Useful Daylight Illuminance (UDI): Assesses the range of illuminance levels that are considered useful for a space, typically between 100 lux and 2000 lux.

Glare (GLR): Evaluates the visual discomfort caused by excessive brightness contrast in a space.

26. Harnessing Grasshopper's Versatility: Evaluating Daylight Performance with Ladybug and Honeybee Plugins

Grasshopper's flexible and modular nature, combined with its extensive plugin ecosystem, makes it a versatile tool for tackling a wide range of design challenges, from simple geometric explorations to complex environmental simulations. In the Ladybug and Honeybee plugins for Grasshopper, **SDA**, **UDI**, and **GLR** are metrics used to evaluate the daylight performance and glare potential within a building. These metrics are essential in understanding how natural light interacts with a space and are commonly used in sustainable design and building performance analysis.

26.1. SDA (Spatial Daylight Autonomy)

SDA measures the percentage of floor area in a building that receives sufficient daylight during standard operating hours over a year. Specifically, it indicates the area that achieves a minimum threshold of IL luminance (usually 300 lux) for at least 50% of the occupied time. SDA is a crucial metric for assessing daylight availability in indoor spaces, helping designers understand how much of a space will be naturally lit without the need for artificial lighting.

26.2. UDI (Useful Daylight IL Luminance)

UDI assesses the range of IL luminance levels that are considered "useful" for a space, typically between 100 lux and 2000 lux. It evaluates how often a space is within this range during occupied hours. UDI helps in determining if a space is receiving too little light (under-lit) or too much light (over-lit), allowing designers to balance lighting conditions for optimal comfort and energy efficiency.

26.3. GLR (Glare)

GLR, or Glare, assesses the visual discomfort caused by excessive brightness contrast in a space, often due to direct sunlight or overly bright areas. It can be evaluated through metrics like Daylight Glare Probability (DGP). GLR is used to identify areas within a building that may cause discomfort to occupants due to glare. Managing glare is essential for creating comfortable and visually pleasant indoor environments.

27. Selection Process and Justification

27.1. Criteria for Evaluation

The selection of the best models was based on several key performance indicators (KPIs) that are critical for assessing the effectiveness of shading devices in terms of energy efficiency and visual comfort. The primary KPIs used were:

- **Spatial Daylight Autonomy (sDA)**: This metric measures the percentage of floor area that receives sufficient daylight during standard operating hours over a year. Specifically, it indicates the area that achieves a minimum threshold of illuminance (usually 300 lux) for at least 50% of the occupied time. High sDA values indicate good daylight availability, reducing the need for artificial lighting.
- **Useful Daylight Illuminance (UDI)**: UDI assesses the range of illuminance levels that are considered useful for a space, typically between 100 lux and 2000 lux. It evaluates how often a space is within this range during occupied hours. UDI helps in determining if a space is receiving too little light (under-lit) or too much light (over-lit), allowing designers to balance lighting conditions for optimal comfort and energy efficiency.
- **Glare (GLR)**: Glare assesses the visual discomfort caused by excessive brightness contrast in a space, often due to direct sunlight or overly bright areas. It can be evaluated through metrics like Daylight Glare Probability (DGP). Managing glare is essential for creating comfortable and visually pleasant indoor environments.

27.2. Simulation Tools and Process

The simulations were conducted using the Honeybee and Ladybug plugins within the Grasshopper platform. These tools are essential for environmental analysis, providing capabilities for daylighting, energy modeling, and thermal comfort analysis. The Wallacei plugin was used for multi-objective optimization, allowing the exploration and optimization of complex design solutions based on multiple criteria.

27.3. Optimization and Selection

The optimization process involved running 800 different models to explore various configurations of shading devices. Each model was evaluated based on the KPIs mentioned above. The selection process included the following steps:

- **Data Extraction**: Relevant variables and lighting data were extracted using the Honeybee and Ladybug plugins. This included metrics such as sDA, UDI, and GLR indices.
- **Multi-Objective Optimization**: Using the Wallacei plugin, the models were optimized to find the best balance between the KPIs. This involved identifying configurations that maximized daylight availability (sDA and UDI) while minimizing glare (GLR).
- **Top Models Selection**: Among the 800 models, the top 5 models were selected based on their performance across the KPIs. These models represented the best trade-offs between maximizing useful daylight and minimizing glare, ensuring both energy efficiency and visual comfort.

27.4. Justification of the Best Models

The justification for selecting the top models is based on their superior performance in achieving the desired balance between daylight availability and glare control. Here's a detailed justification:

- **High sDA and UDI Values**: The selected models demonstrated high sDA and UDI values, indicating that they provided sufficient daylight to a large percentage of the floor area during standard operating hours. This reduces the reliance on artificial lighting, leading to energy savings.
- **Low GLR Values**: The selected models also exhibited low GLR values, meaning they effectively minimized visual discomfort caused by glare. This is crucial for maintaining a comfortable indoor environment, especially in spaces with extensive glass facades.
- **Balanced Performance**: The top models were chosen because they offered a balanced performance across all KPIs. They not only provided ample daylight but also controlled glare effectively, ensuring both energy efficiency and occupant comfort.

27.5. Practical Implications

The selected models provide practical solutions for optimizing shading devices in buildings located in cold, mountainous regions like the Abali resort. By achieving the right balance between daylight availability and glare control, these models contribute to the overall sustainability and energy efficiency of the building design.

By calculating 800 different models, the best state of GLR (Figure 16) and UDI (Figure 17) can be seen.

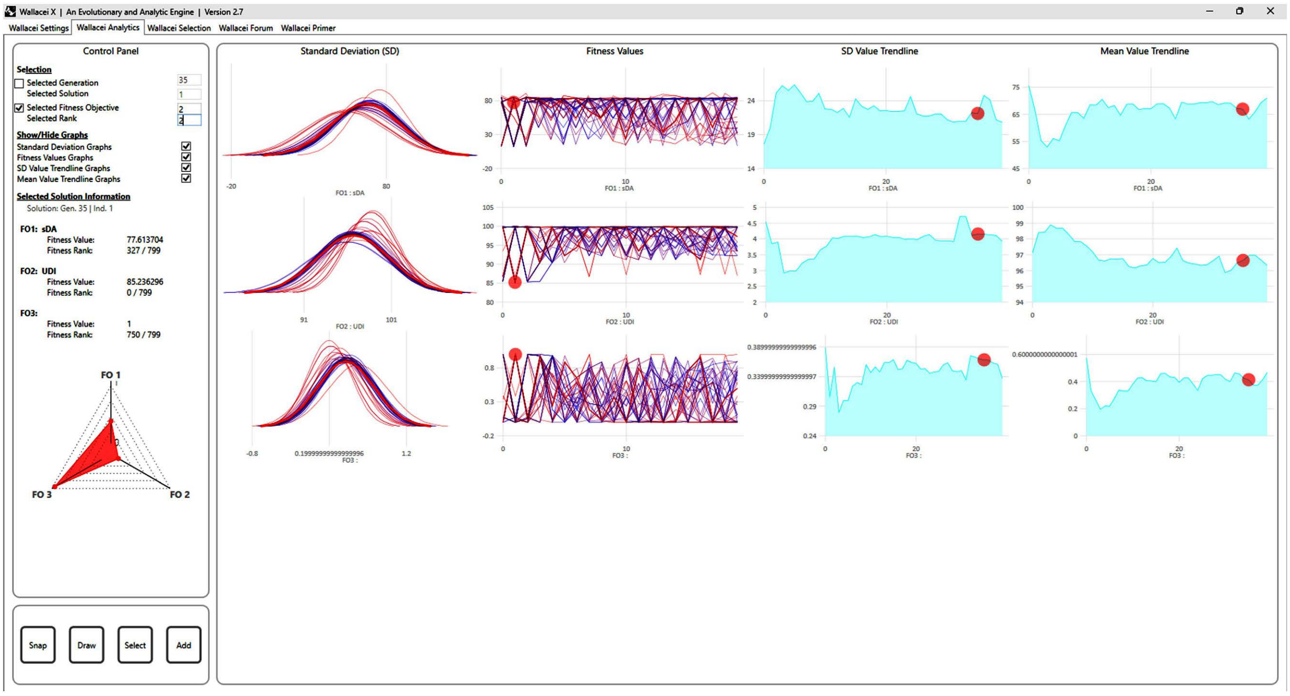

Figure 16. 35 GLR.

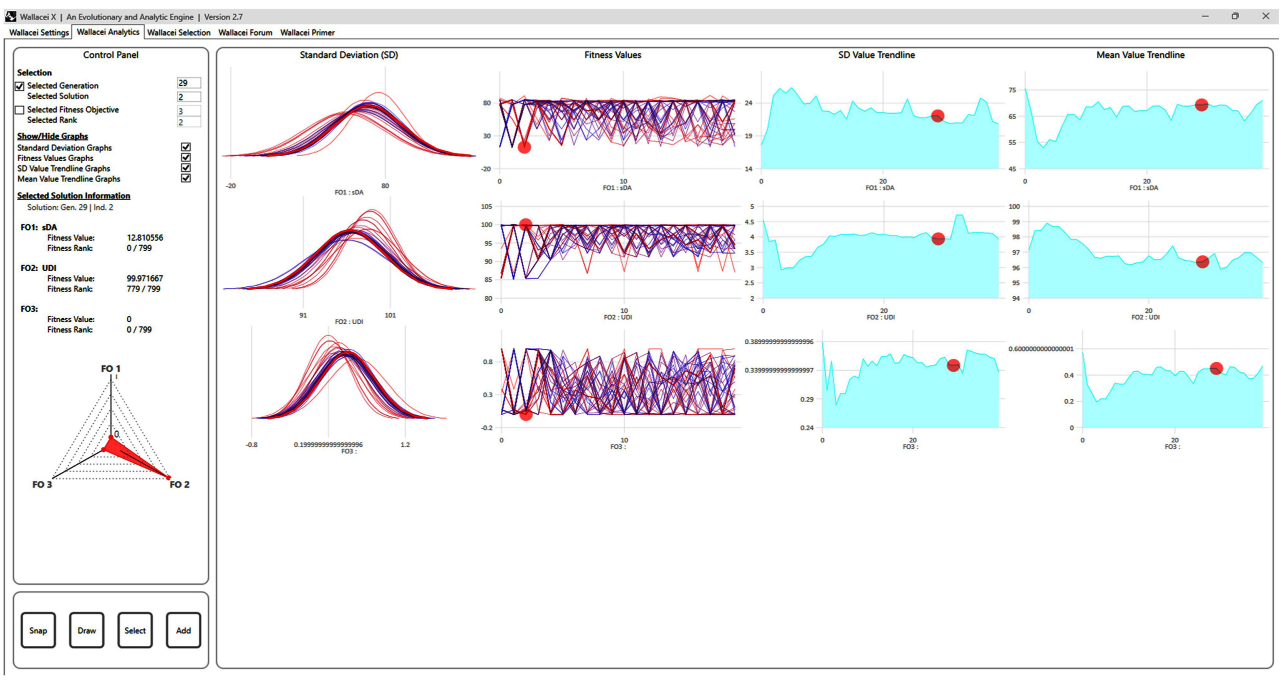

Figure 17. UDI.

28. Discussion

This research aimed to develop a tourism and recreational complex, utilizing the LEED rating system as a foundational framework to guide the design process. The analysis revealed that three key factors—expertise, legislation, and technology—play a critical role in the successful implementation of sustainable practices within the complex. Each of these factors must be considered concurrently throughout the decision-making process to ensure optimal outcomes.

The influence of these elements is notably shaped by the specific socio-cultural context of Iranian society, highlighting the necessity for localized approaches to sustainability. For instance, varying social priorities and intellectual paradigms in different societies could lead to unique interpretations and implementations of sustainable design principles.

Moreover, the findings underscore the importance of energy conservation as a central tenet of the proposed model. This emphasis aligns with the core objectives of the LEED system, which advocates for the efficient use of available energy resources. Additionally, municipal regulations further bolster this initiative by promoting energy conservation, encouraging the use of natural resources, and endorsing energy-efficient technologies.

In light of these insights, it becomes evident that the design of the tourism complex is not only intended to attract visitors from Iran but also aims to uphold environmental integrity. This balance between economic development and sustainability is crucial for the long-term success of such projects.

29. Conclusion

In conclusion, the design of the tourism and recreational complex represents a significant step toward integrating sustainable practices within the framework of Iranian societal values. The research highlights the pivotal role of expertise, legislation, and technology in fostering a conducive environment for sustainable development. By prioritizing energy conservation and aligning with the principles of the LEED rating system, the project sets a benchmark for future initiatives in the region. The selection process of the best models from the 800 simulations was rigorous and based on a comprehensive evaluation of key performance indicators. The use of advanced simulation tools and multi-objective optimization ensured that the selected models provided the best balance between daylight availability and glare control, leading to energy-efficient and comfortable indoor environments. This approach not only enhances the design's performance but also offers valuable insights for similar projects in similar climatic conditions. The findings emphasize that successful implementation requires a holistic approach that considers the specific cultural and social contexts of the community. As such, the tourism complex is designed not only to attract visitors but also to contribute positively to the environment and the local community. Moving forward, it is essential for stakeholders to continue to embrace these principles, ensuring that future developments align with both economic goals and environmental stewardship.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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