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Renovation of an Old Istrian Building

Brina A. Lukic and Inge Kalan Lipar

Abstract

The seminar paper focuses on transforming a historical stone structure in Istria into a boutique restaurant, adhering to the principles of cultural and architectural preservation. The research encompasses the history and traditional construction methods of the Istrian peninsula, analyzing types of vernacular architecture and the use of local materials like stone. It emphasizes the importance of preserving historical elements while incorporating modern design to meet contemporary standards. The research outlines a detailed process for renovation, including theoretical research, and site analysis. It highlights the historical and cultural significance of Strunjan, where the project is located, linking the building's renovation to the broader development of tourism in the area. The project not only restores a neglected structure but also redefines it as a vibrant cultural and culinary destination, enhancing the region's identity while respecting its heritage. This work serves as a model for sustainable preservation and adaptive reuse of historical buildings.

Keywords: renovation, drywall construction, stone processing, Strunjan, restaurant

Istrian Peninsula

Istria, which is the largest peninsula in the Adriatic Sea, presents a notable diversity of morphological aspects. From a geological point of view, we can roughly distinguish three parallel belts running from northwest to southeast, conventionally called White, Gray and Red Istria. White Istria (the northernmost), this stretches from the Trieste Karst towards Kvarner, the Kvarner Bay and is mountainous, with a series of reliefs ending at Učka. The soil is calcareous, partly barren and rocky, and partly overgrown with bushes. Ćićarija, which represents the lower part of White Istria, is interrupted in many places by cultivated depressions (vratačes). Gray or Yellow Istria makes up the central belt of the Istrian territory and is of a sandy-marl character. The relief consists of green hills and wide valleys, and the soil is composed of yellowish-gray clay. Some of the peninsula's waterways originate here. Red Istria (the southernmost) is located below the line running from the tip of Savudrija to Plomin. It is a vast limestone plateau with frequent rounded depressions (vratači), verticals (foibe), covered with a surface layer of fertile reddish soil, covered with lush Mediterranean shrubs, suitable for growing vines and olive trees, despite the relative lack of water resources (Starc, 2012, p. 19).

The Istrian coast is rocky and rugged, but mostly low, except for the northeastern part. The landscape is not rich in water, there are only a few short rivers throughout the territory, of which only the Mirna reaches fifty kilometers in length. Water supply is problematic especially in the southwest, where there are practically no surface watercourses and in many places the average annual rainfall is just over 500 millimeters. The climate is mild in the coastal and inland areas, becoming colder only in winter, when the bora, a cold and violent wind from the east to the northeast, sets in (Starc, 2012, p. 19).

The density of the Istrian population was always low due to the infertile soil. The best conditions for settlement were offered by the coastal strip, which was relatively favorable for agriculture and maritime communications. The continental areas, which were only suitable for extensive farming, were generally less and less populated. According to the last census before World War II, the average density of the Pula region (which included a large part of the peninsula) was approximately 80 inhabitants per square kilometer, higher than in the Balkan regions, but significantly lower than the average of the Italian regions. The lowest values were found in the mountainous municipalities of the northeastern part of Istria, where only 30 inhabitants per square kilometer were recorded (Starc, 2012, p. 19).

Types of Istrian Houses

The traditional construction style and appearance in the Istrian region, both Croatian and Slovenian, were influenced by the available building materials sourced from the natural environment of the rural population: stone, wood, gravel, and marl, which is called “dead stone” because it is prone to crumbling and difficult to shape. This very material defined the look of buildings in Istria, as they were once entirely built from this stone. However, limestone was also added to door frames, window sills, lintels, cornerstones, and roof cornices. Marl, which came in the form of layered slabs, was often used for roadside fences, enclosures for pigsties, manure pits, and ponds, while white limestone was used for household, garden, or even settlement structures that are still preserved today—wells (*širne*), boundary markers (*kunfini*), chapels, and *kažuni* (round stone huts in fields and vineyards) (Nikočević, 2009).

In traditional Istrian architecture, all buildings had walls made exclusively of stone (which was often not of a regular square shape, except for the stone used for corner construction and the stone exposed without a limestone coating), including both white limestone and yellowish-gray sandstone. The use of these materials depended on the geographical location and the availability of resources in different areas of the peninsula. In White and Red Istria, buildings were constructed from limestone, while in Gray Istria, houses were built from sandstone. However, some parts of the most valuable homes (primarily door and window frames and portals) were made of white stone. In the inland areas of Istria, at the borders between two geological zones, houses can also be found with structures made from mixed stone. For centuries, stone was extracted and processed exclusively by hand using tools such as wedges, splitting bars, hammers, and chisels. The best white stone quarries can still be found today in the western part of Istria, from where the stone was historically exported, mainly by sea, to Venice (Starc, 2012, p. 38).

The roofs of houses were usually gabled with a slight slope (hipped roofs were very rare) and covered with curved tiles, or less commonly with stone slabs (called *scrile* in the Italian Istrian dialect, and *škrilje* or *škrle* in Croatian and Slovenian dialects). Thatched roofs were occasionally used, mainly in the Labin and Liburnian areas, until around the 1960s-70s. All types of Istrian houses belong to the Southern European (or Mediterranean) architectural group (Biasutti, 1938, p. 23), with the exception of a house type that once existed in the Podgrad area until the mid-20th century, but has not been preserved to this day (Starc, 2012, p. 38).

Use and Processing of Stone

Natural stone was readily available to builders at the construction site itself. In the coastal regions (Brda, Soča Valley, Goriška, Vipava Valley, Karst, Slovenian Littoral, Brkini, and part of Inner Carniola), where forests are rare and more of an exception, stone became fully established and prevailed in all branches of construction. Natural stone prepared for use in construction must be sound. This means it should not have cracks, fractures, rotted areas, or nests, and must be free of knots, lumps, and ribs. When struck, it should produce a clear sound, and the fractured surface should have a clean and fresh color (Deu, 2019, p. 82).

Differently processed natural stones, assembled in various ways and bonded with lime mortar to form solid walls, contribute to the local characteristics of our identity in construction. The difference between stone walls is not determined only by the type of stone. Both the stone processing and the construction method are important. Both are closely connected to the type of stone, but also to other factors, such as the developed standards and values in local construction practices, the level of stone masonry craftsmanship, and the financial means of the builder. Wealthier individuals chose the best local stone for the walls of their homes and entrusted the construction to stonemasons, who processed it with masterful knowledge. Poorer individuals, however, built on their own, gathering, digging, and breaking the stone themselves, and settling for poorer craftsmanship (Deu, 2019, p. 83).

According to the method of processing, the stone elements used for wall construction are classified into:

- Unprocessed (broken stone – roughly broken, flatly broken, gravel or cobblestone),
- Roughly processed (finished, partially processed broken stone, rough stone, or even worked stone),
- Processed (semi-dressed and dressed stone, dressed stone).

The different processing of stone into shaped stone walls is evident in their appearance, which stands out primarily in unplastered, unprotected walls. Based on the processing of the stone elements, stone walls are divided into two groups. The first consists of stone walls made from unprocessed and roughly processed stone, while the second group includes walls made from processed stone (Deu, 2019, p. 84).

Walls Made of Unprocessed and Roughly Processed Stone

In the first case, natural stone obtained from a riverbank, quarry, or natural gravel pit is incorporated into the wall construction without special processing. The rubble, pebbles, or cobbles are arranged in the wall without regular layers (irregular masonry). The gaps between the larger stones are filled with smaller, equally unprocessed stones (Deu, 2019, p. 84).

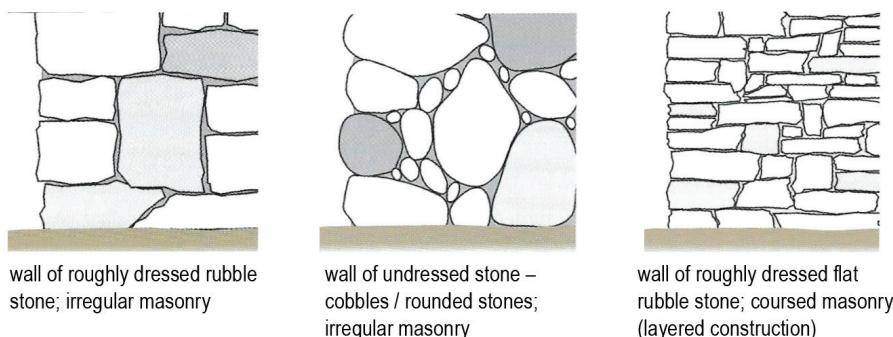
In the second case, broken stone is shaped at the site with a hammer to fit each stone's position. The front face of the rough-hewn stone is simply leveled. These walls lack regular layers, and their appearance depends on the type of rubble and the precision of the work. Often, especially with flatly broken stones, horizontal layers are emphasized, a technique rooted in Romanesque and earlier ancient masonry. This layered construction method was preserved into the 19th century, especially in regions with a strong stone-carving tradition, as it requires skill and expertise (Deu, 2019, p. 84).

The binder is lime mortar, made from locally burnt lime and sand, which was readily available in the immediate vicinity of the construction site. This gives the mortar its characteristic color. Often, crushed stone and earth are also added to the lime mortar (Deu, 2019, p. 86).

Stone walls are typically 50 to 70 cm thick and can be single or multi-layered. A multi-layered wall consists of three layers: both the outer and the inner building sides of the wall are made of stone. The inner layer or the intermediate space is filled with smaller, unprocessed broken stones and stone gravel (Deu, 2019, p. 87).

Figure 1

Appearance of stone walls made from unprocessed and rough-hewn rubble (Deu, 2012)



Walls Made of Hewn and Partially Hewn Stone

Overcoming the resistance of stone material and shaping it into bricks of regular forms is difficult, demanding, and time-consuming work. If the stone wall is covered with a layer of plaster, this work becomes unnecessary (Deu, 2019, p. 88).

In the case of partially hewn stone, the front face and side surfaces are leveled up to a length of 15 cm. A wall made of partially hewn stone is leveled, and the construction method is no different from that of walls built with unworked or rough-hewn rubble (Deu, 2019, p. 88).

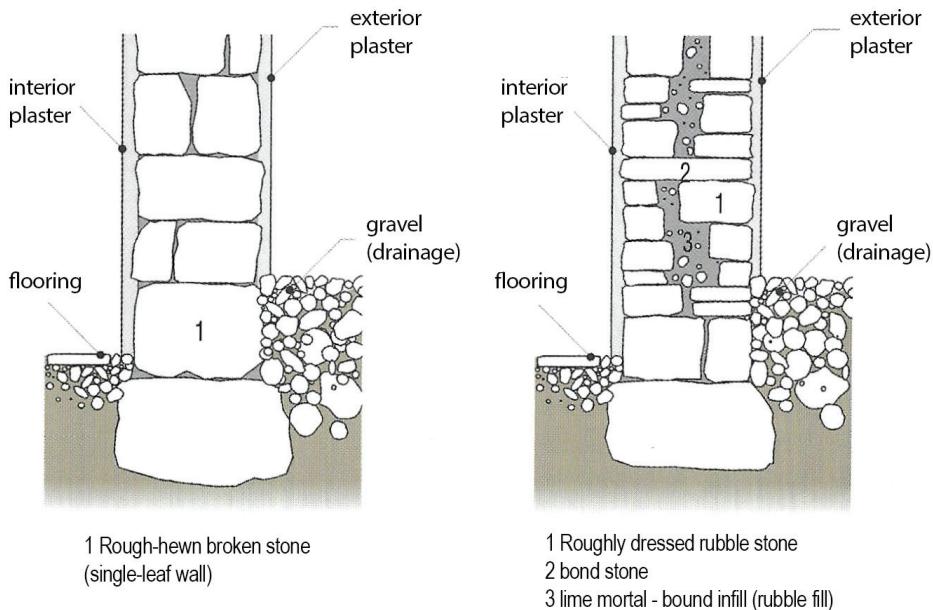
Hewn stone is used for masonry and is carved into a regular-shaped block with smooth sides. Stonemasons carve the stones, or precisely shaped blocks, from rough-hewn or sawn stones, rough-cut stones of irregular shapes. The rough stone is first carved into a regular block, then the sides: the upper surface, called the soft bed, the lower surface, called the hard bed, both side or joint surfaces, the front or face surface, and the back or wall surface are leveled and smoothed. In the past, the only tool used for smoothing the stone was a chisel, but today, stonemasons use machines for this work (Deu, 2019, p. 88).

The front surface of the block is usually not smooth but is finished in various ways. It is especially carefully worked if the hewn stone is intended for the construction of an unplastered envelope structure or its part (foundation). With stonemasonry tools and techniques, different textures can be achieved, ranging from very rough to completely smooth and polished. The diverse stone surface treatments are grouped into three main categories: natural rustic, flat rustic, and smooth surfaces (Deu, 2019, p. 89).

The hewn stones are then laid in the wall by placing stone upon stone in a specific order, following the rules for brick masonry. The vertical joints of each layer must not align with the vertical joints of the layer above, and the offset joint should not be smaller than 10 cm. The front surface of the block can be finished in various ways. When building a wall from stones of different sizes, the height of the hewn stones in each layer of the wall must be the same. The size of the rectangular hewn stone, or the ratio between its height, width, and length, is related to the type of stone (Deu, 2019, p. 89).

Figure 2

Cross-section of a single-layer and triple-layer stone wall. Even in the triple-layer wall, larger stones were placed across the entire thickness for reinforcement at regular intervals. (Deu, 2019)



Dry Stone Masonry

Dry stone constructions have invaluable cultural and aesthetic value; they are an indispensable design element of traditional landscapes and settlements. On a symbolic level, they are monuments to the perseverance, resilience, and survival of many generations who lived in harmony with nature (Orbanić et al., 2015, p. 6).

Figure 3

Dry stone construction. (Macuka, 2019)



In dry stone construction, in the strictest sense of the word, only natural material—stone—is used. Since it was always gathered from the nearest surroundings, the diversity of the stone composition means that dry stone walls differ almost from village to village. Part of the effort within this task is focused on determining the typology of dry stone construction based on the type of stone (predominantly sandstone) and local building peculiarities (Orbanić et al., 2015, p. 9).

The most common forms of dry-stone construction that surround us include free-standing walls, retaining walls (terraces), pavings (streets, catchment areas), stone roofs, tombs (tumuli), viewpoints, shelters, and refugees of various shapes. In settlements, dry stone techniques were used to build courtyards, roadside and garden walls around wells, wells themselves, stone pavings for courtyards and some village paths, smaller agricultural buildings such as pigsties, chicken coops, sheds, etc. Courtyard walls were built in the same way as dry stone walls in the landscape, except they typically used more carefully selected and processed stone (Orbanić et al., 2015, pp. 9–10).

Strunjan

Strunjan is a small coastal town in Slovenia, located between Izola and Piran, to which municipality it also belongs. It is known for its natural beauty, salt pans and cultural heritage, as its construction reflects the rich history of the area and includes various architectural styles and historical monuments.

The oldest evidence of settlement on the Strunjan peninsula dates back to the ancient period, where they were found in the area of St. Bas and Cape Ronek: a Roman villa rustica (an estate with a farmhouse and associated outbuildings), the piers of the former port, which are now submerged after the rise in water levels over the centuries, and smaller individual architectural remains. The area begins to be mentioned in archival sources in the 11th century, when the Patriarch of Aquileia, Popon, left it to the Aquileian Monastery of St. Mary. In 1284, the place name Strungano was first recorded in the sources, which comes from the Latin word Stronnianum meaning "Stronnian's". Since it was common in the 4th and 5th centuries to name areas after owners of large estates, we can conclude that Stronnianum was the name for an estate owned by a person named Stronij (Latin Stronno). Finally, the Slovenian name - Strunjan - was derived from the Italian toponym. (Strunjan Landscape Park, n.d.).

Over the centuries, the town lived in close interdependence with its neighboring Piran. While Piran developed into a typical medieval town on the foundations of a late antique settlement, Strunjan, with its excellent climatic conditions for salt production and fertile soil for growing crops, vegetables and fruit, olives and vines, was always its natural economic hinterland. During the heyday of Trieste at the end of the 18th century and until the end of World War II, farming was the key economic activity of the town. The people of Strunjan mainly transported early vegetables and fruit to the Trieste markets by ship, which, due to the special micro-climate, thrived perfectly on sunny plots and terraces. Later, the farmers focused more intensively on the production of olive oil, wine and persimmons, and a few years ago they also started growing artichokes and developed shellfish farms in the coastal zone. (Strunjan Regional Park)

For the position of Strunjan, which was tied to the port of Piran for major transport, the construction of the narrow-gauge railway Trieste - Poreč with a railway station in the town was of exceptional importance at the beginning of the 20th century. By establishing more favorable land trade connections, this enabled the economic progress of all of Istria, especially the inland, higher-lying areas, which

had until then been almost cut off from the coastal towns. At this time, several villas and guesthouses also grew up in Strunjan. Although the railway line was discontinued in the early thirties, the construction of various tourist facilities in Strunjan continued, as the lost railway connection was replaced by motor vehicle traffic, and the progress inspired and encouraged revived tourism in neighboring Portorož. (Strunjan Landscape Park n.d.).

Architectural Features

Strunjan's most valuable architectural features lie in both the overall settlement pattern and its examples of folk architecture. Houses and smaller building clusters are scattered across the valley and hillsides in neighborhoods such as Sveti Duh, Center, Karbonaro, Ronek, Punta, and Pacug. Although oral tradition attributes several centuries of age to some homesteads, most surviving traditional buildings date from the late 19th and early 20th centuries. These are complexes of residential and agricultural structures forming linear or enclosed courtyard arrangements that reflect both craftsmanship and the social organization of farming families (Hojer et al., 1986).

The built heritage is a basic document of the knowledge and taste of the inhabitants, and it also tells us about their way of life in the past and today, about economic activities and opportunities, and about social relations. The formation and development of the entire settlement is also inextricably linked to the demographic and social past of the place. For example, many houses were originally inhabited by colonists, mezzadri (colonnat, mezzadria). They entered into a special relationship with the local landowners, in which temporary lease was combined with wage labor. When such a colonist acquired enough of his own funds, he bought the house. At that time, the simple buildings underwent their first changes and improvements (Hojer et al. 1986).

Today, illegal construction and other new constructions, especially weekend houses built from unsuitable materials, on the most beautiful viewpoints, in exposed places, represent a violent breach in the material culture of Strunjan. They have an even worse impact on local social life, as they introduce foreign elements and unacceptable phenomena of social differentiation into the neighborhood (Hojer et al. 1986).

Preservation of Cultural Heritage

According to Article 2 of the Natural and Cultural Heritage Act, natural and cultural heritage is real estate, movable property and their groups, areas and individual parts of nature that have cultural, scientific, historical or aesthetic value for the SR Slovenia or its narrower area. Subject to the condition from the previous paragraph, natural heritage is, in particular, geological formations, mineral and fossil deposits, geomorphological forms, surface and underground karst phenomena, gorges and gorges, glaciers and forms of glacial activity, springs, waterfalls, rapids, lakes, swamps and bogs, streams and rivers with banks, the sea coast, rare and characteristic ecosystems, habitats of plant and animal species, relict, endemic, rare and characteristic plant and animal species; trees, landscape areas, viewpoints and picnic areas, mountain peaks, objects of garden architecture and designed nature. (Natural and Cultural Heritage Act, 1992)

The natural and cultural values of Strunjan have already been defined in the Urban Plan for the City of Piran (amendment 1976) and in other municipal urban and spatial documentation, in which they are verified with the protection category of a landscape park, and part of the area with the protection category of a nature reserve of national importance (Hojer et al. 1986).

With its characteristics in the settlement structure, with preserved folk architecture, which is of high quality and functional design, with the heterogeneity of the ethnic composition and with the cultural continuity of the population, Strunjan is a unique area in our ethnic space and is protected in its entirety. Taking into account the fact that it is possible to develop the settlement while preserving the existing characteristics, that the settlement has already begun in its testimony due to inappropriate interventions and that the activities in this area (agriculture, salt production, fishing, shellfish farming) are part of the existing situation that must be protected. The area is under the supervision of the monument service and its consent is required for any intervention.

Guidelines for the further development of natural heritage must ensure the preservation of physical-geographical characteristics and thus also the natural heritage and cultural landscape values of the area. Uncoordinated intervention in the space would degrade the physical-geographical identity and thus devalue and impoverish its landscape image (Hojer et al. 1986).

We followed all the written values and guidelines dictated by the recommendations of experts and legislation in the design and adaptation of the old Istrian building,

located at the top of the Strunjan Peninsula, and tried to attract new tourists who would contribute to local development.

Concept Design for Restaurant

The old Istrian house is located in the municipality of Izola. The building offers a beautiful view of the Stunjan Bay, Piran Punta and Cape Ronek to the west, and Izola and Koper to the north. The plot extends in the area of Dobrava, which borders the Strunjan Landscape Park. The property is accessible by local road from the Belveder-Strunjan and Strunjan-Belveder directions. Behind the plot is the Strunjan footpath, which is part of the Strunjan landscape park. It is a connection between the municipalities of Piran and Izola.

Figure 4

Analysis of the studied area



The three-story building is currently used for storing tools. The owners are engaged in agriculture and are well-known producers of olive oil under the brand name "Kmetija Ronko Izola". They also once lived there. Due to wear and tear, the house is in quite poor condition. It needs a complete renovation. It has utility connections, but they are not connected to the building.

Figure 5

Existing condition of the building's exterior



The only joinery on the building is represented by doors, and the window portals are covered with metal bars that prevent break-ins and the entry of animals. Despite constant repairs, the roof is dilapidated and needs to be replaced. The walls of the house are built of double drywall and, given its age, have no thermal insulation. The floors, which are covered with concrete on the ground floor, have begun to crack over the years, and with the addition of extensions, the owners did not pay attention to the same pressure level. The floors are connected by steep stairs that lead to a connecting corridor between the left and right wings of the building. From there, impassable, crumbling stairs lead to the attic. Due to the poor condition of the wood, the floors on the first floor are also impassable in some places. provided access to the attic. Due to wood deterioration, parts of the upper floors are impass-

able. The plot is surrounded by cypress trees and an olive grove, enclosed with a metal fence separating it from neighboring properties. The access road is directly connected to the main road.

Figure 6

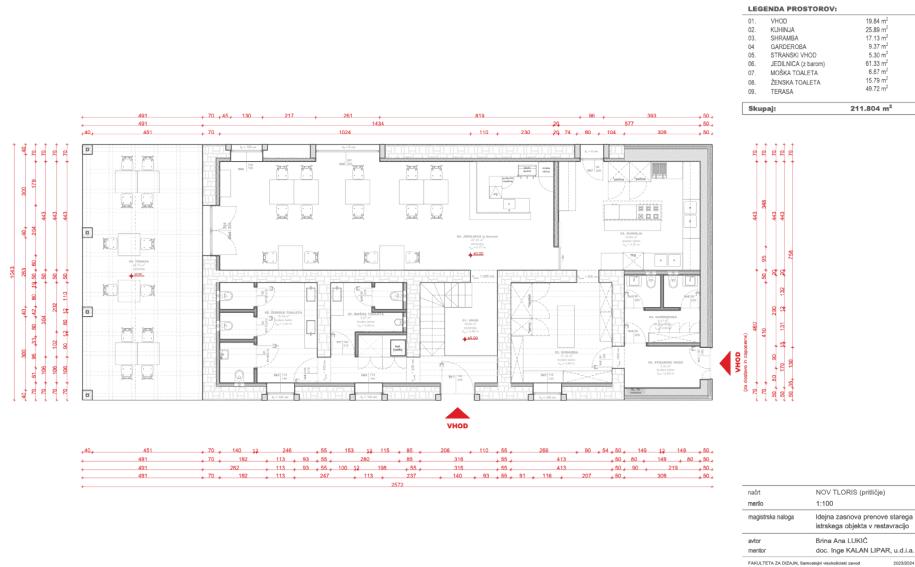
Existing condition of the interior



After consulting with the clients, they decided to renovate the dilapidated building into a boutique restaurant with local produce and food that is traditional to the local area. With the renovation, we have strived to preserve as much of the existing architectural features of traditional Istrian construction as possible and to renovate poorly preserved exterior elements. The renovation included replacing the roof with local roofing, "korci", and a new canopy over the terrace, which will serve as the outdoor part of the restaurant. We have removed the plaster from the building to expose the raw stone, which we will restore appropriately. This will bring the Istrian house back to life and give it its original appearance. We will design a parking lot for guests and employees on the plot, and renovate the courtyard to match the new appearance of the building.

Figure 7

Ground floor plan of the conceptual design



The interior will be expanded into the existing auxiliary buildings, ensuring that the facade remains unchanged. The floor levels will be equalized to make the ground floor accessible for people with mobility impairments. The new layout will include a kitchen, storage, staff changing rooms, and restrooms, a dining area with a bar, and restrooms for guests. The upper floor will have separate areas for private groups and an office. The entire interior style will feature traditional Istrian architecture with modern furniture elements. The modern kitchen and dining area will have the capacity to serve twenty guests. We enlarged the interior within the dimensions of the existing auxiliary buildings, while ensuring that the appearance of the facade was the same as the existing one. We equalized the height levels of the rooms so that the entire ground floor is suitable for people with disabilities. The new layout includes a kitchen, storage, cloakroom and toilets for employees, a dining room with a bar and toilets for guests. On the upper floor there are two separate booths for closed groups and an office. The overall style of the equipment is in Istrian architecture with modern elements of furniture pieces. The modernly designed kitchen and dining area have a capacity for twenty guests.

Figure 8

Visualizations of the conceptual renovation design (Lukić, 2025)



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Shaping Ecological Spaces Through the Integration of Artificial Intelligence and Green Building Certification Systems

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Abstract

This research examines the contributions that artificial intelligence can achieve in the context of green building certification systems, especially to the evaluation and optimization of indoor environmental quality (IEQ) criteria included in the LEED (Leadership in Energy and Environmental Design) system. Within the scope of the study, the role of artificial intelligence in the classification and analysis of the basic elements in the IEQ category of LEED, such as air quality, lighting efficiency, sustainable material selection, acoustic performance and ergonomic design, was investigated. The research was carried out with a hybrid methodological approach that combines qualitative content analysis of existing LEED-certified projects with a conceptual simulation model based on artificial intelligence-supported decision-making algorithms. The model simulates how the capabilities of artificial intelligence tools, such as real-time data processing, pattern recognition, and predictive analysis, can be used in the certification process. Data sources include LEED v4 documentation, artificial intelligence software used for environmental simulations, and expert interviews with sustainability consultants and architects. The findings reveal that artificial intelligence integration can significantly increase efficiency, objectivity and accuracy rates in the evaluation of indoor quality criteria. It has been observed that artificial intelligence systems can identify optimization opportunities for complex balance points between energy use and user comfort, which cannot be detected by traditional manual evaluation methods. In addition, the potential of artificial intelligence to reduce subjective interpretations in the evaluation process and to accelerate the general certification process was emphasized. This study contributes to the artificial intelligence-supported sustainable design literature by providing a concrete methodology and reveals the transformative effect of artificial intelligence on ecological interior architecture. The results obtained indicate that artificial intelligence-based evaluation frameworks can be standardized in green building certification systems that will come around the world, not only specifically for LEED.

Keywords: Interior Design, Artificial Intelligence (AI), Green Building Certification System, LEED

Introduction

As in all living things, man has felt the need to interact with nature in order to continue his life since his existence. However, today, consumption-oriented growth forms have caused the depletion of natural resources and the deterioration of the ecological balance (Yıldız, 2019; Cigan & Yamacli, 2020). In this context, green building certification systems (LEED, BREEAM, etc.) developed in line with sustainability principles aim to produce environmentally friendly and energy efficient structures (Doğan et al., 2018). Although these systems encourage ecological design, current practices are still largely based on manual evaluations and fall short of integrating with emerging technologies. Studies conducted in recent years reveal that artificial intelligence is effectively used in the architectural discipline in areas such as energy modeling, structural optimization and material analysis (Zhang et al., 2023; Zhang et al., 2024). However, the integration of these technologies with the interior design criteria of green building certification systems is still limited. There is not enough research on the role of artificial intelligence in the evaluation of user-oriented criteria such as indoor air quality, natural and artificial lighting, acoustics, ergonomics and material choices.

This study aims to remove the gap in question. The main questions of the research are:

1. How can artificial intelligence applications be integrated into green building certification processes?
2. How does this integration improve in the evaluation of indoor environmental quality criteria?
3. How can artificial intelligence support user comfort and spatial sustainability?

In this direction, a mixed approach has been adopted. The contributions of the system to the interior performance criteria were examined by using content analysis of LEED v4 certified projects and conceptual simulations based on artificial intelligence-supported decision algorithms. The findings show that artificial intelligence can overcome the limitations of manual evaluations by increasing accuracy, speed and objectivity in evaluation processes. In addition, it has been revealed that indoor atmospheres can be optimized more effectively by considering user health and comfort. This study provides an original methodological framework for the integration of artificial intelligence into green building evaluation processes and proposes a new technology-based opening in architectural designs targeting ecological sustainability.

Literature Review

Green Building Certification Systems

Problems such as increasing drought due to global warming, thinning of the ozone layer and environmental pollution have made the construction of structures that are sensitive to nature and have low environmental impact a priority goal (Erdede & Bektaş, 2014). In this context, the “green buildings” that emerge in this context are structures that optimize the use of natural resources and aim to improve user health and well-being with criteria such as natural light and clean indoor air quality (Celik, 2009). These buildings, which do not harm the environment after demolition and can be brought back to nature by recycling, are called today with different names such as “sustainable”, “ecological” or “environmentally friendly” and are evaluated throughout the entire life cycle of a building (Erdede & Bektaş, 2014). Green building certification systems are rating systems that evaluate these structures according to objective criteria. Not only does it measure building performance, but it also encourages investors and designers to consider environmental impacts throughout the process (Mutlu et al., 2019). Although these systems differ according to the climate, geography and socioeconomic structures of the countries, some globally accepted standards come to the fore. Among the most widely used systems are: LEED (USA), BREEAM (UK), CASBEE (Japan), Green Star (Australia), SBTool (Canada), and DGNB (Germany) (Celik, 2016).

In this study, LEED and BREEAM systems were specifically discussed in the context of indoor environmental quality (IEQ). These two systems evaluate the performance of structures based on criteria such as indoor air quality, natural and artificial lighting, acoustic comfort, thermal comfort, ergonomics, material selections and effects on user health. However, most of these criteria are still evaluated with manual measurements, certification expert interpretation, or standardized but stationary procedures, which results in subjectivity, temporal delays, and evaluation discrepancies. The contribution that artificial intelligence can provide at this point is to ensure that the evaluation becomes more objective, more data-oriented, faster and sustainable. In the literature, there are examples in which artificial intelligence applications are used, especially in areas such as building energy modeling (Namlı, et al., 2018), user behavior estimation (Yan, et al., 2023) and optimization of indoor environments with smart building systems (Bajwa, et al., 2022). However, most of these applications focus on outer shell performance and energy efficiency; research on the evaluation of indoor environmental quality criteria with the

support of artificial intelligence remains very limited. The aim of this study is to investigate how artificial intelligence technologies can be integrated in the evaluation of indoor quality criteria within the scope of LEED and to develop a data-based model proposal that can provide solutions to the methodological deficiencies of existing certification systems. Thus, it is aimed to contribute to the design of more optimized, healthy, and environmentally sensitive interior spaces in terms of both architecture and user experience.

LEED (Leadership in Energy and Environmental Design)

LEED (Leadership in Energy and Environmental Design) is the world's most popular green building evaluation and certification system developed by the US Green Building Council. It has 5 levels with 'Certified', 'Silver', 'Gold' and 'Platinum' levels, which represent better environmental performance. If a building is certified by passing the LEED evaluation, it will receive benefits such as less energy consumption, water consumption and operating costs. LEED is the first green building rating system launched in 1995 and used in 91 countries. It is predicted that LEED will become more widespread in the future and will be adopted as a global standard for green building. For a greener world, LEED's impact is great (Gorgun, 2012).

The LEED (Leadership in Energy and Environmental Design) certification system consists of a set of criteria and criteria aimed at negatively affecting the outlook and ensuring sustainability protection. It was created by the US LEED Green Building Council (USGBC) and is widely recognized worldwide. The system, which is suitable for different project types and expectations, is divided into 4 different categories Arslan, (2015).

- Building Design and Construction (BD+C)
- Interior Design and Construction (ID+C)
- Building Operation and Maintenance (O+M)
- Neighborhood Development (ND)

Each category is evaluated with specific criteria and buildings score according to a specific scoring system. According to the total score, buildings can receive a LEED certificate. LEED certification contributes to energy saving, sustainability and human health by increasing the environmental performance of buildings (Ertugrul, & Altin, 2022).

Table 1

LEED Certification Parameters (Ertugrul & Altin, 2022).

Sustainable Site Selection	Water Efficiency	Energy and Atmosphere	Materials and Resources	Indoor Environmental Quality
Site selection and development	Water-efficient equipment	Improved energy efficiency	Sustainable materials	Ventilation and filtration
Climate control, transportation, and accessibility	Irrigation and land management	Use of renewable energy	Waste management	Thermal comfort
	Rainwater management	Atmospheric emissions	Indoor air quality	Lighting

Note. The table summarizes the interior quality criteria of LEED, clarifying the areas where artificial intelligence can provide improvement. In this aspect, it forms the basis for the study.

The LEED (Leadership in Energy and Environmental Design) certification system is the most widely accepted and applied green building evaluation system in terms of assessing environmental performance and promoting sustainable design worldwide. Built to be suitable for different types of projects, LEED offers a comprehensive evaluation framework that focuses on interior environmental quality (IEQ) criteria, especially with the Interior Design and Construction (ID+C) category. This category includes extremely critical criteria for user health and comfort, such as indoor air quality, thermal comfort, ventilation, lighting and material-induced emissions. However, most of these criteria are still evaluated with manual, stationary and sometimes subjective methods. This creates limitations in terms of consistency, speed and objectivity in the certification process.

For this study, the LEED system is extremely important both in terms of providing a concrete operational framework for artificial intelligence integration and in terms of identifying deficiencies in existing evaluation methods. The main goal of this study is that artificial intelligence contributes to data-based, real-time and objective evaluation processes by integrating it with the interior criteria determined by LEED. Therefore, in this research, LEED is not only considered as an example system, but also as a critical application ground where sustainable interior design and artificial intelligence technologies meet.

Methodology

This research analyzes the LEED ID+C (Interior Design and Construction) category in the LEED certification system via ChatGPT, known as two artificial intelligence-based chatbots, and Leonardo Ai programs that allow text to be photographed from text to image. The most important factor in the selection of materials related to artificial intelligence programs selected in this analysis process is due to the popular preference in the world.

Within the scope of this research, the output obtained after asking questions about LEED to ChatGPT, the chatbot, will be analyzed according to the LEED ID+C category after the answers received are written to Leonardo Ai, who is artificial intelligence from the text to the image. All data on this will be obtained by referring to the two open-source artificial intelligence programs ChatGPT and from Leonardo Ai. Then, the main principles on LEED ID+C will be tabulated and evaluated.

Interior Design and Construction (ID+C)

LEED's classification of "Interior Design and Construction (ID+C)" helps to achieve environmental goals in projects aimed at reshaping or modernizing the interiors of completed buildings. This certification category can be applied to various building types such as offices, retail stores, restaurants, hotels and residences (Ertuğrul & Altın, 2022).

The main goal of the LEED ID+C system is to increase the environmental performance and energy efficiency of buildings. In line with this system, structures are evaluated in the following six basic categories:

- Sustainable Location Selection
- Water Efficiency
- Energy and Atmosphere
- Material and Resource Utilization
- Interior Quality
- Innovation and Regional Priorities

Under these subheadings, the concept of Indoor Environmental Quality (IEQ) is of great importance. IEQ refers to the sum of environmental factors such as air quality, lighting, thermal comfort and acoustics that directly affect the health and comfort of people living and working in a building. A quality interior environment significantly increases people's health, productivity and quality of life (Öktem, 2020).

Criteria such as indoor air quality, lighting, material selection, acoustic comfort and ergonomics, which are within the scope of the LEED certification system, play a critical role in terms of user health and indoor comfort. While indoor air quality aims to reduce health risks through the control of volatile organic compounds (VOC) and other pollutants (U.S. Green Building Council [USGBC], 2021), natural and energy efficient lighting solutions both reduce energy consumption and positively affect user psychology (Reinhart, 2019). Preferring low-emission, recyclable and locally sourced products is encouraged in material selection, which both contributes to indoor air quality and reduces environmental impact (Liu et al., 2019). Acoustic comfort is critical to increasing employee productivity, especially in open office designs, and requires detailed planning in terms of sound insulation and echo control (Bluyssen, 2013). Ergonomic design, on the other hand, increases the accessibility and functionality of space for individuals of different ages and physical capacities (Attaianese & Duca, 2012). All these criteria can be optimized with artificial intelligence-supported analysis and automation systems, which makes it possible to go beyond manual evaluation processes.

Text to Image Artificial Intelligence

Artificial intelligence is a technology that mimics the cognitive functions that humans associate with the human mind, such as learning and problem solving. It is used in many fields from marketing to banking and finance, from agriculture to health and safety, from space research to robotics and transportation, from chat robots to artificial creativity and production. In recent years, artificial intelligence applications have become an integral part of the city by managing transportation systems, restaurants and shops and repairing the urban infrastructure (Bayrak, 2022).

Artificial intelligence is a set of technologies and algorithms that allow computers to perform certain tasks like human intelligence. Artificial intelligence algorithms specialized in a branch called natural language processing (NLP) can be used in tasks such as analysis and interpreting of texts. It usually uses one or more of machine learning, deep learning, or natural language processing techniques (Reviriego & Merino-Gómez, 2022). The process of creating an image or image from text data can be used to transform the text-based description or story into a realistic image. Artificial intelligence, which usually works with deep learning techniques, provides learning on data sets, creating artificial neural networks that can then be processed with new data. Generative Adversarial Networks (GAN) algorithms developed in recent years have provided a great improvement in text-to-image tech-

nologies. Recently, with the self-improvement of computer science, many artificial intelligence-based programs have been made from text to image. Today, there are many examples of these systems such as DALL·E 2, Craiyon, Nightcafe, Midjourney, Starry Ai, Pixray, Leonardo Ai and Shutterstock Ai (Ece, 2022).

Leonardo AI

Leonardo AI is a system that uses an artificial intelligence infrastructure called Stable Diffusion. Founded in 2021, this artificial intelligence initiative has created a large community of more than 200,000 professionals and seven research centers worldwide. Thanks to open-source principles, this community has access to the most up-to-date research and is working on artificial intelligence models that offer revolutionary advances in many areas of scientific research (Stability, 2024). The collaboration with Amazon Web Services has made it possible to use the Ezra-1 UltraCluster, the world's fifth largest supercomputer, thus paving the way for significant developments. The application development process on Stable Diffusion's open-source platform has been quite effective. For example, just one month after the release of SD 2.0, four of the 10 most popular applications on the Apple App Store started working with Stable Diffusion support. In addition, Stability AI's external applications, including Stable Diffusion-based applications such as Lensa, Wonder and NightCafe, have reached more than 40 million users and this number is growing (Stability, 2024). Stable AI CEO explains these developments with the following words:

“Our goal is to create the foundation that will activate the potential of humanity.”
(Stability, 2024)

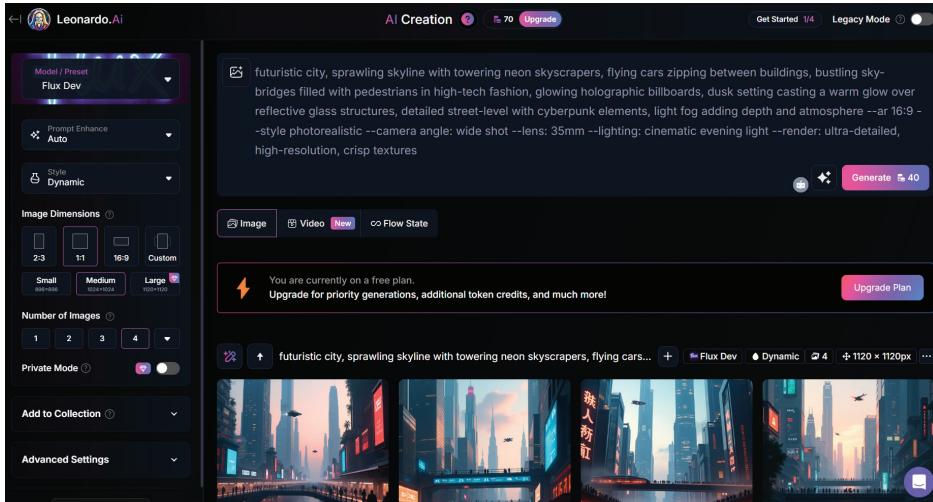
With its user-friendly interface and fast visual production, Leonardo AI offers effective solutions especially in the fields of architectural visualization, interior design and art. Thanks to this system, realistic, detailed and artistic digital images can be created based on text inputs (Leonardo AI, 2025).

Use cases are supported by the result images taken from the Flux Dev interface and evaluated according to LEED criteria. (Leonardo AI, 2025).

Usage samples were supported by the result images taken from the Flux Dev interface and evaluated according to LEED criteria.

Figure 1

Result views from Leonardo Ai's Flux Dev (Leonardo AI, 2025)



This image of the Leonardo.Ai interface shows how artificial intelligence-supported visualization tools can convert high-resolution and aesthetically consistent content using user-given text inputs (prompt). Complex, multi-layered and detailed descriptions given as input are processed by the system with style, composition, ratio and resolution settings and photorealistic urban scenes are obtained. Such interfaces have great potential for interior architecture and green design applications, especially in terms of creating architectural design scenarios of the future, testing interior atmospheres and moving conceptual ideas to the visual plane.

Text-to-Text Artificial Intelligence

Text-to-Text AI is a system that uses natural language processing (NLP) technology to translate text written in one language into another. This technology aims to eliminate communication barriers between people who speak different languages and increase translation accuracy. When a company needs to communicate with customers in different countries, it can be used in many areas, such as language learning and training, automation of classification processes, or responding to customer e-mails. However, artificial intelligence systems that work from text to text are not perfect. They may have difficulty, especially in complex texts that contain very meaningful or vague cultural references. Despite these limitations, artificial intelligence technology, which works from text to text, is considered an impor-

tant development that transforms the way we communicate between languages. These systems, which are constantly developing and improved, are becoming an increasingly valuable tool to overcome communication barriers and support global understanding (Erul & Isin, 2023).

ChatGPT

ChatGPT is a conversational AI system developed by OpenAI that uses advanced natural language processing algorithms to produce human-like responses to user queries (OpenAI, 2025). It is based on the GPT-4o architecture, which uses deep learning techniques to produce responses that are both relevant and consistent. It is designed to be highly flexible and customizable, and its ability to produce responses that are virtually indistinguishable from those of a human is impressive. ChatGPT is currently used in a variety of applications, including customer service, virtual assistants, and language learning. It has the potential to revolutionize the way we interact with machines by making it easier and more natural for us to communicate with technology. While technology still has some limitations, ChatGPT represents a breakthrough in the field of conversational AI.

Findings

To write a prompt that can be used in artificial intelligence from text to image to ChatGPT, a text has been prepared and sent to the chat robot. I want you to act as a fast engineer. You will help me write information prompts for an artificial intelligence art generator named Leonardo Ai. I'm going to provide you with brief content ideas, and your job is to detail them in complete, clear, consistent prompts. Prompts include explaining the content and style of images in a short and accurate language. It is useful to use references to LEED v4 for Interior Design and Construction and home to be open. Your focus should be on names and adjectives. I will give you some sample prompts for your reference. Please identify the camera that should be used exactly. Here's a formula for you to use (enter content names here) (medium: enter artistic medium here) (style: add references to genres, artists, and popular culture here) (reference to lighting, lighting here) (colors reference color styles and colors) (palettes here) (composition: reference cameras here, specific lenses, shot types and positional elements). When giving a warning, remove square brackets, speak natural language and be more prominent, use precise and understandable language. Always send me four different full prompt options. Sam-

ple prompt: Wet Shamrock Armored, green ray saber, Aleksi Briclot's portrait of the Celtic Jedi Sentinel with bright wet dramatic illuminat.

The answer received is as follows, Prompt 1: A LEED v4 certified kitchen in a residential home that showcases sustainable design elements such as quartz countertops, energy-saving devices and a recycling station. Medium: Digital 3D creation. Style: A stylish, modern aesthetic reminiscent of the clean lines and functional design of Bauhaus architecture. Lighting: Natural light fills the room through large, energy-efficient windows supported by LED recessed lights. Colors: A monochrome white and gray palette with stainless steel accents. Composition: The kitchen island captured by a wide-angle lens is in the foreground and directs the eye to the cabinets and household appliances in the background. When this prompt is written to Leonardo Ai, the images that appear are as follows.

Figure 2



Prompt 2: A LEED v4 certified residential bathroom that showcases sustainable design features such as low-flow fixtures, recycled glass tiles, and a double-siphon toilet. Medium: Digital 3D creation. Style: A spa-like aesthetic that reminds you of the calm interiors of Japanese ryokans. Lighting: Warm ambient lighting emphasizes the sustainable features of the bathroom while creating a relaxing atmosphere. Colors: A relaxing palette of earth tones, along with green bangs from indoor plants. Composition: Captured by a wide-angle lens, the bathtub is in the foreground and directs the eye to the dressing table and shower area in the background. When this prompt is written to Leonardo Ai, the images that appear are as follows.

Figure 3

Result views from A LEED v4- Prompt 3



Prompt 3: A LEED v4 certified home office that showcases a sustainable workspace with a reclaimed wooden table, ergonomic furniture, and a vibrant green wall. Medium: Oil paint. Style: Inspired by the calm, minimalist interiors of Japanese architect Tadao Ando. Lighting: A soft, diffused light filters through energy-efficient roof windows, creating a calm working environment. Colors: A calming earth tones pale where the vibrant greens of the vibrant wall are the focal point. Composition: When viewed with a standard lens, the office is neatly framed with a table in the middle and a green wall in the background. When this prompt is written to Leonardo Ai, the images that appear are as follows.

Figure 4

Result views from A LEED v4- Prompt 4



Prompt 4: A LEED v4 certified residential interior with an open concept seating and dining area with sustainable design elements such as bamboo flooring, low VOC paints and energy-saving devices. Medium: Digital 3D creation. Style: A modern farmhouse aesthetic reminiscent of cozy, rustic interiors designed by Joanna Gaines. Lighting: Natural light flows through large, three-bay windows supported by LED pendant lamps. Colors: A soothing palette of whites and grays with green bangs from natural wood tones and indoor plants. Composition: The living space captured with a wide-angle lens is in the foreground, and the eye is directed to the

dining area and kitchen in the background. When this prompt is written to Leonardo Ai, the images that appear are as follows.

Figure 5

Result views from A LEED v4- Prompt 5



Prompt 5: A LEED v4 certified bedroom in a resident home with sustainable elements such as a cork floor, low VOC paints and energy-efficient ceiling fan. Middle: Watercolor painting. Style: A Scandinavian-inspired design that focuses on simplicity and functionality, reminiscent of Arne Jacobsen's works. Lighting: Soft, diffused light filters passing through energy-saving curtains create a comfortable and inviting atmosphere. Colors: A calming palette of blue and white with natural wood tones. Composition: When viewed with a standard lens, the bed is neatly framed in the middle and the window and table area is visible in the background. The prompts were generated by AI. When this prompt is written to Leonardo Ai, the images that appear are as follows.

Figure 6

Result views from A LEED v4- Prompt 6



Evaluation

Table 2

Evaluation of AI-Generated Interior Images Based on LEED-Inspired Indoor Environmental Quality Criteria

	Indoor Air Quality		Lighting		Materials		Acoustic	Ergonomics and Design
	Indoor Air Quality	Green Cleaning & Maintenance	Natural Lighting	Energy Efficient	Low-Emission Materials	Durable Materials	Recycled Content	Fast / Flexible
Figure 2	X	X	X	X	X	X	X	X
Figure 3	X	X	X	X	X	X	X	X
Figure 4	X	X	X	X	X	X	X	X
Figure 5	X	X	X	X	X	X	X	X

Figure 6

Indoor Air Quality	Green Cleaning & Maintenance	Ventilation	Natural Lighting	Energy Efficient	Lighting Quality	Low-Emission Materials	Durable Materials	Recycled Content	Fast / Flexible	Noise Control	Acoustic Comfort	User Control	Ergonomic Design
X	X	X	X		X	X		X		X	X	X	X

For Figure 2, It is seen that importance is given to indoor air quality in this place. User health is supported using green cleaning products and effective ventilation systems. The effective use of natural light and the preference of energy-efficient lighting systems increase the sustainability of space. Materials containing low volatile organic compounds (VOC), durable building elements and recycled ingredients show that the choice of materials is made with environmental sensitivity. Noise control is included for acoustic comfort, and the user experience has been optimized with user control and ergonomic design elements. In this respect, both environmental sustainability and user-oriented design have been successfully achieved.

For Figure 3, this interior meets the LEED criteria in terms of both air quality and material use. Especially natural ventilation, green cleaning applications, and natural light use contribute to the health and comfort of the space. Energy efficiency is ensured in lighting, and low emission, durable and recyclable materials are included in the choice of materials. In addition, sound insulation was provided for acoustic comfort and an arrangement was made that allows user control. This space is compatible with both functional and environmentally friendly design principles.

For Figure 4, this space stands out especially in terms of lighting and material use. In addition to natural light, interior balance is achieved with energy-saving lighting. Low emission and durable materials are preferred. In addition, the use of fast renewable materials contributes to environmental sustainability. While air quality is protected with ventilation and green cleaning applications, acoustic comfort is provided with voice control. User comfort has increased with ergonomic arrangements. This area has established a good balance between aesthetics and functionality.

For Figure 5, this design successfully reflects the interior principles integrated into nature. It complies with LEED standards, especially in terms of air quality, use of natural light and energy efficiency. Durable and recycled products with low VOC

are preferred in material selection. Sustainability has increased by using fast renewable materials. Noise control, acoustic comfort and user control are provided, and the physical comfort of the users is prioritized with ergonomic arrangements. This place also coincides with the principles of biophilic design.

For Figure 6, this interior shows high performance in all categories. Indoor air quality is supported by green cleaning, ventilation and natural light; energy efficiency is provided in lighting. Low emission, durable and recycled materials and fast renewable resources are preferred. Voice control and echo reduction are provided in terms of acoustic comfort; user comfort has increased with ergonomic furniture and controllable arrangements. This space is an ideal interior example in terms of both environmental sustainability and user experience.

Result

The joint address of green building certification systems -especially LEED- and artificial intelligence technologies opens the doors of a new era in sustainable architecture. Although the advantages of artificial intelligence in design, construction and operation processes attract more and more attention, the full integration of these technologies into the green building processes still faces some technical, ethical and structural limitations. Existing artificial intelligence systems are heavily dependent on data quality and may lack contextual understanding in complex, user-oriented indoor environments. In this study, indoor environmental quality criteria such as indoor air quality, lighting, material selection, acoustic comfort and ergonomics were evaluated with artificial intelligence-supported methods. The findings show that artificial intelligence can provide highly detailed and precise analyses in line with LEED standards, thus making it possible for certification processes to become more objective and efficient.

However, human control is a must for these technologies to be used effectively. Especially when it comes to ethical, aesthetic and contextual decisions, it is not enough to act with algorithms alone. For this reason, interdisciplinary cooperation between architects, environmental engineers, data scientists and decision makers is of great importance. Future research should focus on the development of hybrid systems that combine expert opinion with artificial intelligence algorithms; these systems should be configured in a transparent, auditable, and user-friendly way. In addition, standard data sets that can be used in the field of sustainable design should be created, and education models compatible with LEED and similar sys-

tems should be developed. As a result, artificial intelligence should be seen as a complementary tool instead of replacing human expertise. When integrated correctly, artificial intelligence can contribute to the creation of more livable and sustainable spaces by making green building certification processes more responsive, scalable, and adaptive.

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Creating a Fire Station in Bujanovac, Serbia

Fatlinda Veliu

Abstract

The inspiration to work in such an institution is the fact that there is no fire station in Bujanovac at all. As an architecture student, it has been essential to work at the fire station that fulfills all needs, both functional and aesthetic. The primary focus was on organizing access to the institution to create quick, free entry or exit in emergency cases and to give the institution a more beautiful, modern look. Such a station was critical and was required in the city where I live, because in emergency cases, you always have to wait 25-30 minutes for the firefighters to arrive from the nearest city, Vranje.

With a population of around 50-60 thousand people, I think it is a serious problem that this city lacks a building like this one, which is primary and which affects the safety of the citizens who live here. In my creative design, the primary focus was on security and building a comfortable space for the employees of this institution. The building has three emergency exits and is designed with sustainability in mind. The materials are selected from local ones that do not require long transport, natural ventilation, greenery, a solar system, or a geothermal system. For this project, I used various methods of analysis, including site visits, site analysis, interviews with employees of this institution, discussions with urban planners, sketches, analyses of fire stations across Europe, consultations with various professors, etc.

Introduction

The fire station is a vital institution because it serves the needs of the city's citizens. As architects, our job is not only to create beautiful buildings but also to design buildings that are essential to the community and to improve people's safety. The location I chose for this project was well thought out. It is surrounded by many public buildings, including the Kindergarten, two primary schools, a secondary school, a university, the sports hall, the city stadium, the police station, the ambulance, the municipality, the law office, and many restaurants, as well as residential buildings. Given this urban context, it was necessary to build this building at this location so that I can serve citizens more quickly in emergency cases. The current situation in Bujanovac isn't satisfactory for the citizens. In many emergency cases, due to the lack or delay of the fire brigade, the city has lost many buildings, people's lives have been endangered, and, in some cases, the situation has escalated into disasters in which people's lives are lost. This shows that the city lacks basic services that a complete and safe city should have. In addition, the design of a fire station became not only an academic project but also a necessary contribution to insurance and the city's development.

Project Description

Location

The project site is located in the city of Bujanovac, along the main road K. Petrovica, which connects the city center directly. The area is surrounded by two secondary roads on both sides, which makes circulation and access to the building easier and more effective. The entire area is 7500 m², of which approximately 30% is used for construction, and 70% is dedicated to rotation, training areas, greenery, relaxation areas, and parking for staff and fire trucks.

The fire station has a main entrance for fire trucks that is connected directly from the main road, a private entrance for staff vehicles in the parking area, and three entrances for pedestrians: a public entrance, a private entrance for personnel, and an entrance that is direct to the sports area, which citizens can also use for different activities.

Figure 1.

Site plan



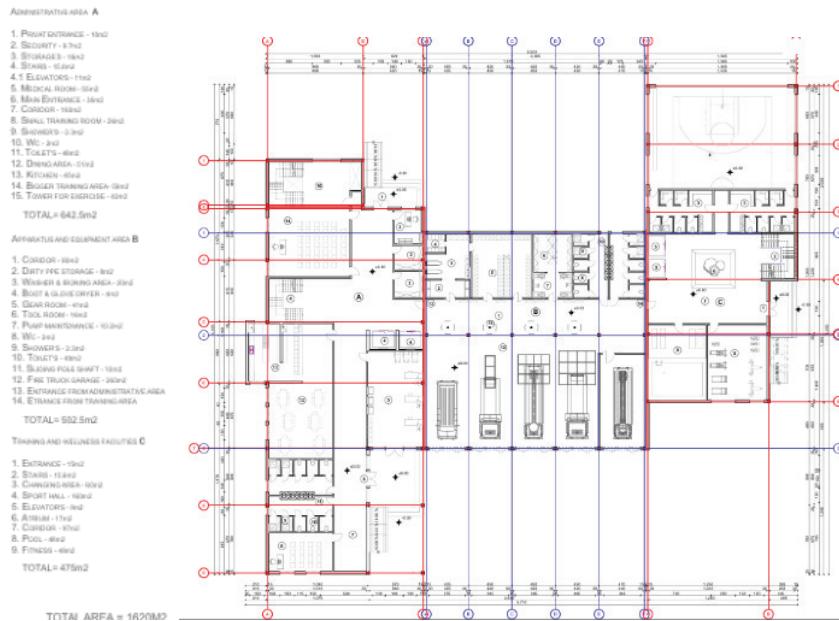
Program and Functional Layout

The building is separated into three essential parts, designed to complete the requirements for a modern station:

1. The first part is the administrative part, where there are a total of two floors. So, on the first floor are the kitchen and tableware, security room, medical room, two training rooms, toilets and bathrooms, storage, and vertical communication.
2. The second part is the central part of the station, which includes the garages for fire trucks and all the necessary rooms, such as equipment storage, changing rooms, and technical spaces.
3. The last part includes a fitness area, swimming pool, and sports hall designed not only for the employees of this institution but also for the citizens

Figure 2.

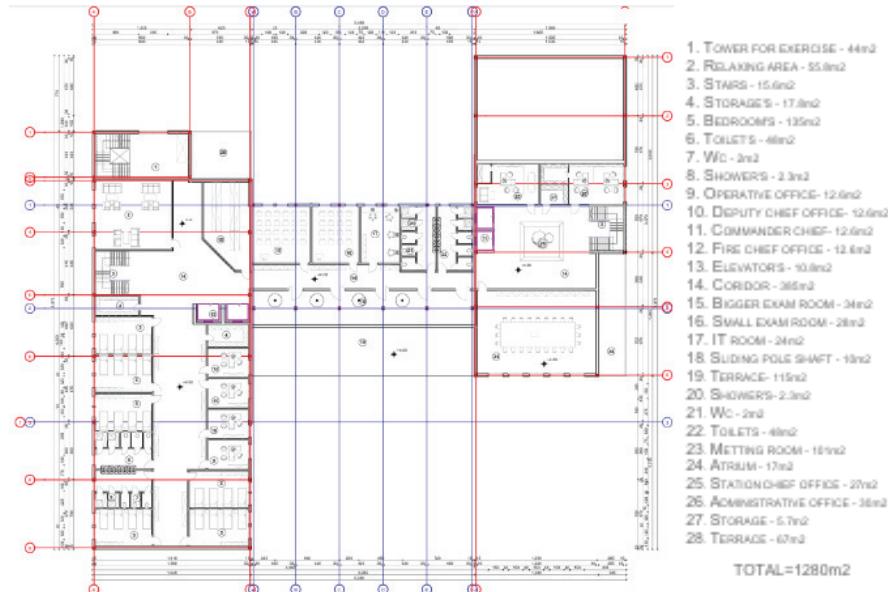
Ground floor plan



Regarding the first floor plan, the program includes sleeping rooms, a library, a relaxation area, two terraces, administrative offices, IT rooms, exam rooms, meeting rooms, and a fire pole for quick access in any emergency.

Figure 3.

First floor plan

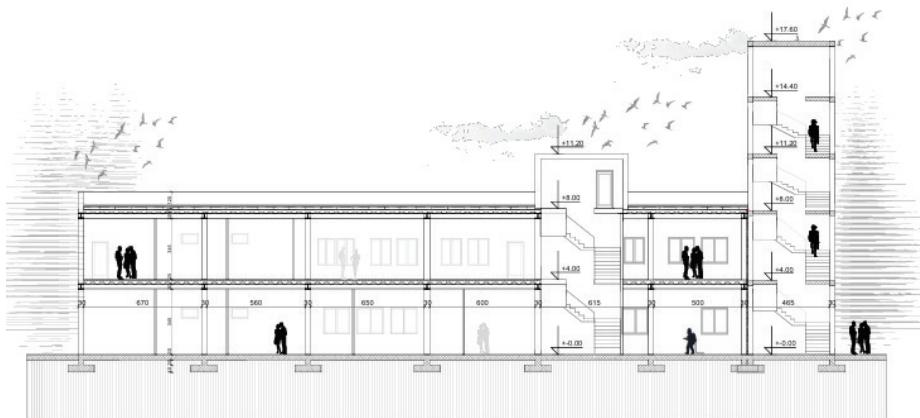


Structure and Materials

The building has a steel structure combined with a concrete foundation. The training tower is built entirely of reinforced concrete to ensure stability and safety during physical training. In the structure, it is worth noting that there are also three dilatations, which serve to connect the structure and maintain stability during temperature changes or structural movements.

Figure 4.

Section of the building



The materials are selected carefully based on functionality, sustainability, and local availability. The primary materials include reinforced concrete facades, anthracite panels, and red metal cladding on the exterior. The red color gives the building a strong, recognizable identity that clearly conveys its function as a fire station.

Figure 5.

3D model of a building



Figure 6.

Front elevation of the building



Methodology

The design process for the fire station in Bujanovac follows several significant stages, from research and analysis to development and final design concept. Each step helps create the most justifiable function, security, and a building that responds to the needs of the citizens.

Site Analysis

The first step was to study the location and surroundings to gain an effective idea. This includes topography, traffic connections, site entries, building orientation, and neighborhood buildings. The analysis has helped me choose the best placement for site entrances, parking spaces, and fire truck circulation, and to position and design spaces for training and relaxation.

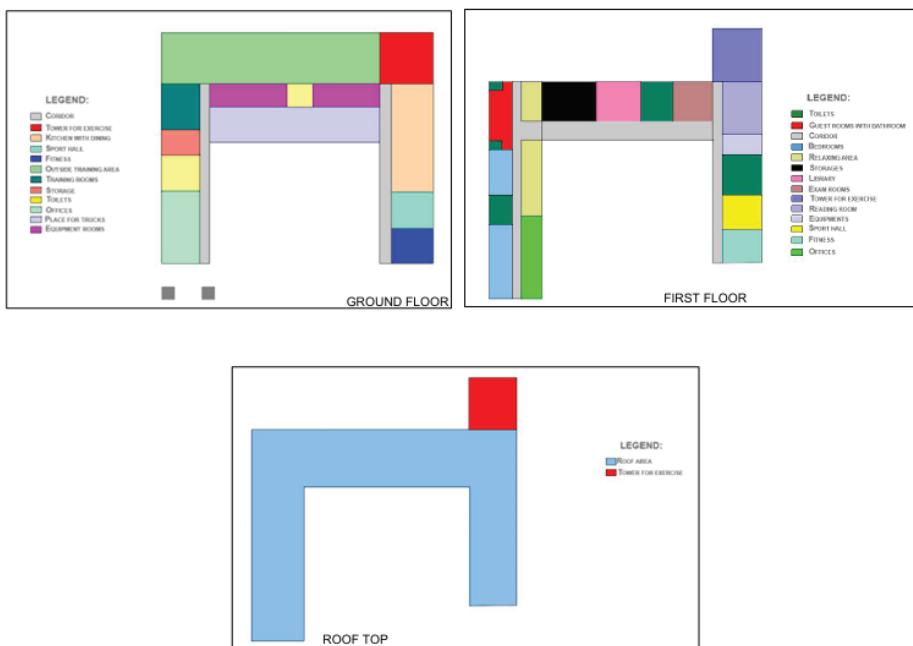
Research and Case Studies

To make a clear sense of how a fire station should function and what such an institution should contain, I have studied examples of fire stations in various European countries, as well as in different books on rules, m^2 , necessary spaces, etc. Those different examples and analyses from different books helped me understand how spatial organization, safety systems, and architectural approaches work. By comparing these designs, I really understood how a fire station in Bujanovac can function best and created the final design.

Functional and Spatial Analysis

The research was analyzed in general, and I then created a functional diagram by organizing all the spaces by use: operational, residential, administrative, and training. From this process, we can clearly see a smooth internal movement and quick response times in emergencies, as well as which spaces should have direct access to the main space.

Figure 7. *Proposal plans*



Concept Development

Based on the collected information, I have developed the most crucial concept, which combines private aspects into a design framework, including Function, Security, and Sustainability. The idea is to support firefighters' daily activities and, to make this building even more valuable and interesting, connect the local community with the building itself.

Design Process

The design was developed through sketches, a floor plan, interviews with employees who work in such buildings, visits to different fire stations in Macedonia and Kosovo, speeches, and research by various architects. I also had to analyze many different designs until we reached the final design and function. Special attention had to be devoted to natural lighting, the orientation of the rooms to get more natural light, the use of local materials, the elimination of long waits for transport, and the integration of as many spaces with greenery as possible, as well as spaces for spending free time and staying.

Evaluation

During the process, I also reviewed the design against the fire station's standards and the project goals. Feedback from the professor and others who really understand how these things work helped me improve the organization of the function and safety system, as well as the aesthetic quality of the project.

Review of Examples

Before starting the design process, I have analyzed lots of examples of the modern fire station in Europe, and to have a clearer view of how the function should be as effective as possible, have fast access, security in construction and function, and also, an important thing is the comfort of firefighters in the space where they spend plenty of time. With a background of many references, I have chosen two that have an impact on the design of my project: Fire Station Saragossa in Spain and Fire Station in Munich, Germany.

Fire Station Saragossa No.4, in Spain

The Saragossa fire station is famous for its modern design, which includes its simplicity. The institution is well designed to have access as fast as possible in emergent cases. Large open spaces and easy circulation are the main points of this building. In the architectural aspect, concrete and metal materials are used, which reflect on strength and durability, and also large windows that provide natural daylight. This building also included green spaces and training areas around it, from which I drew inspiration to implement in my project as well.

From this excellent job, I learned more about the importance of the most functional areas, the separation of the administrative part from the operational one, and, at the same time, the well-connected nature of both, with quick and straightforward access.

Figure 8.

Fire station Saragossa, IDOM Architects (ArchDaily, 2018)



Fire Station 4, Munich, Germany

This project is also an example of and an inspiration for efficiency and technical organization. It is designed to support a 24-hour working schedule, with clean circulation and well-planned spaces for cars, training, and administration. The institution's structure is steel and concrete. The idea of three main areas came from this one because it also has three main areas: the garage and technical area on the ground floor, the living and administrative areas on the first floor, and the exercise tower directly bordering the building.

The design is focused, let's say, more on safety, access, and natural lighting, which have influenced my design for the project in Bujanovac. I have also made progress on many things from this example. Still, some of the most important were: direct access to the main road for fire trucks, divided spaces for living and working, and entrances to the building dedicated to the public and private, and from a simple geometric shape and modern materials taught me that materials should be used to express a strong and functional identity of the institution.

Figure 9.

Fire Station 4, Munich , AG Niederberghaus & Partner GmbH , (Canzler, n.d.)



Results and Outcomes

The final design of the Fire Station in Bujanovac successfully meets the primary goal, intended from the beginning, to build a building that fulfils Function, safety, and sustainability, serving both workers and citizens.

The organization of spaces allows fast and direct movement between the main areas, the garage, administrative areas, and training spaces. It is planned so that fire-fighters respond immediately in emergencies, thereby reducing the risk of injury and loss of life. Vertical communication and emergency exits improve security and ensure easy access in the event of an emergency. The building's shape is simple; I used clean lines and a compact U shape, and the surrounding space features areas for relaxation and greenery. Natural lighting is provided on all the building's facades, with large openings that improve the working environment and reduce the need for artificial lighting. The combination of materials and colors, such as red, anthracite, and concrete, gives the building a strong, recognizable character that clearly conveys its function.

Sustainability was also an essential part of this project. I decided to use local materials to reduce transportation costs and environmental impact. The project also includes a geothermal system, solar panels, green areas, natural ventilation, and natural materials in the building's interior. More than 70% of the site is dedicated

to circulation, outdoor training areas, and green areas for relaxation, creating a healthy space for firefighters. The project is not only a technical building but also a socially necessary space for the citizens of this country. Since parts of my project, such as the sports hall, fitness center, and swimming pool, are open to the public, this also strengthens the connection between the fire brigade and the community. This helps us to make this station a symbol of safety, service, and community care, a place where people will feel safe and proud to have it.

Discussion

The design of the Fire Station in Bujanovac was a valuable learning experience that combined architecture, functionality, and urban responsibility. The project, with a successful conclusion, addressed the city's primary needs by providing practical functionality, clean circulation, quick access in emergency cases, and well-organized areas for operations, training, and administration. The building is safe, built with modern materials and techniques, and sustainable. At the same time, this also serves the citizens by allowing the use of spaces inside and outside the building and by strengthening their connection to this object as much as possible.

As for construction, it was the best solution for durability and safety, and the training tower section can also serve as an emergency exit.

Despite all the successes, during the design, I encountered many difficulties with the combination of private and public spaces. But after some research and consultation with professors, I concluded that the partitioning of spaces with specified entrances is the end. On the other hand, the chosen location has its own limitations, such as traffic flow along the main road and around the surrounding apartment buildings, which should be considered even more in areas such as garages, parking lots, and outdoor training areas.

Through this project, I learned more about the importance of safety in an object, its function, and the need to consider the urban context. Another important thing that I knew was how sustainable materials and green spaces can improve the working environment and strengthen the building's relationship with the community.

Overall, this project demonstrates how a functional, sustainable Fire Station can improve safety, efficiency, and community life in a mid-sized city such as Bujanovac.

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PROJECT PRESENTATION

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Designing a Wellness Centre at Jägala Waterfall, Estonia: A Sanctuary of Reflection, Nature, and Healing

Jasemen Ramadani

Abstract

With this paper, I am representing a wellness retreat centre located at the Jägala Waterfall in Estonia. The name of the project, The Veil of Reflection, is closely tied to its concept, where I have intended to include reflection both as a natural phenomenon that is being represented by the element of water and an inner journey, where the project is designed intentionally as a sanctuary for healing: physically, mentally, and spiritually. Inspired by the surrounding forest and river, the design seeks harmony between the natural and built environment.

Research methods are mainly based on environmental observation, site and climate analysis, traffic, accessibility and utility analysis, vegetation and water flow analysis, material and form experimentation, and references to masters such as Peter Zumthor, Carlos Scarpa, Tadao Ando, and Frank Lloyd Wright. The philosophical aspect lies in the so-called 'sensory architecture', highly inspired by Juhani Pallasmaa's "The Eyes of the Skin" (2005), aiming to design spaces that not only have visual weight but also value feelings, sounds, and scent. The functions of the centre are knitted around four natural elements: earth, water, air, and fire, each corresponding to a specific form of therapy. A crucial part in integrating the authenticity and cultural resonance play the local traditions and ancient healing techniques, such as metseravi (Estonian forest bathing therapy).

With the intention of minimizing the environmental impact, the centre is constructed with local limestone, timber, and concrete, demonstrating how the building itself becomes a natural extension of the surrounding forest by merging into the landscape rather than standing as an incongruous detached object.

Keywords: reflection, wellness centre, sensory architecture, healing, waterfall, organic design.

Introduction

The design of a wellness retreat emerged during my time in Estonia, often visiting the Jägala Juga, being mesmerised by the meditative rhythm of the waterfall itself, and the quiet density of the surrounding forest. My presence there led me to the thought of finding a way to create a space where other people, as well, will have the opportunity to experience this extraordinary feeling of serenity during the four seasons. The idea itself reminded me of Pallasmaa's philosophy, which I considered while designing each little detail of the project.

"Our bodies and movements are in constant interaction with the environment; the world and the self inform and redefine each other constantly. The percept of the body and the image of the world turn into one single continuous existential experience; there is no body separate from its domicile in space, and there is no space unrelated to the unconscious image of the perceiving self." (Pallasmaa, 2005).

In this way, the human becomes a part of nature, letting the healing happen naturally without forcing it, through all five senses: listening to the sound of the flowing water, feeling the cold air against the skin, observing how light fractures across the mist, and smelling the pine forest, together with the various types of local herbs and flowers, which are also integrated into the project through aromatherapies.

Project Description

The wellness centre is placed on the bank above the Jägala River, on Estonia's largest natural waterfall. The site itself is an ideal setting for introspection and retreat, veiled with the clear sky and surrounded by the pine forest, which creates such a secluded character. The concept lies in four main zones, each representing a specific element, which embodies a specific healing phase:

The arrival and grounding is represented by the **Earth Zone**, including the entrance and the central area of the retreat, where earth-toned materials are used intentionally, such as stone and oak, creating a sensory balance and inflicting a grounding energy.

Healing by reflection is represented by the **Water Zone**, mainly focusing on the parts closer to the river, containing hydrotherapies, massage rooms, saunas, an outdoor pool, and calm chambers facing the waterfall. The purpose is to use water as a therapeutic element where it becomes a vessel of purification, both in a literal and symbolic aspect.

Breathing and meditation are represented by the **Air Zone**, containing meditative, yoga rooms, and terraces where the purification happens spiritually, a form of architecture that's rather felt than seen.

Reconnection is represented by the **Fire Zone**, focusing on the common zones where healing happens through socializing by the exchange of energy and warmth.

In addition to these main zones, there is one more zone that represents the revival after the healing process, represented by the Renewal Zone, containing the accommodation rooms that float lightly above the landscape. These bedrooms are purposefully oriented towards the northeast, maintaining privacy and silence, and yet allowing the first morning light to enter, creating a visual connection with the river and the forest.

Concrete is used on the structural elements such as columns, slabs, and walls, meanwhile, the façade consists of local limestone blending in with the site's geology and giving the centre a traditional character. The material palette of the interior design mainly includes wood, glass, travertine, and terrazzo, following the architectural language of a restrained, minimalist yet sophisticated and contemplative aesthetic.

Figure 1

Parti Pris Diagrams

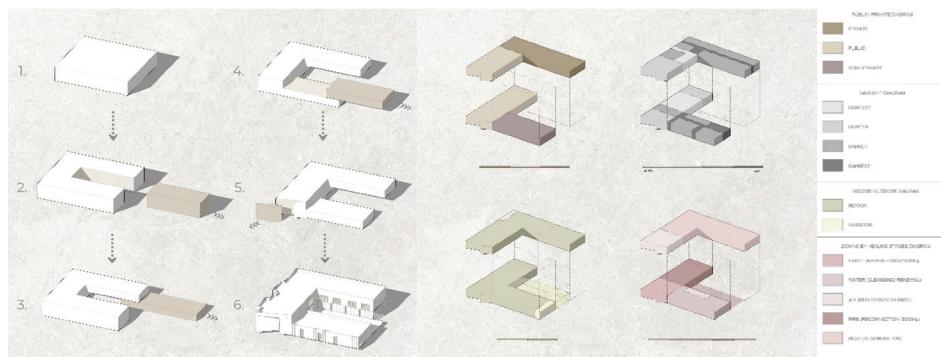


Figure 2

Ground Floor Function Diagram

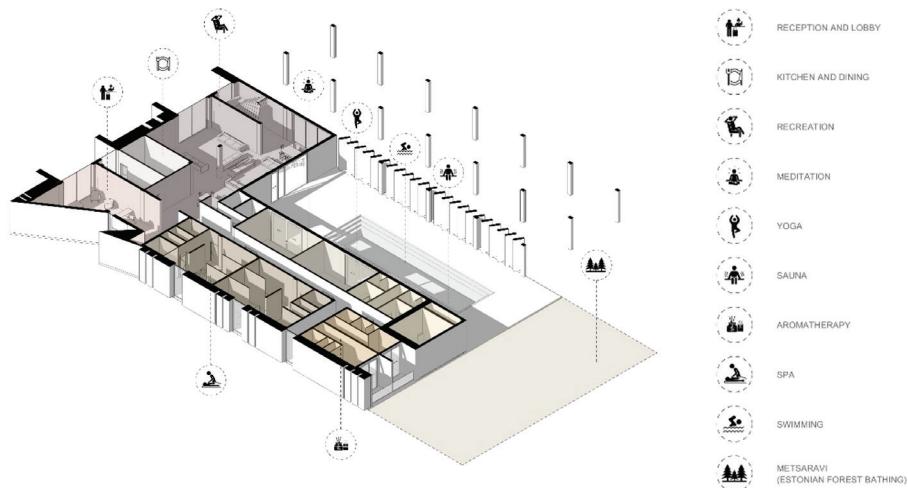


Figure 3

First Floor Function Diagram

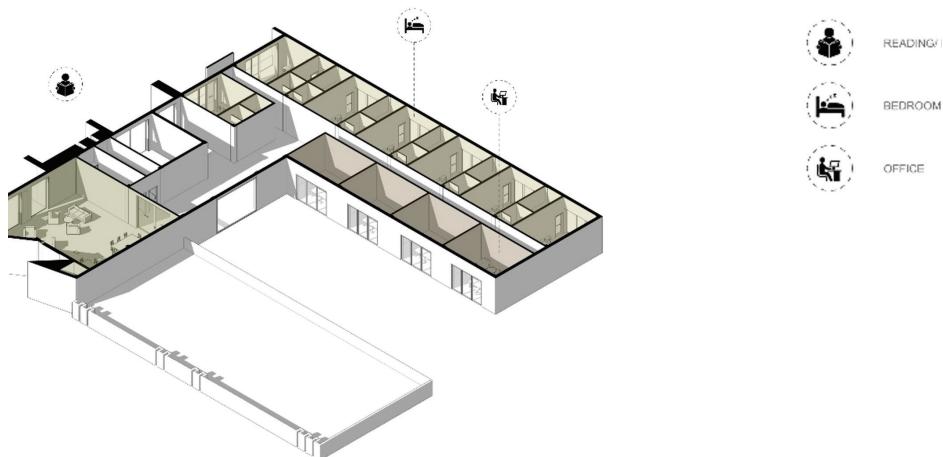


Figure 4

Horizontal and Vertical Communication Diagrams

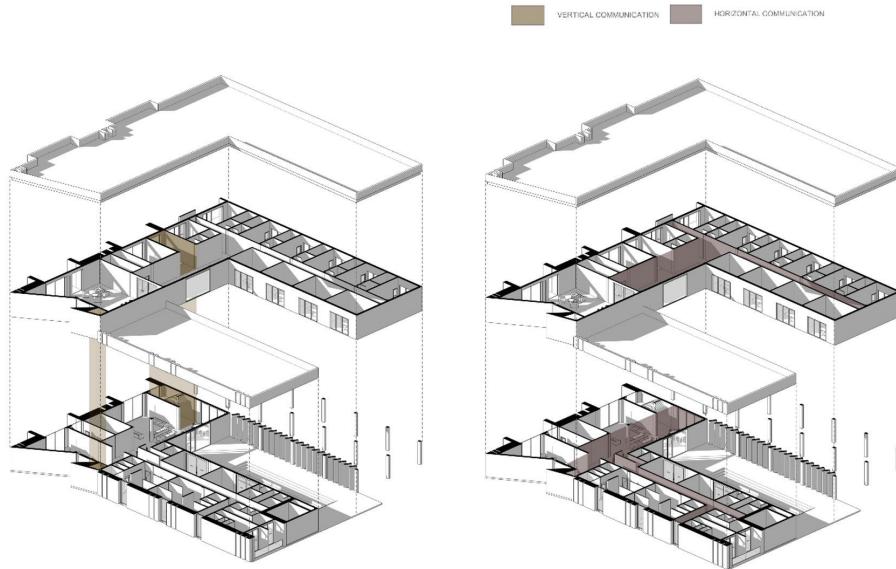


Figure 5

Latitudinal Section

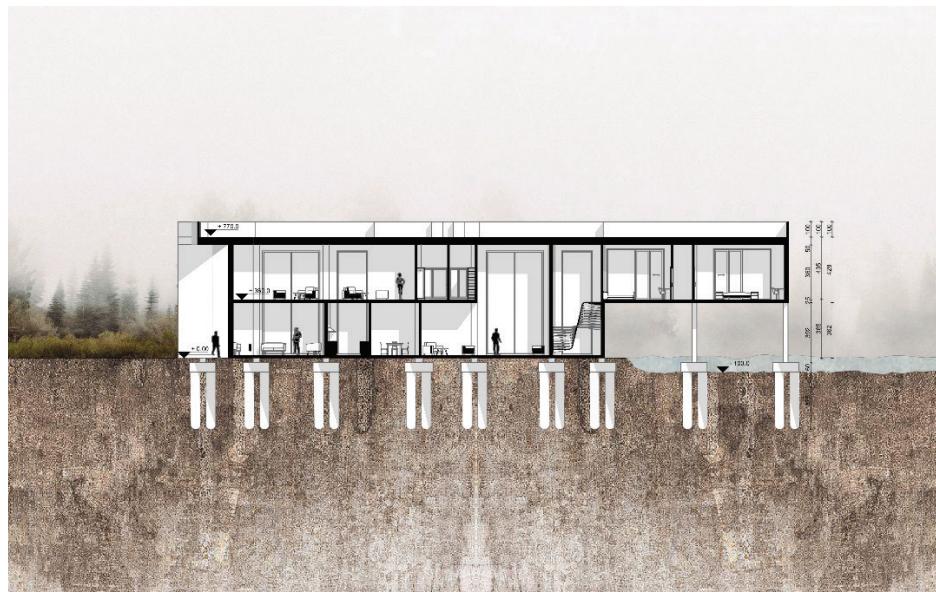


Figure 6

Longitudinal Section

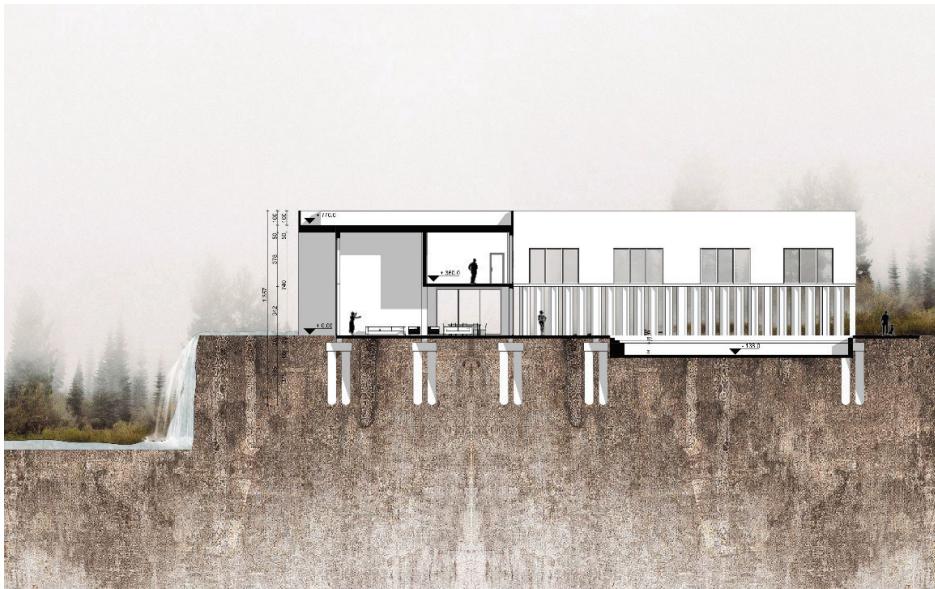


Figure 7

Axonometric Site View

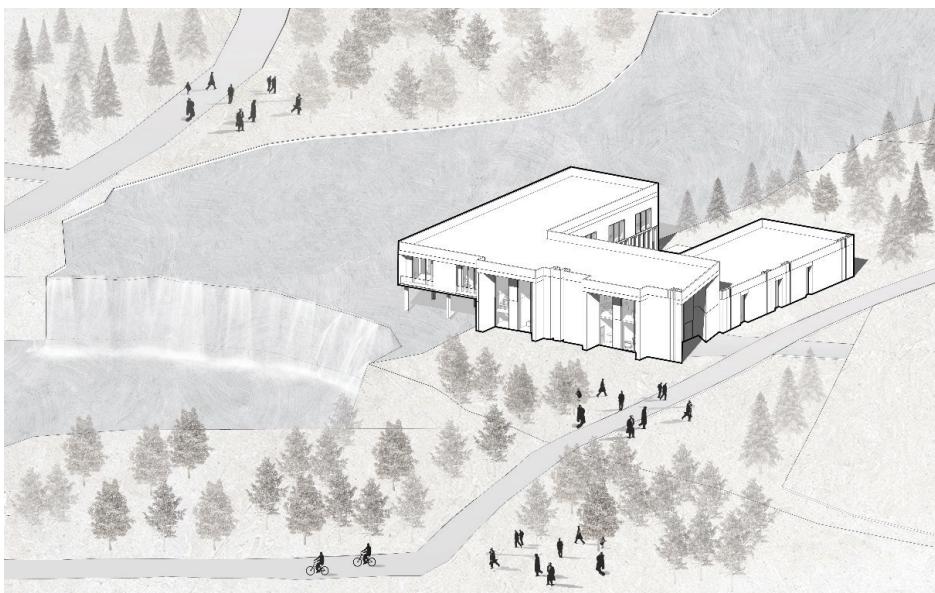


Figure 8

Exterior Render



Figure 9

Exterior Render: Outdoor Pool



Figure 10

Exterior Render: Entrance



Figure 11

Interior Render: Reception and Lobby



Figure 12

Interior Render: Reception and Lobby



Figure 13

Interior Render: Spa Room



Figure 14

Interior Render: Spa room, with a Sauna



Figure 15

Interior Render: Living and Dining Area, with a view towards the river and the outdoor pool



Figure 16

Interior Render: Living and Dining Area

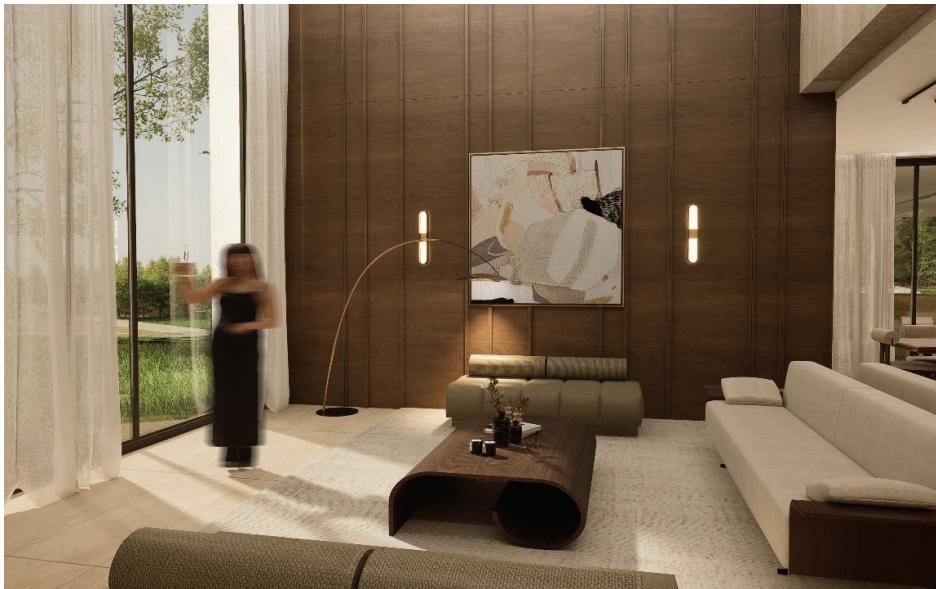


Figure 17

Interior Render: Staircase



Figure 17

Interior Render: Glass Partition Wall, Living and Dining Area



Methodology

The methodology included in the research consists of visual observation, material experimentation, and mostly qualitative analysis.

The site's acoustics, light orientation, and seasonal transformation, are provided through first-hand location visits and analysis. Volume experimentation and spatial organization evolved through freehand sketches and various diagrams, where the functional zoning was mainly guided by the four natural elements. Sustainability and structural stability were achieved by the low-impact construction, passive heating, and natural ventilation, while creating a balance between cantilevered components and grounded cores.

The native vegetation was preserved by letting the building blend in naturally, intentionally avoiding artificial greenery and emphasizing the local craftsmanship.

Results and Outcomes

The achieved result aims to create a harmony between atmosphere, intention, and material. The transition begins from the outdoors, continuing with the indoors. The cantilevered section that extends over the river acts as a threshold, both literally and metaphorically, connecting the seen and the unseen. There is a gradual shift from the public to the semi-public and the deeply private area, which acts as a mirror of the internal reflection process of the clients.

Based on the feedback from conceptual evaluations and peer reviews, the project contains the capacity to evoke calmness and introspection. This spatial sequencing that begins from the dense forest, approaches paths and reaches open water views, creating a feeling of catharsis and revitalization. The acoustic elements of the landscape as the waterfall's murmur, the distant wind, the rustling of leaves, define the sensory identity while the light interplay becomes a design element as well.

The material choices contribute to the retreat's tactile storytelling, where the limestone facades represent the graceful aging, wooden elements in the interior radiate warmth, and concrete maintains the stability against the northern climate.

Conclusion

In function, The Veil of Reflection is a wellness retreat, but in its core, it represents an introspective journey through architecture's healing capacity, by incorporating emotion and resonance. By developing the idea around the concept of reflection, one of my purposes was to reflect fragments of myself as the designer, valuing the language of silence and the reverence of nature. It can be seen if looked at carefully at the hidden details, such as the lilies that I used at various parts of the design, flowers known for their symbolism of purification. In this way, I intended to let nature lead instead of trying to dominate it, which affirms the philosophy that architecture can become a spiritual mediator.

As Scarpa once said, "If the architecture is any good, a person who looks and listens will feel its good effects without noticing" (Scarpa, 1979). This retreat seeks to embody that quiet power, architecture that listens, heals, and mirrors the soul.

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A Library Meant For Our Tomorrow

Maja Mihevc, Zeynep Yilmaz and Turgay Kenger

Abstract

Throughout history libraries were primarily established as expansive troves meant to store knowledge and provide education. As the world has moved on from ancient times, however, libraries have expanded far beyond their original intentions to satisfy our needs and varied usage of these spaces. They are now not only echelons of hundreds of years of history and memory but also vibrant community centers enabling us to foster creativity, curiosity and social bonds between generations of all ages. To accommodate, or rather celebrate such an evolution, our team has developed several ideas through the Futuristic library project. Our goal is to create a library truly meant for society's tomorrow. The project's goal is to unite the rapid growth of technological innovation with nature inspired design to provide comfort, inclusivity, and accessibility in an environment which acknowledges human needs. The Futuristic Library demonstrates how technology and nature can converge to create a modern, interactive, and welcoming cultural space that redefines the role of libraries in the 21st century.

Keywords: design, sustainability, technology, library, public space, generative AI

Introduction

In the current age, libraries of the past, as simple quiet spaces for reading and borrowing books, no longer exist. They have transformed from mere public spaces into large community spaces, furthering education, idea sharing and socialization spanning all generations, interests and abilities. They have become centers to accommodate and include a large variety of people, from those looking for a simple, comfortable space to spend their time, to those lost and waiting to find something. The goal of the Futuristic Library was therefore to accommodate and satisfy all of these new needs, combining the clever technology of today to create a nature-inspired design for the future. Here the old and new meet – through long-standing materials and our thoughts, all encompassed in a beautiful, smart building (Dixon, 2019).

Inspiration and Influences

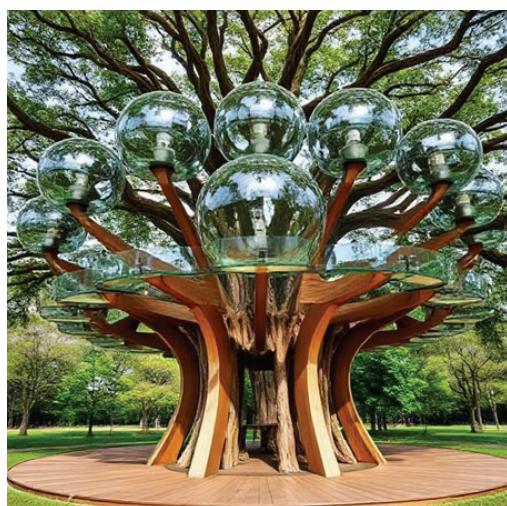
The Futuristic Library's primary inspiration for its shape and function was taken from what by many, could be considered the most 'natural' shape in existence. When we think of nature many envision a vast forest or meadow, perhaps even a beach – but the scenery is certain to contain at least the vague inkling of a tree in the distance. Thus, our inspiration as well has led us to use the outline of a large tree as its basis, providing organic shapes for its design. As a communal space that is meant to be a blend of both nature and technology it was important for the overall aesthetic of the library to retain the organic shapes of its base idea – both structurally and statically. From paper-drawn sketches and adjustments, to our contemplations of using a genuine, large tree as a basis the idealized visual materials were then further conceptualized with the help of AI software to create probable, realistic renders. This gave the sketches an earthier, tangible feel, providing us with clearer, more detailed, and exciting images of the Futuristic Library to share (Sullivan & Zimmerman, 2016).

Instead of traditional bookshelves, we opted for the use of large digital screens and tablets where visitors can instantly find and read thousands of books. This provides both space-saving solutions, makes searching faster, cuts down on paper consumption, and enables the building to follow an open concept floorplan. Last but not least it is also in step with the overall digitalization of reading material boosted by companies such as Kobo, Kindle and Amazon wherein the large majority of available titles, both journalistic as well as those under fiction and other prose are released only in EPUB, that is to say digital, formats. In order to contrast

and offset the use of digital space the Futuristic Library uses wood and glass as its primary building materials. Due to plans of, hopefully, building the library within the confines of a park or some other non-urban open space, a large portion of the glass is meant for its large windows, accommodating sunlight and view of the surrounding greenery (Coldewey, 2017). The Futuristic Library would also use innovative thermochromic surfaces that change color with sunlight and temperature (on hot days, they turn lighter to reflect heat; on cold days, they turn darker to absorb warmth from the sun). This helps regulate heat environmentally, reduces energy use and strengthens the library's connection to the landscape upon which it is situated. A portion of the energy consumption may also be managed with solar panels. Additionally, special care was also given to the library's layout, as it was mapped as a flexible space to accommodate all kinds of groups and needs: a play area for the children, comfortable hangout zones for teens, quiet reading spots for adults and a general, large open space for educational purposes, concerts and further cultural events. The individual usage of such spaces would be further enhanced by digitalized management depending on needs befitting a specific occasion, allowing for further enjoyment and efficiency.

Image 1

Futuristic Library



Note: Created using ChatGPT based on the in-classroom brainstormed ideas

Image 2

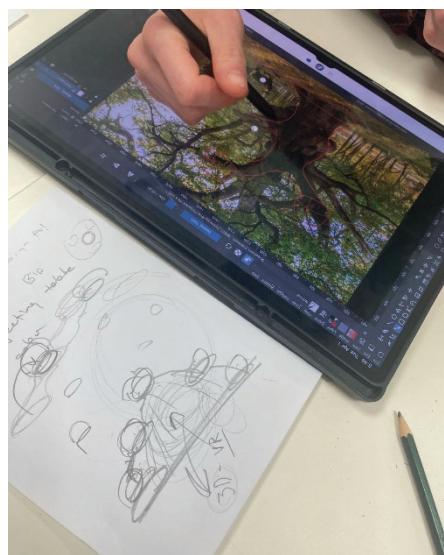
Futuristic Library



Note: Created using ChatGPT based on the in-classroom brainstormed ideas

Image 3

Futuristic Library



Note: Created using ChatGPT based on the in-classroom brainstormed ideas

Contextualization

The Futuristic Library's primary goal was the creation of a communal space, particularly to use and adapt the ever-evolving technology in new ways. Younger generations are becoming ever more adept with the use of touch screens, mobile devices and other smart and portable gadgets, from watches to laptops and the rest of society is slowly shifting to follow suit, even among the older, less adept generations. Libraries such as this one would, due to its abundance of interactive materials (namely interactive displays), be of great help to the elderly or those troubled with technology as places where they could learn to operate such systems; this is achievable both through organized classes or general offered aid. It would enable the visitors to gain knowledge and confidence in their actions and bridge not only generational gaps but enable socialization of groups with increased diversity. Such all-inclusive spaces allow for a friendlier, more enjoyable environment. One of the strengths of the Futuristic Library is also its space-saving solutions. Unlike regular, physical databases, the Futuristic Library's inventory would be entirely digital, enabling both more usable physical space and greater customization of fonts, backdrops, and colors when reading for the visually impaired visitors.

Its open-space leaning concept provides variety in the type of furniture or accessories provided providing a cleaner layout and cutting back on crowd reduction during busier, more eligible days for visitors. Such design helps us create better places for everyone, enabling people of all ages and interests to find, within the Futuristic Library, a piece of something they may love and cherish. In such a way, design can help us ensure kindness towards our planet and its occupants through sustainability and energy friendly means.

Conclusion

With all of its strengths, the concept of the Futuristic Library represents not only a creative, smart idea but the essence of a building through which we can establish growth and comprehension to more securely shape the future. It is; by using its beauty, calm, and efficiency, a place meant to truly care about nature, provide happiness and ensure the continuous transition of knowledge, showing us, the conjunction of nature and bright usage of provided technological advancements can create truly amazing spaces. Growth and inspiration come not only from the communities which provide them but also spaces providing them a loving home. Of course, the Futuristic Library's base idea is the result of a shorter workshop –

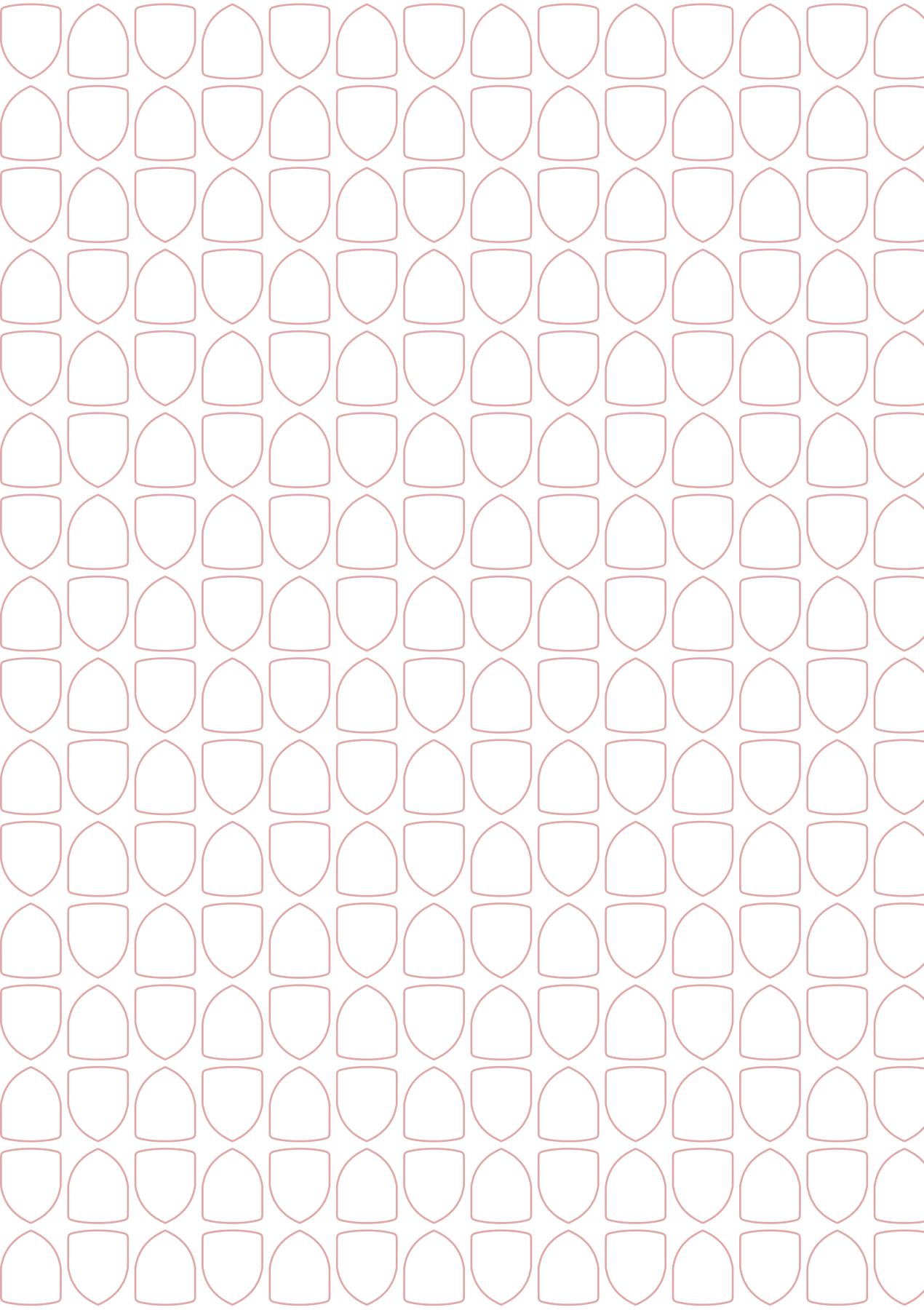
as such it requires extensive further designing further improvements to become an authentic, realizable project. In the meantime, however, it is still a peek into what our future public spaces could look like, painting a very exciting picture indeed.

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