SUSTAINABLE URBAN ARCHITECTURAL REHABILITATION OF AIRPORT INFRASTRUCTURES

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This paper presents a proposal for the sustainable urban-architectural rehabilitation of the former Quito airport building in Ecuador. The research focuses on exploring the implementation of nature-based solutions to optimize environmental performance and mitigate the impacts of climate change at the urban scale. Additionally, sustainable, and bioclimatic design strategies are investigated to enhance energy efficiency and resource consumption at the architectural scale. A notable aspect of the rehabilitation of the existing building is the use of glued laminated timber as the main material. This construction system has become an increasingly popular solution due to its technical, aesthetic, and environmental advantages, positioning it as a sustainable alternative capable of significantly reducing carbon emissions associated with construction. This approach not only enables the conversion of an obsolete urban area but also contributes to the preservation of important architectural heritage, making this proposal a flagship project in the responsible use of renewable natural resources in the construction industry.

Keywords: Sustainable urban development, Nature-based solutions, Mixed construction systems, Glued laminated timber, Urban regeneration, Reuse of heritage buildings.

1 INTRODUCTION: SUSTAINABILITY AS A COMMON OBJECTIVE FOR AN URBAN AND ARCHITECTURAL REHABILITATION PROJECT

Initially named “Parque del Lago”, Bicentenario Park is an urban, architectural, and landscape project situated in Quito, Ecuador. It places a strong emphasis on the implementation of strategies for sustainable urban development with a systemic vision of the city. In this regard, the rehabilitation of urban areas with obsolete infrastructures presents an opportunity to achieve, through new green infrastructures, not only the creation of conducive spaces for new urban ecological systems but also to weave together fragmented scales and areas of the city with its geographic support (Mistó et al. 2022). Likewise, to achieve a holistic management of the territory, it is necessary to ensure a governance system with multiple levels that includes the participation of diverse stakeholders. Additionally, an integrated approach that combines different sources of funding and the incorporation of a monitoring and evaluation system allowing continuous improvement of implemented projects is crucial (Fioretta et al. 2020).

The old airport of Quito, situated at an elevation of 2,880 meters above sea level with panoramic views of the Andes, becomes a unique enclave. It is also crucial to highlight, as pointed out by Correa and Almeida (2013), that with the construction of the city's first metro line, the adjacent areas to the stations become highly relevant enclaves for additional interventions transforming the surrounding urban spaces, configuring them as future centralities of the
Ecuadorian capital. Similarly, Busquets and Correa (2007) emphasized the importance of repurposing the old airport grounds as a metropolitan opportunity capable of restructuring the city, as has happened in Munich, Athens, Berlin, Denver, Caracas, and Hong Kong.

In 2008, with the transfer of the Mariscal Sucre International Airport outside the urban core, the Municipality of the Metropolitan District of Quito (MDMQ) announced the international design competition for the transformation of the old airport into a new urban park. Ernesto Bilbao and Robert Sproull, winners of the first prize for the landscape design and environmental recovery proposal, describe how the proposal incorporated the transformation of the 127.9 hectares of the airport infrastructure, which would become the city's most significant green area with wetlands, streams, lagoons, forests, and cultivation zones (Bilbao 2014). The project also foresaw the architectural rehabilitation of the old terminal building.

In 2013, the park was inaugurated as Bicentennial Park, and the MDMQ presented ordinances: ord.86 and ord.161, outlining the urban development of the sector and the different components that would transform the location into a cosmopolitan center dedicated to innovation and global connection of Quito with the world. According to these ordinances, the future development will include a convention center (whose first phase is already finish), an outdoor entertainment arena, an interactive center, a cinema and media library, a commercial area, a covered entertainment arena, and a reserved area for the development of hotels and offices. This set of facilities will be built in the immediate vicinity of the Quito Innovation Center, invigorating the activity and urban life of the entire sector (see Figure 1).

![Figure 1. Architectural Rehabilitation: The Quito Innovation Center (QIC).](image)

With this background, in 2022, the Korea International Cooperation Agency in Ecuador (KOICA) announces a national design competition in collaboration with the Municipality of Quito (MDMQ), through the Economic Promotion Corporation CONQUITO, to carry out the architectural rehabilitation of the Mariscal Sucre Airport's old terminal building and create the design for the Quito Innovation Center (QIC). The project aims to enhance the architectural features of the historical and culturally significant Mariscal Sucre Airport terminal building, contributing to the strengthening of the city's business and entrepreneurship support system. The building to be rehabilitated was designed by the Canadian architect Victor E. De Mers of the Airways Engineering Corporation of Washington D.C. and was inaugurated on August 8, 1960. At the time of its inauguration, the local press, specifically the El Comercio newspaper, described the
building as 'one of the most modern in Latin America'. Until 2013, when it ceased functioning as the Mariscal Sucre Airport terminal, it hosted significant events in Ecuador's public life (Monard Arciniegas 2020).

2 REHABILITATION OF THE TERMINAL BUILDING OF THE FORMER QUITO AIRPORT

2.1 Historical Layers: Architectural, Structural, and Functional Palimpsest

The original project, inaugurated in 1960, underwent several volumetric alterations over time to meet the growing demands of airport infrastructure. Until the year 2013, while the building has been in operation, the following additions were annexed: a front pavilion with a structure of reinforced concrete porticos and flat beams; an additional floor with a gabled roof on top, built with a steel and aluminum structure; and a rear porch in reinforced concrete (Jaramillo and Van Sluys 2020). The proposal suggests the demolition of these added constructions to restore the original volume of the building.

2.2 Design as Added Value: Spatial, Material, and Symbolic Configuration

According to the winning proposal by Jaramillo and Van Sluys (2020), the guiding concept for the rehabilitation of the old terminal building, for its transformation into the Innovation Center of Quito, stems from the idea that the design should reflect the purposes of the intervention in terms of innovation, sustainability, and historical-cultural relevance. These three key ideas will be pervasive in the proposal concerning the conception of the project's spatiality, the need for architecture to support transformations, the efficient and coherent use of materials and resources, and finally, the interior-exterior integration and connection with nature and the local landscape, highlighting the geographic location of the project, the historical significance of the place, and connectivity with the world.

To embody the spatial concept of the proposal, three project actions were considered. First: recover fundamental morphological aspects of the original building through the preservation of the double height of the main hall in strategic locations that allow the visualization of the heritage murals contained in the building; the recovery of the exterior porch as a characteristic element of the historical facade of the building; and the incorporation of a connecting walkway and access to the first floor that reinterprets the sleeve of the old terminal. This circulation element allows visual connection with the park and the landscape. Second: project the new architecture while respecting the design for the structural reinforcement of the existing concrete building. For the expansion of the existing space, the creation of a mezzanine built in glued laminated timber is proposed, differentiating it from the main structure of the building and emphasizing its environmental qualities and reusability. Third: highlight Ecuadorian art, emphasizing the importance of the murals considered part of the artistic and cultural heritage. The mural by Jaime Andrade is made of stone with two bronze sculptures representing deities: the sun, revered by Andean civilizations, and Prometheus, a god-titan of Greek mythology considered the protector of humanity. Galo Galecio's mural is painted in the double height of the main hall of the building and illustrates the first flight over the Ecuadorian Andes, carried out in 1920 by the Italian aviator Elia Liut.

3 THE CONSTRUCTION SYSTEM AS A COMPREHENSIVE SOLUTION FOR THE REHABILITATION PROJECT

The structure of the original building in reinforced concrete will be strengthened to comply with the current structural regulations in Ecuador for the year 2022. For the substructure of the
mezzanine that will allow the expansion of the area to accommodate the requested program, a mixed construction system is proposed, mainly composed of glued laminated timber due to its easy assembly and disassembly on-site and subsequent reuse if necessary. In addition, glued laminated timber, sourced from sustainably managed forests, is highlighted for its strength, durability, and carbon storage capacity. By incorporating this material in the airport rehabilitation, an efficient and safe structural design is achieved, respecting the required load and safety standards.

The interior enclosures are also proposed in lightweight wood panels with reforestation certification, using locally manufactured rice straw acoustic insulation. The system also allows great construction versatility in transforming interior spaces according to the project's usage needs. The use of materials with low carbon footprint, easy maintenance, and high space transformation capacity has been prioritized.

The conception of the mixed mezzanine structure consists of a floor slab and a roof supported on wooden beams. The numerical part encompasses two fields: the static analysis carried out using computer software based on the ETABS program and the design part developed in ETABS based on the requirements of the American Institute of Steel Construction (AISC), the NDS, and the EN1995 considering a service life of 50 years.

The structure basically consists of a mixed spatial skeleton formed by wooden beams and concrete columns reinforced with metal plates at the beam-column joints. The new wooden beams are connected to the existing concrete columns through bolted plates, and these connect the wooden beams using plates and structural screws. A solid slab, 6cm thick, is supported on these beams, which, in turn, forms a mixed wood and concrete beam through shear connectors. The section of the existing columns is 460x720mm. The depth of the wooden beams is 200, 250, 450, 500, and 600mm. Structural analysis was carried out using the ETABS program to determine all forces corresponding to all gravitational load combinations established in the Ecuadorian Construction Standard NEC-SE-DS; the design complies with AISC standards.

![Figure 2. QIC Internal view and detail of the glued laminated timber construction system.](image)

The plates connecting to the existing columns, connection plates for wood, and, in general, all metal structural elements are constructed with ASTM A572 Gr50 quality steel. The concrete slab is \( f'c=240 \text{ kg/cm}^2 \), and the wooden beams are made of radiata pine with a moisture content of less than or equal to 12%. The structural wood will be fire-protected by applying fire retardant chemicals. All metal structures will be coated with a corrosion protector, and the wood must contain protection against biological attacks and water repellent protection (see Figure 2).
4 SUSTAINABLE DESIGN STRATEGIES AND NATURE-BASED SOLUTIONS (NBS)

In accordance with the International Union for Conservation of Nature (IUCN 2020), Nature-Based Solutions (NBS) refer to a set of actions or policies that harness the power of nature to address some of our most pressing social challenges, such as the threat to water availability, the increasing risk of natural disasters, or climate change.

The strategic location of the building in the city allows for sustainable mobility of its users through collective transportation (metro and bus system), alternative means (bicycles and electric bikes), and pedestrian options (tree-lined boulevard and park). Additionally, the installation of charging points for electric vehicles in existing parking spaces is suggested.

The reuse of an existing building through structural and functional rehabilitation is one of the main sustainability strategies highlighted in this intervention. It contributes to reducing the carbon footprint, decreasing the use of materials in civil construction, extending the lifespan of the pre-existing structure, and optimizing resource consumption through the renewal of facility systems with new solutions for greater efficiency in resource consumption. Considering that the intervention is implemented in an existing building, the project seeks to optimize, especially on its east facade, the longest side in contact with the exterior area, the capture of natural lighting and ventilation.

For responsible resource management and consumption strategies, energy-saving, water, and waste management strategies are considered. Energy savings are achieved through the efficient use of artificial lighting with the implementation of sensors, maximizing the use of natural light, and the use of energy-efficient lamps. Additionally, the installation of photovoltaic panels on the building’s roof is proposed to facilitate energy generation for QIC’s own consumption. The exterior porch also serves as a shaded area, protecting the east facade from direct sunlight, preventing undesired temperature increases inside the building. In this sense, the project aims to maximize natural lighting while protecting the facade from direct sunlight, enhancing control of the interior temperature through a passive system of natural cross-ventilation.

Water systems involve the implementation of grouped hydro sanitary installations in wet cores, low-consumption toilets, and faucets. The incorporation of green areas increases soil permeability and the capacity for rainwater collection, retention, and infiltration in the intervention's environment. The use of native and endemic species also contributes to a biodiverse natural environment in harmony with the local landscape and with low water consumption for irrigation. These strategies also align with the implementation of Nature-Based Solutions.

Regarding waste management, the rationality and modularity of the proposed architectural and construction design allow for waste reduction and the maximization of material use during the construction phase. A waste management plan is also proposed for this stage, promoting recycling in collaboration with local stakeholders in the city of Quito. For the building's operational stage, a waste recycling plan is proposed for the generated waste, including an outdoor composting area associated with the natural areas proposed in the project, also coordinated with local stakeholders in the city.

5 FINAL CONSIDERATIONS AND FUTURE CHALLENGES

As a conclusion, the project unfolds within the framework of public policies oriented towards sustainability at different scales, from urban to architectural. At the urban scale, the project stands out for its integration with the environmental regeneration proposal of the park, understood as part of the city's green infrastructure, as well as its connection with the public transportation system, redefining the obsolete fabric and endowing it with ecological and social functionality in the 21st century. At the architectural scale, the revaluation of the city's modern heritage is emphasized,
along with the possibility of repurposing existing buildings for new uses and facilities. This intervention requires continuity across different municipal administrations, and despite political discontinuity, the participation of various public actors, multilaterals, and professional associations has been achieved through urban and architectural competitions for the project's different components and phases. In this sense, the competition mechanism is understood not only as a space for participation but also as a tool for the development of applied research proposals in the fields of urban design, architecture, and construction innovation. These experimentation spaces pose the challenge and the need to develop normative standards that allow for the quantitative and qualitative measurement of the impact of such interventions at different scales and, at the same time, enable the replication of best practices.

References


Jaramillo, E., and Van Sluys, C., *Memoria del Primer Premio del Concurso Nacional de Anteproyectos para el diseño del Centro de Innovación de Quito*, Agencia de Cooperación Internacional de Corea en Ecuador (KOICA), Municipio del Distrito Metropolitano de Quito (MDMQ), Corporación de Promoción Económica CONQUITO, 2020. (texto no publicado)

