

Enhancing Urban Livability with Vertical Gardens in Mexico City Strategies for Sustainable Urban Development

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Abstract

This thesis explores the implementation of vertical gardens in Mexico City as a strategic approach to enhance urban livability and promote sustainable development. Faced with environmental challenges such as severe air pollution and the urban heat island effect, coupled with limited availability of green space due to high urban density, Mexico City requires innovative solutions to improve its urban ecosystem. This research examines the role of vertical gardens in addressing these challenges by purifying air, reducing temperatures, and supporting urban biodiversity. Additionally, it investigates the socio-economic and psychological impacts of increased greenery on the community. The study draws on case studies from cities with similar challenges and proposes tailored implementation strategies for Mexico City, assessing the potential benefits and impacts of vertical gardens on property values, community well-being, and public health. This thesis contributes to the field by providing a comprehensive framework for integrating vertical gardens into urban landscapes, potentially transforming them into more sustainable and livable environments.

Keywords: urban livability, vertical gardens, sustainable urban development, Mexico city, air quality, urban heat island, green architecture

1. Urban Challenges in Mexico City

Mexico City faces significant environmental challenges that critically impact its urban livability and sustainability. Predominantly, the city grapples with severe air pollution, which is exacerbated by its geographical basin location that traps pollutants, and a high volume of vehicle emissions. This issue is further compounded by the phenomenon of urban heat islands, where built-up areas are significantly warmer than their rural surroundings due to human activities and dense construction

materials that absorb and re-emit the sun's heat more than natural landscapes.

Complicating these environmental issues is the city's struggle with spatial constraints that limit the availability of green spaces. Mexico City's rapid urban expansion and high population density have led to a scarcity of open areas, squeezing out potential green spaces essential for environmental and recreational purposes. This lack of green infrastructure not only contributes to the heat island effect but also reduces the quality of urban life, making it

challenging to implement solutions that could alleviate the city's environmental burdens.

The integration of vertical gardens is viewed as a promising approach to address these interlinked challenges. By incorporating greenery into the urban fabric vertically, Mexico City can potentially mitigate air pollution and moderate urban temperatures, while also overcoming the hurdle of limited horizontal space for traditional parks and gardens. This approach not only aims to enhance the aesthetic value of the city but also contributes significantly to improving urban air quality and reducing heat retention in built environments.

2. Role of Vertical Gardens in Urban Ecosystems

Vertical gardens, or living walls, play a transformative role in enhancing urban ecosystems, particularly in densely populated cities like Mexico City. These innovative structures contribute significantly to improving air quality and moderating temperatures, addressing two of the city's most pressing environmental issues.

By integrating plants vertically along the exteriors of buildings, vertical gardens act as natural air filters. Plants absorb pollutants and carbon dioxide, releasing oxygen back into the atmosphere. This process is particularly valuable in Mexico City, where air pollution levels often exceed safe limits. Studies have shown that certain plant species used in vertical gardens can effectively remove toxic agents such as nitrogen dioxide and particulate matter from the air, making urban environments healthier for residents.

In addition to air purification, vertical gardens also play a critical role in temperature control within urban areas. The plants and soil in these gardens help insulate building exteriors, reducing the need for air conditioning in the hotter months and heating in cooler times. This natural form of temperature regulation contributes to reducing the urban heat island effect, where city centers become significantly warmer than surrounding rural areas. The cooling effect is achieved through the process of evapotranspiration, where plants release water vapor into the air, lowering the ambient temperatures.

Furthermore, vertical gardens support urban biodiversity by providing habitats for various species of birds, insects, and other wildlife,

which are often scarce in urban settings. This reintroduction of biodiversity not only helps in maintaining ecological balance but also enriches the urban landscape, promoting a closer connection between city dwellers and nature.

The strategic implementation of vertical gardens in Mexico City could, therefore, not only alleviate environmental stress by purifying the air and cooling the environment but also enhance urban biodiversity, contributing to the resilience and sustainability of the urban ecosystem.

3. Implementation Strategies for Vertical Gardens

Design and Technology Considerations: The design of vertical gardens should be tailored to the specific microclimates of different urban areas within Mexico City. This includes choosing plant species that are suited to the local climate and air quality conditions. Drought-resistant and pollution-tolerant plants are ideal in reducing maintenance needs and enhancing survival rates in the urban atmosphere. The structural design must also integrate efficient irrigation systems, such as drip or hydroponic systems, which conserve water and ensure even distribution throughout the vertical garden. Additionally, the use of lightweight and durable materials for the garden's framework is crucial to support the weight of the soil and vegetation without compromising the structural integrity of the host buildings.

Case Studies of Successful Implementations: Looking at successful case studies from cities with similar environmental challenges provides valuable insights.

CaixaForum, Madrid, Spain



Figure 1. CaixaForum, Madrid

The CaixaForum in Madrid features a

prominent vertical garden designed by Patrick Blanc, a renowned botanist and artist known for pioneering vertical garden technology. This garden spans approximately 24 meters high and covers 460 square meters of wall space with over 15,000 plants from 250 different species. The selection of species was tailored to create a self-sufficient bio diverse system that does not require seasonal replanting. This vertical garden acts as a natural air filter, absorbing pollutants and carbon dioxide while releasing oxygen. It also provides thermal insulation, reducing the need for heating in the winter and cooling in the summer. The presence of the garden has transformed the urban landscape, adding aesthetic value and becoming a focal point that attracts tourists and locals alike, thus also supporting local businesses.

Clearpoint Residences, Rajagiriya, Sri Lanka



Figure 2. Sri Lankan apartment block to be world's tallest vertical garden

Clearpoint Residences is the world's tallest vertical garden in a residential building, designed with sustainability as a core principle. Each of the building's apartments includes a balcony garden that spans the entire width of the unit, creating a continuous green facade. The gardens are irrigated with recycled wastewater treated on-site, demonstrating an innovative approach to water management. The plant life contributes to cooling the building's exterior and interior, significantly reducing reliance on mechanical air conditioning and promoting energy efficiency. Moreover, these gardens enhance privacy and reduce noise pollution, improving the quality of life for residents. The building's design not only addresses the thermal comfort but also promotes biodiversity by attracting local bird species and insects.

In adapting these models to Mexico City, considerations must be made for local climatic conditions, pollution levels, and urban density. For instance, species selection would focus on native plants that are tolerant to air pollution and require minimal water, considering Mexico City's water scarcity issues. Structural adaptations might include reinforced frameworks to support the weight of mature plants and integrated water recycling systems to ensure sustainability.

Furthermore, engaging with local communities from the planning stage could foster a sense of ownership and responsibility towards the maintenance of the vertical gardens, ensuring their long-term success. Collaborative efforts with local universities and environmental NGOs could also help in researching and selecting the best plant species and technologies that suit Mexico City's specific needs.

These detailed case studies illustrate how vertical gardens can be effectively implemented in urban environments facing similar challenges as Mexico City, providing practical insights and adaptable models for sustainable urban development.

4. Impact and Benefits Assessment

Socio-economic Benefits: Vertical gardens can transform urban landscapes, not only by beautifying the city but also by contributing to its economic vitality. One of the primary benefits is the potential increase in property values. Buildings that incorporate green elements like vertical gardens are often more attractive to potential buyers and renters, commanding higher prices and rental rates. Additionally, these green installations can lead to savings in energy costs, as they provide natural insulation and reduce the need for air conditioning, which is particularly valuable in Mexico City's temperate climate.

Beyond individual property benefits, vertical gardens can enhance community well-being by creating more pleasant and healthier environments. They can also provide opportunities for local employment, from the initial installation and ongoing maintenance to the potential for urban agriculture initiatives integrated within these vertical spaces. This can foster a new economic sector within the city, promoting sustainable practices and community involvement.

Psychological and Health Impacts: The presence

of green spaces within urban settings has been consistently linked to improved mental health and psychological well-being. Vertical gardens offer a way to bring nature into densely populated areas where traditional parks might not be feasible. Studies have shown that even small amounts of greenery can decrease stress, improve mood, and enhance overall happiness. For residents of Mexico City, these spaces can serve as tranquil retreats from the urban hustle, potentially decreasing rates of urban stress and associated mental health issues.

Furthermore, vertical gardens can improve physical health by filtering pollutants from the air, leading to better respiratory health outcomes. This is particularly critical in Mexico City, where air quality often falls below recommended standards. By improving air quality, these gardens can reduce the prevalence of respiratory problems such as asthma and allergies, contributing to the overall health of the population.

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