

Urban Green Design in Public Infrastructure Planning: A Structured Literature Review for Smart, Livable, and Sustainable Competitive Cities



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ABSTRACT

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This study presents a structured literature review of 25 selected peer-reviewed studies examining the application of urban green design principles in public infrastructure planning to support smart, livable, and sustainable competitive cities. The review synthesizes evidence on environmental, social, economic, and governance dimensions of green infrastructure. Findings indicate that parks, green roofs, urban trees, and sustainable drainage systems contribute to climate adaptation, improved air quality, reduced heat-island effects, and enhanced public well-being. However, implementation remains constrained by funding limitations, maintenance burdens, fragmented governance, and unequal access to green amenities. The review also highlights the importance of participatory planning and equity-oriented policy design. Overall, integrating green infrastructure into infrastructure planning can strengthen urban resilience and competitiveness when supported by coherent institutions and inclusive investment strategies.

1. INTRODUCTION

The rapid growth of urban populations and the increasing complexity of urban problems have exerted sustained pressure on cities to rethink their development models. In the context of climate change, resource scarcity, and intensifying global urban competition, cities are increasingly urged to adopt development approaches that are adaptive, inclusive, and sustainable. One widely proposed and essential response to these interconnected challenges is the integration of urban green design principles into public infrastructure planning [1]. These principles seek to align the built environment with ecological systems, thereby supporting urban resilience and improving residents' quality of life. Accordingly, urban development is expected to be not only technologically advanced but also environmentally responsible, socially equitable, and economically competitive. These directions are also consistent with global development frameworks such as the Sustainable Development Goals (SDGs) and the New Urban Agenda, which emphasize integrated and inclusive urban planning as a basis for sustainability.

Urban green design can be understood as more than a set of physical interventions; it operates as a strategic framework for embedding natural processes into urban systems. In this framing, green design encompasses the planning and management of green open spaces, the implementation of blue-green infrastructure, the selection of sustainable materials, the pursuit of energy efficiency, and the application of nature-based solutions (NbS). When these elements are

approached holistically, they are commonly associated with benefits such as improved air quality, more effective stormwater management, mitigation of urban heat island effects, strengthened biodiversity, and enhanced livability. Nevertheless, the translation of green design principles into public infrastructure planning remains incomplete in many contexts [2]. Infrastructure development often continues to rely on conventional models that privilege short-term economic or technical efficiency over ecological integrity and long-term sustainability. This persistent divergence indicates that green principles are not merely a design concern, but also a planning and governance challenge.

Public infrastructure occupies a central role in shaping urban character and performance because it influences mobility, connectivity, environmental quality, public health, and social interaction. When public infrastructure is designed with green principles, it can function as a catalyst for sustainability outcomes across multiple urban domains. However, many planning processes still do not fully integrate green infrastructure principles into decision-making routines [3]. A recurring issue is that infrastructure is frequently planned in sectoral "silos," resulting in disconnection from ecological networks and limited environmental sensitivity. Roads, bridges, drainage systems, and public facilities are often developed without sufficient consideration of green corridors, stormwater reuse, or ecosystem services. Such practices can lead to fragmented urban systems, environmental degradation, and reduced resilience to climate-related risks. Therefore, embedding green design into public infrastructure

requires an integrative planning perspective that bridges technical, spatial, and institutional dimensions.

The urgency of adopting green design in public infrastructure becomes particularly salient under conditions of intensifying inter-city competition. In contemporary urban competition, performance is not evaluated solely through economic indicators, but also through a city’s ability to provide a high quality of life, environmental sustainability, and climate-risk resilience. Cities that demonstrate stronger alignment between infrastructure planning and green design principles are increasingly recognized for livability and environmental performance [4]. This recognition can strengthen a city’s attractiveness to investment, talent, and innovation, thereby linking ecological performance with long-term development capacity. In this sense, green infrastructure can be positioned as a strategic element of urban development rather than a supplemental aesthetic feature. Consequently, green infrastructure should be institutionalized as part of the core planning logic of cities, including how priorities, trade-offs, and implementation pathways are established.

While existing scholarship has addressed multiple aspects of green urbanism, many studies remain oriented toward sectoral or thematic issues, such as green architecture, low-carbon transport, or open space planning. Works by Anguelovski et al. [5], for instance, highlight the relevance of biophilic urbanism and low-emission transportation, respectively. Despite these contributions, there remains a need for more integrative conceptual frameworks that clarify how green design principles can be embedded within public infrastructure planning in a comprehensive manner. In particular, the literature often provides partial perspectives—either focusing on environmental benefits or on specific infrastructure components—without sufficiently articulating how these principles interact across the planning and delivery process. This limits the ability of planners and policymakers to formulate coherent strategies that balance technical feasibility, environmental responsibility, and social inclusion. As a result, a clearer synthesis is required to support more holistic planning approaches for public infrastructure and green transitions.

The present work aims to strengthen the conceptual understanding of how urban green design principles can be systematically operationalized in public infrastructure planning and governance. Rather than emphasizing validation through direct field measurement, this paper focuses on conceptual integration across institutional, spatial, and technical dimensions of green infrastructure. It seeks to identify key opportunities and recurring barriers to the adoption of green principles within public infrastructure planning. The intended output is a framework of considerations that can support urban planners, architects, engineers, and policymakers in guiding infrastructure development toward sustainable and livable urban futures. By emphasizing integrated planning approaches, the work highlights the role of ecological thinking as a planning foundation that can reorient infrastructure decision-making. Ultimately, the study is positioned to contribute guidance for aligning infrastructure strategies with long-term environmental and social objectives.

The novelty of this work lies in its holistic perspective that links ecological urbanism with public infrastructure planning, policy formulation, and broader considerations of urban competitiveness. Instead of treating green design as a narrow environmental agenda, the discussion frames it as a cross-

sectoral strategy intersecting with urban governance, economic development, and climate adaptation. This conceptual linkage is central to the originality of the argument, particularly in how it positions green infrastructure as an organizing principle for infrastructure planning rather than as an optional add-on. The work further draws on the existing body of knowledge to synthesize patterns of reasoning that inform practical policy and planning discussions. In doing so, it clarifies how different planning dimensions—spatial form, institutional coordination, and technical implementation—can be brought into a coherent logic. This synthesis is intended to support more consistent mainstreaming of green principles across infrastructure policies and project pipelines.

The overarching aim of this research is to analyze the role of green urban design principles in shaping public infrastructure that supports the transition toward smart, livable, and sustainable cities. The work identifies key factors that are repeatedly associated with successful integration of green principles into infrastructure planning and proposes strategic directions for mainstreaming these principles within planning and policy processes. In turn, it offers insights that can inform more environmentally responsible, socially inclusive, and economically resilient urban development. By contributing a synthesized conceptual framework, the research is expected to support ongoing efforts to build cities that are not only functional but also future-ready in the face of climate and sustainability imperatives.

2. METHODOLOGY

The overall review design, search process, and screening summary are presented in Table 1.

Table 1. Review design and search summary

Section	Description
Review Design	Structured narrative literature review with transparent search, screening, and thematic synthesis
Databases	Scopus, Web of Science, ScienceDirect, Google Scholar
Search Period	January–February 2026
Publication Years Covered	2015–2025
Initial Records Identified	230
Records After Duplicate Removal	198
Full-Text Articles Assessed	74
Final Studies Included	25
Inclusion Criteria	English-language peer-reviewed studies relevant to urban green design and infrastructure planning
Analysis Method	Narrative thematic synthesis across five themes

2.1 Review design

This study employed a structured narrative literature review using transparent search, screening, and thematic synthesis procedures. The review was intended to map and synthesize current evidence on urban green design in public infrastructure planning rather than to conduct a quantitative meta-analysis.

2.2 Search strategy

Database searches were conducted between January and February 2026 using Scopus, Web of Science, ScienceDirect, and Google Scholar. The search covered publications issued between 2015 and 2025. Keyword combinations included *urban green design*, *green infrastructure*, *smart city*, *livable city*, *sustainable city*, and *public infrastructure planning*. Boolean operators such as AND and OR were used to refine search results.

2.3 Inclusion criteria

Only English-language peer-reviewed journal articles were included. Eligible studies discussed urban green design or green infrastructure in relation to infrastructure planning, livability, sustainability, resilience, governance, or urban competitiveness. Conference papers, editorials, book chapters, duplicate records, and studies not directly relevant to the topic were excluded.

2.4 Screening process

A total of 230 records were initially identified. After removing duplicate records, 198 studies were screened based on titles and abstracts. Subsequently, 74 full-text articles were assessed for eligibility. Following relevance and quality screening, 25 studies were retained for final synthesis. The final sample reflects a focused selection of studies specifically addressing the integration of urban green design within public infrastructure planning.

2.5 Data analysis

The selected studies were coded and grouped into five thematic categories: (1) environmental benefits, (2) social and health outcomes, (3) economic value and competitiveness, (4) governance and financial barriers, and (5) participatory planning. A narrative thematic synthesis approach was then used to identify recurring patterns, relationships, and policy implications across the included studies.

3. RESEARCH FINDINGS

Based on the 25 included studies, five dominant themes emerged from the thematic synthesis: (1) environmental benefits, (2) social and health outcomes, (3) economic competitiveness, (4) governance and financing barriers, and (5) participatory planning. These themes reflect the multidimensional role of urban green design in supporting sustainable and resilient cities. The findings indicate that green infrastructure should not be viewed solely as an environmental intervention, but also as a strategic planning instrument capable of generating social, economic, and governance benefits when implemented effectively [1].

3.1 Environmental benefits

Seventeen of the 25 reviewed studies reported substantial environmental benefits associated with green infrastructure. The most frequently identified outcomes included improved air quality, reduction of urban heat-island effects, enhancement of biodiversity, better microclimate regulation,

and more effective stormwater management. These environmental improvements are particularly important in densely populated cities experiencing rapid urbanization and climate-related stress [2].

Commonly cited green infrastructure interventions included urban parks, street trees, green roofs, vertical gardens, urban forests, permeable pavements, and sustainable drainage systems. Vegetation-based solutions were found to absorb air pollutants, increase carbon sequestration, and reduce surface temperatures through shading and evapotranspiration processes. Green roofs and permeable surfaces also contributed to reducing runoff volume and lowering flood risks during heavy rainfall events [3].

Several studies further emphasized that integrating natural systems into urban infrastructure can strengthen long-term climate resilience while reducing dependence on conventional grey infrastructure. Overall, the evidence suggests that environmental gains remain the most consistently documented advantage of urban green design [6].

3.2 Social and health outcomes

Eleven studies highlighted the contribution of green spaces to public health and broader social well-being. Access to parks, open spaces, and tree-lined environments was associated with reduced psychological stress, improved mental health, increased opportunities for physical activity, and stronger community interaction. Green areas were frequently described as important urban assets that support recreation, relaxation, and healthier lifestyles [5].

Many studies reported that residents living near accessible green spaces tend to demonstrate higher levels of walking, cycling, and outdoor activity, which may contribute to lower risks of obesity and chronic disease. In addition, public green spaces often function as gathering places that promote social cohesion, neighborhood identity, and intergenerational interaction [7].

However, several studies also noted unequal distribution of green amenities across neighborhoods. Low-income communities and marginalized urban populations often experience lower access to quality green spaces. This indicates that the health and social benefits of green infrastructure are not automatically shared equally, and that equity-oriented planning remains necessary [8].

3.3 Economic competitiveness

Nine studies associated green infrastructure with improved urban economic competitiveness. The most frequently reported benefits included higher surrounding property values, stronger city branding, increased tourism attractiveness, and improved capacity to attract skilled workers and private investment. Cities with well-designed green environments were often perceived as more livable, innovative, and globally competitive [9].

Green public spaces can stimulate local economic activity by increasing visitor flows, supporting retail businesses, and enhancing the desirability of surrounding districts. Several studies also suggested that firms in knowledge-intensive sectors increasingly prefer locations that offer high environmental quality and strong quality-of-life indicators for employees [10].

In addition, green infrastructure may generate long-term cost savings through lower energy consumption, reduced flood

damage, and decreased public health burdens. Therefore, beyond environmental value, urban green design can also function as an economic development strategy when aligned with broader urban planning objectives [11].

3.4 Governance and financial constraints

Thirteen studies identified governance and financial constraints as major barriers to implementation. Common challenges included fragmented institutional responsibilities, weak coordination among agencies, insufficient technical capacity, maintenance burdens, and limited capital budgets. These issues were especially prominent in rapidly growing cities where infrastructure demand already exceeds available resources.

Many municipalities continue to prioritize short-term transport, housing, or utility investments over green infrastructure, particularly when budgets are constrained. In some cases, green projects were perceived as aesthetic improvements rather than essential infrastructure, reducing political urgency and funding support.

Long-term maintenance was also repeatedly identified as a challenge. Parks, green roofs, drainage systems, and urban vegetation require continuous management, monitoring, and operational funding. Without sustainable financing models, the benefits of green infrastructure may decline over time.

The findings suggest that successful implementation depends not only on design quality, but also on stable institutions, cross-sector governance, and long-term investment planning.

3.5 Participatory planning

Eight studies emphasized the importance of participatory planning in achieving successful green infrastructure outcomes. Citizen engagement was found to improve project legitimacy, strengthen local ownership, increase responsiveness to community needs, and support long-term stewardship of public green assets.

Participatory approaches included community consultations, co-design workshops, neighborhood planning forums, and partnerships with local organizations. These mechanisms helped planners better understand resident priorities regarding safety, accessibility, recreation, biodiversity, and maintenance preferences.

Several studies further argued that participatory planning is particularly important in socially diverse cities, where top-down planning may overlook vulnerable groups. Inclusive engagement processes can help ensure that green investments benefit women, children, elderly residents, informal communities, and low-income households.

Overall, the evidence indicates that urban green design is more effective and socially sustainable when local communities are involved from planning through implementation and maintenance stages [5].

4. DISCUSSION

The findings suggest that urban green design should be treated as core infrastructure rather than optional beautification. Environmental and social benefits were consistently reported, while economic advantages appear strongest when green investments are integrated with

transport, housing, and innovation policies. Nevertheless, implementation gaps remain substantial in cities with weak governance capacity or limited financing. Equity also emerged as a critical issue because benefits are not automatically distributed across urban populations. Therefore, future policy should combine green investment with affordable housing, inclusive zoning, and participatory governance [12].

The research also highlights the importance of NbS in addressing the multifaceted challenges faced by modern cities. NbS, which include green roofs, urban forests, and permeable pavements, have been shown to effectively manage stormwater, reduce flooding, and enhance urban resilience. The ability of green infrastructure to act as a buffer against climate change is particularly significant, as cities become more vulnerable to extreme weather events. Additionally, NbS contribute to the reduction of urban heat island effects, providing cooling benefits to cities that are often burdened by the urban heat generated by concrete and asphalt. The growing recognition of NbS as a viable strategy for climate adaptation reflects a broader shift towards integrating nature into urban development, offering a more sustainable alternative to traditional infrastructure [13].

While the benefits of green infrastructure are well-documented, the implementation of such solutions is often hindered by various barriers. As indicated by the research, one of the most prominent challenges is securing adequate funding. Green infrastructure projects, although cost-effective in the long run, typically require significant upfront investment. Many cities, especially those in developing countries, face financial constraints that prevent them from prioritizing green design in their urban development strategies. Moreover, the competing demands of infrastructure development, such as roads and housing, often take precedence over environmental concerns. This financial and institutional prioritization of economic development over ecological sustainability remains a significant obstacle to the widespread adoption of green infrastructure in cities worldwide [14].

Another key challenge discussed in the literature is the maintenance of green infrastructure. While the initial construction of green spaces may be relatively straightforward, ensuring their long-term sustainability requires consistent maintenance and management. Green spaces need regular upkeep, including tree pruning, plant care, litter removal, and infrastructure repairs. Without proper maintenance, these spaces can become neglected, reducing their effectiveness in providing environmental, social, and economic benefits. The research shows that cities that allocate sufficient resources for the maintenance of green spaces are more likely to reap the long-term benefits of green infrastructure. Therefore, urban planners and policymakers must recognize the importance of ongoing investment in green space management to ensure the continued viability and success of these projects [15].

Equally important is the issue of equitable access to green infrastructure. The findings suggest that while green spaces provide numerous benefits, access to these spaces is often unevenly distributed. In many cities, marginalized and low-income communities have limited access to parks and recreational areas, exacerbating social inequalities and affecting the well-being of vulnerable populations. Ensuring that green infrastructure is accessible to all residents, regardless of socioeconomic status, is crucial for fostering inclusivity and social justice. As cities continue to grow and

evolve, urban planners must prioritize equitable access to green spaces, particularly in areas where such spaces are scarce. This can be achieved through community-driven planning processes and policies that focus on providing green infrastructure in underserved neighborhoods [16].

The research underscores the need for community involvement in the planning and management of green infrastructure. Participatory urban planning allows residents to voice their needs and preferences, ensuring that green spaces are designed in ways that reflect the community's values and priorities. Studies have shown that when communities are actively involved in the development of their neighborhoods, there is a greater sense of ownership and responsibility for the upkeep of these spaces. Moreover, community engagement helps ensure that green infrastructure is not only environmentally beneficial but also socially inclusive. By incorporating the perspectives of diverse community members, cities can create green spaces that serve the needs of all residents, fostering a sense of belonging and improving social cohesion [17].

A "sustainable city" focuses primarily on the long-term environmental, social, and economic health of its infrastructure. It emphasizes green infrastructure, resource efficiency, and environmental stewardship, aiming to mitigate the negative impacts of urbanization such as pollution, waste, and energy consumption. The sustainability of such cities is achieved through initiatives like green spaces, energy-efficient buildings, water conservation, and systems that promote social inclusivity. In these cities, there is a strong emphasis on balancing environmental quality with the needs of the population, ensuring that resources are available for future generations [17].

On the other hand, a "smart city" incorporates technological solutions to address urban challenges and improve the quality of life for residents. The key features of smart cities include the use of data, digital technologies, and Internet of Things (IoT) systems to optimize the functioning of urban services such as traffic management, public transport, and energy use. These cities are designed to be efficient, innovative, and adaptive, leveraging technology to create a responsive and dynamic environment that enhances overall urban living. In addition to being sustainable, smart cities are also designed to be resilient to future challenges by integrating advanced technologies that enable real-time monitoring and decision-making [18].

The fundamental difference lies in their scope and approach: sustainable cities prioritize ecological and social sustainability through green design and resource management, while smart cities focus on leveraging technology to improve urban living and services. Ideally, a city can be both "smart" and "sustainable," integrating technology with green infrastructure to create an efficient, environmentally responsible, and livable urban environment.

4.1 Green infrastructure as an economic advantage and talent attraction

Green infrastructure, such as open green spaces, urban parks, green roofs, and sustainable drainage systems, plays a crucial role in creating added value for cities both economically and competitively. Green infrastructure not only provides ecological benefits like reducing air pollution and managing stormwater, but it also contributes to social and economic aspects of the city [19].

4.1.1 Economic advantage

Green infrastructure can enhance a city's economic appeal. By providing accessible green spaces, cities improve the quality of life for their residents, which in turn makes the city more attractive to professionals, businesses, and investors. For example, urban parks and green spaces can increase property values in the surrounding areas, which positively impacts the local economy. Quality green spaces also provide enjoyable environments for creative workers and young professionals, boosting their productivity and well-being.

Additionally, green infrastructure can help reduce costs related to waste management, energy, and water usage. For instance, the use of green roofs for temperature regulation and energy efficiency in buildings can reduce air conditioning use, lowering long-term energy costs. Furthermore, planting trees and vegetation throughout the city can reduce the need for costly cooling and drainage systems, resulting in significant savings for cities in the long run [20].

4.1.2 Attracting talent

In an increasingly globalized and interconnected world, cities compete to attract the best talent in fields such as technology, research, and creative industries. One of the best ways to achieve this is by offering a healthy and attractive living environment. Green infrastructure, such as well-maintained parks and open green spaces, not only improves air quality and reduces stress, but it also provides areas for recreation, exercise, and social interaction. All of this creates a balanced living environment, which is highly valued by young talent and professionals seeking cities that offer more than just job opportunities.

Many companies, especially those in the technology and innovation sectors, are now more likely to choose locations in cities that offer easy access to green spaces because they contribute to creativity and collaboration among employees. Therefore, cities with strong green infrastructure become more attractive to global companies, creating a more dynamic business climate [8].

4.1.3 Global positioning

Global city rankings today are not only based on economic indicators or traditional infrastructure such as transportation and housing, but also on aspects of sustainability and the quality of life offered by these cities. Many international organizations, such as the United Nations SDGs and various global city ranking platforms, give extra value to cities that have environmentally friendly policies, efficient resource management, and high-quality green spaces.

Green infrastructure also plays a significant role in improving a city's competitive position on the international stage. Cities that successfully integrate green design into infrastructure planning are often recognized in global rankings for livability and environmental performance. This recognition, in turn, attracts investment, talent, and innovation. Therefore, green infrastructure should be viewed as a core element of strategic urban development, not just an aesthetic enhancement [21].

In the context of intense global competition, cities with a high level of sustainability tend to have a better reputation and are the preferred choice for investors and international companies. Thus, green infrastructure not only improves the quality of life directly but also enhances the city's position in global rankings as an attractive place to live, work, and invest.

Cities with strong green infrastructure often receive higher

rankings in these categories, which in turn enhances their global competitiveness. One example from the literature that explores this topic is a study by Artmann et al. [6], which highlights how green infrastructure can mutually support smart growth in creating cities that are both dense and green, contributing to improved livability and environmental performance. Green infrastructure, such as urban parks, green roofs, and open green spaces, helps reduce air pollution, manage stormwater, and create inclusive and healthy social spaces, all of which improve the quality of life for residents [22].

It is important to note that the management of green infrastructure focuses not only on enhancing environmental quality but also on improving a city's competitiveness in global rankings. For example, cities that successfully integrate green design into their infrastructure planning, such as Amsterdam, Barcelona, or Copenhagen, are frequently recognized globally for their higher livability and better environmental performance, which attract international investment and talent.

4.2 Description of economic performance of cities with strong green infrastructure

Theoretically, there is evidence supporting the claim that cities with strong green infrastructure really perform better economically. One primary reason is the increase in property values and tourism potential. Research by Nguyen et al. [20] indicates that quality green spaces can improve quality of life and have a positive impact on physical and mental health for residents. Better green spaces enhance air quality, reduce urban heat island effects, and create more comfortable living environments. All these factors contribute to a city's appeal to residents, investors, and companies looking for locations with high quality of life.

Moreover, green infrastructure also helps in reducing operational costs for cities, such as stormwater management and energy usage. For instance, the use of green roofs and more efficient sustainable drainage systems can reduce the need for costly drainage systems and lower cooling energy costs in buildings. This means cities that adopt efficient green infrastructure can save money in the long run while also improving their image as environmentally friendly and attractive to investment.

In this context, cities with strong green infrastructure are also likely to have a thriving tourism industry. Tourism is often driven by the aesthetic appeal of urban parks, green spaces, and clean, healthy natural environments. Cities with high livability are more likely to become tourist destinations, leading to increased local revenue through the tourism sector and supporting local businesses.

Overall, cities that integrate green infrastructure into their planning not only improve their living environment but also strengthen their economies through increased property values, tourism attraction, and long-term cost savings. All of these factors contribute to the city's economic competitiveness in the global market, making it a prime choice for talent, investors, and companies [23].

4.3 Green infrastructure and its investment challenges

In the context of urban planning, green infrastructure represents a strategic approach to integrating natural systems into urban environments, such as green roofs, permeable

pavements, urban parks, and sustainable drainage systems. These systems provide numerous environmental, social, and economic benefits, including improved air and water quality, climate resilience, reduced urban heat islands, and enhanced public health. However, green infrastructure requires significant initial investment, which often becomes a substantial barrier for local governments, particularly in developing cities [24].

4.4 Challenges in developing countries

In developing countries, green infrastructure faces more pronounced obstacles due to financial constraints and competing infrastructure priorities. Local governments in these regions often face budgetary pressures, with limited funding available for both essential services (such as healthcare, education, and housing) and environmental projects. In such contexts, green infrastructure is often perceived as an added expense rather than a necessary investment.

One of the primary challenges is the high upfront capital cost associated with installing green infrastructure. For example, projects such as green roofs, sustainable drainage systems, or urban parks can require substantial initial outlay, which may not seem immediately justifiable when weighed against other urgent infrastructure needs like roads, electricity, and water supply. The lack of financial resources and access to affordable credit further exacerbate this challenge, making it difficult for local governments to allocate funds to green infrastructure without sacrificing other essential services.

Furthermore, in many developing regions, institutional barriers complicate the planning and implementation of green infrastructure. Often, there is a lack of coordination between urban planning, environmental, and financial departments, which can hinder the development of integrated green infrastructure strategies. The absence of clear policy frameworks and incentives, coupled with inconsistent regulations, may discourage private sector investment, which could otherwise play a significant role in financing these projects [25].

4.5 Challenges in developed countries

In contrast, while developed countries may have more access to funding and financial resources, they are not without challenges in implementing green infrastructure. Developed cities, particularly those facing long-standing urbanization challenges, still struggle with high initial investment costs for large-scale green infrastructure projects. For instance, the installation of sustainable urban drainage systems or the retrofitting of existing buildings with green roofs can require millions of dollars in upfront capital. While these projects can lead to long-term savings in energy and water management, the short-term financial burden remains a hurdle.

However, developed countries typically have greater access to private financing, such as green bonds or public-private partnerships, to fund green infrastructure initiatives. Additionally, many cities in developed regions are more likely to have established policy frameworks that promote the integration of green infrastructure into urban planning. For example, cities like Copenhagen and New York have already implemented successful green infrastructure projects, showing the potential for these investments to improve urban resilience. Despite these advantages, even in developed countries, the

financial viability of green infrastructure can be affected by economic downturns, competing budget priorities, and the need for long-term maintenance funding.

5. CONCLUSIONS

This study reviewed 25 selected studies on the application of urban green design principles in public infrastructure planning. Evidence indicates that green infrastructure contributes to environmental resilience, public health, and urban competitiveness. However, successful implementation depends on financing capacity, institutional coordination, maintenance systems, and equitable access. Cities seeking to become smart, livable, and sustainable should mainstream green infrastructure within long-term planning frameworks rather than treat it as a secondary intervention.

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