Requirements for Achieving the Social Benefits of Urban Green Infrastructure (UGI)

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Abstract: The rapid transformation of urban neighborhoods, alongside changing lifestyles, has prompted cities to prioritize not only mitigating climate stress but also improving the well-being of their residents. According to a study reported in the 2022 World Urbanization Prospects, cities emit greenhouse gases ranging from 40% to 70%. There is a possibility that these proportions could increase to 60% and 70% if the shrinkage of open and green spaces continues significantly, and public places become the available alternatives for people to interact socially away from their overcrowded homes. Therefore, research is focusing on studying the implementation of Urban Green Infrastructure (UGI) in cities and the resulting social benefits. The research aims to propose a set of requirements that must be met to achieve the social benefits of urban green infrastructure. This will serve as a reference for urban planners and any institution involved in creating open public spaces to enhance the capabilities of workers before and after the implementation of urban green infrastructure projects. The research addresses the concept and evolution of Urban Green Infrastructure (UGI), including its components, planning methodologies, obstacles, and strategies. The research also presents an analytical study of global projects in this field. The research concludes that integrating central green areas, corridors, and steppingstones with urban green infrastructure strategies helps to achieve social benefits for and with the community.

1. Introduction

Recently, most of the world's population has migrated to urban areas, leading to urban expansion and increased population density. More than 50% of the world's population now lives in urban areas, and this number is projected to increase to over 70% by 2050.[1]

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As a result, the concept of urban green infrastructure has been developed within the urban framework based on specific principles. It serves as a model for envisioning connected green spaces in urban areas. This is achieved through processes and methodologies related to policies that embody the principles of urban green infrastructure. When adopted, these principles can enhance and preserve the quality of life in resource-efficient and climate-beneficial cities[2] . Research has also focused on studying the contribution of urban green infrastructure to biodiversity conservation, mitigating climate risks, strengthening the human-nature connection, and reducing economic pressures and livelihood loss. The research aims to define the requirements for achieving the societal benefits of green urban infrastructure Considering the social fabric and community interests. The study presents key social concepts for the development of urban green infrastructure, provides in-depth information on each of these requirements, and highlights comprehensive issues and the advantages of urban green infrastructure (environmental, social, sustainability, decentralization, and decision-making) in fostering eco-friendly urban interventions.

1.1 Research Problem

One of the primary concerns regarding cities in the Middle East and North Africa is how they cope with the effects of climate change. Urban areas in this region are facing growing threats from floods, heat waves, sandstorms, and rising sea levels. These phenomena pose challenges to the entire region, impacting infrastructure, roads, and homes. To adapt to these challenges, cities in the Middle East and North Africa need to reevaluate their preparedness and consider enhancing their current infrastructure.

Egypt, situated in the northeastern part of Africa and home to the Nile Delta, is facing significant challenges due to the rising sea levels caused by climate change. With 40% of its population residing in coastal areas, Egypt is among the top five countries most affected by rising sea levels globally. Since 2012, the sea level has been rising by 3.2 mm annually, leading to coastal floods, erosion, and increased groundwater salinity. The ongoing rise in sea level continues to negatively affect agriculture in a country that is heavily reliant on imported food. Furthermore, the challenges associated with rising sea levels are evident across various sectors, including the environment, economy, food security, and infrastructure. To adapt to these challenges, Egypt needs to reassess its preparedness and consider improving its current infrastructure. Therefore, the concept of urban green infrastructure emerged in the 1990s and spread worldwide. However, there seems to be a lack of understanding of green infrastructure, as well as a general lack of environmental awareness regarding the crucial role of biodiversity in human life. The research is going to explore the potential for enhancing living conditions in less fortunate areas by highlighting the requirements to achieve the societal benefits of urban green infrastructure. It aims to guide city planners and other institutions involved in creating open public spaces in cities.

1.2 Research Objectives
The research aims to:
1. Increasing the city's open green spaces by **10%** over the next five years, which can be achieved by measuring the ratio of green spaces to the total area of the city.

2. Reducing the city's greenhouse gas emissions by **15%** over the next ten years can be accomplished by collecting emissions data from environmental monitoring stations and annual emission reports.

3. Increasing the utilization of public open spaces by **20%** over the next three years, by monitoring visitors' activity through cameras, sensors, surveys, and opinion polls.

4. Improving the city's air quality by **25%** over the next five years by installing air quality monitoring stations in various locations throughout the city.

5. Increasing the percentage of residents who understand the importance of green infrastructure by **30%** over the next three years through regular surveys and questionnaires.

6. Incorporating green infrastructure elements in **50%** of new projects in the city over the next five years by reviewing project plans and evaluating their inclusion of green infrastructure elements.

7. Developing green corridors that connect **70%** of green spaces with residential areas over the next five years by using Geographic Information Systems (GIS) that facilitate tracking the relationship between green spaces and residential areas.

These goals provide a framework for measuring progress towards achieving the social benefits of urban green infrastructure. They can be utilized by city planners and engaging institutions to enhance performance and promote sustainability.

1.3 Research Methodology

The main research methodology aims to outline a set of requirements to attain the societal benefits of urban green infrastructure for decision-makers in the community. Two methods were used to formulate these requirements: the first involved referring to a review of literature related to the research topic including government reports, UN reports, and publications from global organizations, and the second, is an entailed study and analysis of urban green infrastructure projects at the global level.

The selected projects revealed that the successful implementation of urban green infrastructure relies on the integration of green technology with traditional grey infrastructure, the enhancement of environmental connectivity, the provision of multiple functions for green infrastructure, as well as effective integration and community engagement. Sustainability and the environment are key pillars across all these projects, contributing to the enhancement of the quality of life for local communities.

This can be achieved through the research methodology consisting of the following:

1. Concept, Origin, and Evolution of Green Infrastructure.

2. Concept and Components of Urban Green Infrastructure Network.

3. Challenges in implementing urban green infrastructure UGI

4. Societal Benefits of Urban Green Infrastructure.

5. Planning methodologies for assessing the level of community engagement in urban green infrastructure project implementation.

6. Principles and strategies for planning, designing, and implementing urban green infrastructure UGI

7. Analysis of projects based on urban green infrastructure.

8. Drawing up a set of requirements to achieve the societal benefits of urban green infrastructure.

9. Drawing recommendations from the research.

2. Concept /Origin and Development of Green Infrastructure

2.1 Concept of Green Infrastructure

A strategically planned network of natural and semi-natural areas, along with other environmental features, was designed and managed to deliver a wide range of ecosystem services. Such services include green spaces (or blue spaces in the case of aquatic ecosystems) and other physical features in terrestrial (including coastal) and marine areas. GI is found in both rural and urban areas [3].

2.2 Origin and Development of Green Infrastructure (GI)

The Urban Green Infrastructure (UGI) concept has evolved through a series of historical developments and changes in concepts related to sustainable city planning. The evolution and beginnings of urban green infrastructure are depicted in the table below:

Table 1: Origins and Development of Green Urban Infrastructure [4]

Period	Key Events and Developments
19th Century	• Emergence of the first public parks in major industrial cities such as "Hyde Park" in London and "Central Park" in New York, in response to air pollution and its negative impact on public health.
20th Century	• Urban planning began to incorporate the importance of public parks and green spaces. • The concept of "**Green Belts**" around cities gained traction, aiming to curb urban sprawl and protect agricultural lands and natural areas.
1960 s and 1970s	• Environmental movements gained momentum, raising awareness about the significance of preserving the environment and nature within cities. • National parks and nature reserves were developed in the United States and Europe to protect natural resources.
1990 s	• The term "Urban Green Infrastructure" emerged in environmental and urban studies and research. • Implementing Exemplary urban green infrastructure projects in major cities like Portland and Seattle in the United States.
New Millennium	• Focusing on sustainability and environmental urban planning due to climate change and global environmental challenges. • Integration of urban green infrastructure concepts into public policies and cities' strategic planning
2010s	• Enhancing research and practical applications of green infrastructure in cities worldwide. • Implementing large-scale green infrastructure projects in major cities such as "New York," "London," and "Singapore."
2020s	• Prioritizing urban flexibility and addressing the challenges of climate change through green infrastructure. • Incorporating smart technology into the design and management of green infrastructure to enhance efficiency and long-term sustainability.

3. Concept and components of the urban green infrastructure network

### 3.1 Concept of the Urban green infrastructure

The definition of urban green infrastructure is a strategic approach to the preservation of open spaces through the development of networks of green and blue spaces that are planned, maintained, and offer a range of ecosystem services and other advantages at all spatial levels within the city .It will be capable of addressing a wide range of urban challenges such as biodiversity, climate change adaptation, supporting the green economy, improving social cohesion, and enhancing environmental well-being and quality of life [4].

3.2 Components of the Urban Green Infrastructure Network

The concept of **urban green infrastructure Planning** has evolved within the urban context based on a set of components, each with its function and benefit to the urban system. The following are the elements of the network of urban green infrastructure:

3.2.1 Urban Patches (Hubs)

Urban Patches, Central Green Areas, are large centres of ecologically important natural areas that provide habitats for species of animals and plants that cannot thrive in small patches of forests or meadows. As seen in figure (1), they come in a variety of sizes and forms, including expansive protected areas like national parks, wildlife reserves, and original landscapes like national forests, working lands, privately run farms that produce crops, protected regional parks, smaller parks, and other community-level locations [5].
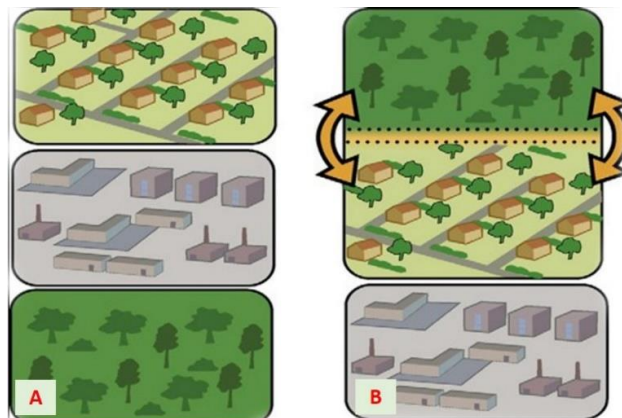
A.implementing two types of supplementary land uses separately from each other
B.implementing two types of supplementary land uses near each other to increase ecological diversity

Fig.1: Urban Patches (Hubs) [6]

3.2.2 Urban Corridors (Links)

Links are what connect the system, enabling green infrastructure networks to function. They can be thought of as linear stretches of habitats or landscapes that link various locations. They frequently follow waterways like rivers and channels that support wildlife and occasionally offer recreational opportunities [5].

Fig.2: Interconnection of green areas Central with corridors Within urban areas [7]

3.2.3 Stepping Stones (Urban Matrix)

Urban matrixes are small patches of natural areas or habitats that serve as corridors for animals to communicate and move, facilitating the dispersal of seeds and pollen among centres. Stepping stones are often found and established locally, within open spaces in cities. Green corridors connect these stepping stones in the heart of the green spaces [8].
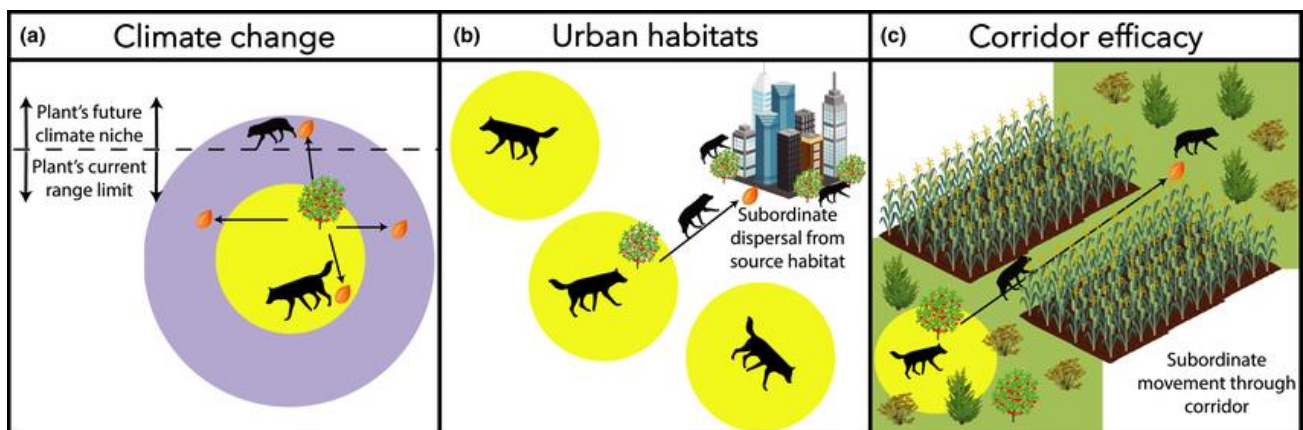

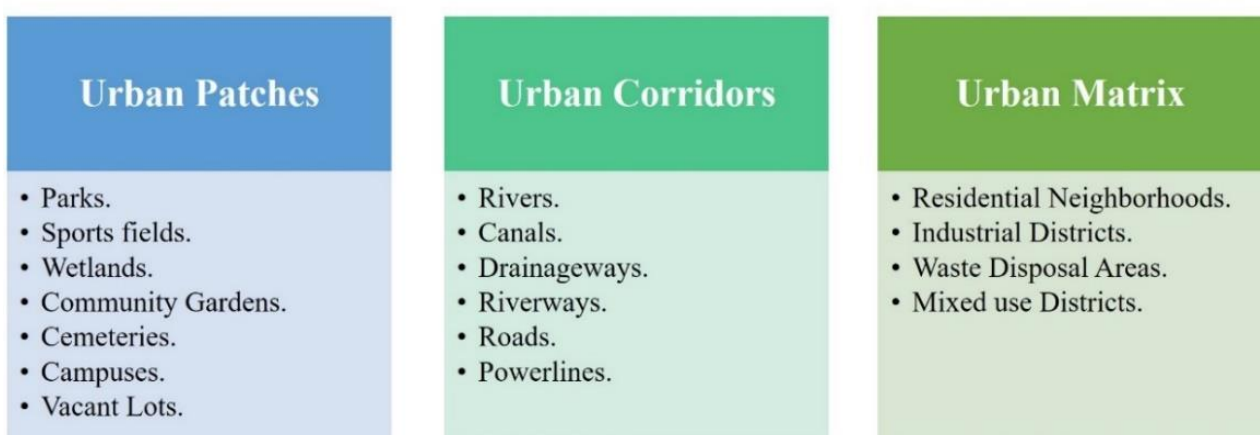Fig.3: Stepping Stones (Urban Matrix) [9]

Fig.4: Components of green infrastructure[10]

4. The challenges of Implementing Urban Green Infrastructure

Implementing green urban infrastructure is a challenging task that requires significant effort from all parties involved. From the government's perspective, the challenges primarily

revolve around financing, policy implementation, and ensuring the alignment of urban green infrastructure projects with community goals. Private investors may encounter challenges due to their lack of experience in green infrastructure investments and the necessity for clear regulatory frameworks. Contractors may encounter challenges related to education and training in green infrastructure installation, as well as the requirement for specialized equipment and materials. The following is a comprehensive summary of the difficulties in implementing urban green infrastructure, as shown in Table 2:

Table 2: Challenges Facing the Implementation of Urban Green Infrastructure

Challenges	Description
Promoting Green Economy	The current state of the world economy and the persistent environmental issues make it clear that economies must change to promote sustainability rather than undermine it. The green economy differs from traditional financial objectives, which prioritize cost avoidance, economic efficiency, competitiveness, and job opportunities, by embracing broader and more sustainable goals and frameworks. The green economy aims to enhance the quality of urban environments and reduce resource consumption by creating a synergy between job creation and improving the city's competitiveness [12]. This not only attracts new residents, companies, and tourists but also generates income. For example, it boosts revenue in the food and service industries through recreational activities and special events.
Preserving Biodiversity	Urbanization has an adverse effect on the biodiversity of forested and green spaces, which is a major global threat to biodiversity. Biodiversity encompasses diversity within and among species, as well as natural and semi-natural biological diversity, including human-designed landscapes such as forests, dry grasslands, or public parks [13].
Adapting to Climate Change	Cities are increasingly facing the hazards and consequences of climate change, including coastal erosion, flooding from heavy rainfall, extreme heat, drought, health impacts, increased energy demand for heating and cooling, reduced water availability, and food scarcity. This necessitates urgent action to mitigate and adapt to the effects of climate change, in addition to addressing the impact of the urban heat island effect in densely populated areas. A key component of reducing these effects and preparing for climate change is green urban infrastructure [12].
Achieving Equality and Social Cohesion	Social equality aims to guarantee that individuals from diverse backgrounds have equal access to life opportunities, including green spaces. Green infrastructure not only addresses social exclusion but also fosters social cohesion by providing free and accessible spaces for everyone to interact. This can help reduce stress and fatigue, making it easier for people to connect and enhance social unity. The unequal distribution of green spaces in cities is often linked to geographical differences. As a reflection of the social and economic standing of the populace, more centralized areas typically have less green space than outlying areas [14].

5. Social Benefits of Urban Green Infrastructure

Urban green infrastructure has the potential to improve people's quality of life, health, and well-being on two levels:

5.1 First: at the individual level

The ability of **urban green infrastructure** has been proven to provide numerous benefits to individuals, enhancing their living conditions and quality of life. These benefits include the following:

5.1.1 Physical Safety and Health Benefits

Urban green infrastructure projects have been shown to have a positive effect on both mental and physical health. It can promote social cohesion and boost the local economy. However, caution must be exercised as the evidence is associative in nature, and no definite conclusions can be drawn. The evidence suggests that there is a link between natural environments and physical health in general [11] as follows:

- It has been shown that going to green spaces that are **one to three kilometers** away from one's home improves public health, particularly for housewives, seniors, and members of socially and economically disadvantaged groups.
- Individuals residing in densely green residential areas engage in physical activities three times more than those living in gray areas. They are also 40% less likely to be overweight [12] In addition to having a cooling effect and improving biodiversity and water storage, green or blue infrastructure has been shown to lessen the effects of urban heat islands[13].

 As a result, it is important to note that the larger the green spaces, the better the cooling effect they produce. While green spaces smaller than 0.05 square kilometres seem to contribute the least[14]. In addition, green infrastructure helps reduce noise pollution, improve air quality, decrease particulate matter, and consequently enhance overall health. These spaces act as green lungs for highly urbanized cities. The larger they are, the more effective they are in mitigating the urban heat island phenomenon [15]. As shown in Fig. 5.

Fig.5: Green space in the Shawn Du Mars area in Paris[15]

5.1.2 Emotional, Cognitive, and Psychological Benefits

Taking into consideration the needs of diverse groups based on race, religion, age, gender, and social location from the beginning is the key to achieving emotional, cognitive, and psychological benefits of urban green infrastructure [16]. Studies have found that visiting green spaces plays a significant role in improving health and happiness. Moreover, the positive effects are not limited to physical presence in green spaces; even having views of green spaces from homes or street level has the same beneficial impact. It has been shown

to be greater for those experiencing stress and anxiety, as illustrated in Fig.6 Moreover, studies have demonstrated that walking through and experiencing urban green spaces can improve people's cognitive abilities [17].

Fig.6: Amsterdam Noord - Saadet Gökmen Archive [15]

The quality of urban life has limited children's ability to play freely outdoors or explore nature compared to older generations. Some designers integrate playgrounds in urban areas (urban patches), as shown in Fig.7, or encourage quiet play in the neighbourhood, as shown in Fig.8.Therefore, the cognitive and behavioural performance of residents living near natural areas is significantly better in terms of cognitive and behavioural aspects than those residing farther away. Furthermore, kids who have plants close to their homes have better concentration levels. [11].

Fig.7: Tile patterns to encourage children to play hopscotch in an open space [11]

Fig.8: Chess game in a residential urban park in Geneva [11]

5.1.3 Situations and Participatory Activities

Attractive and easily accessible green spaces can enhance community identity, create a sense of place, improve site aesthetics, and provide a gathering place for social interaction that supports participatory activities. Integrating green landscapes in these public spaces can enhance the connection to nature, which, in turn, fosters social cohesion. Additionally, studies have demonstrated that being in nature improves people's social skills, empathy, trust, and cooperation. [18].

5.1.4 Volunteering

It is essential to involve the community in planning urban green infrastructure projects to contribute to the conceptualization and design of green spaces. Urban green infrastructure

projects also offer social interaction opportunities, allowing people to get to know their neighbours, develop a stronger sense of altruism, and deepen their connection to the place in order to support their community and take care of shared areas. [19].

5.1.5 Leisure Time [20]

Modern life brings many pressures; however, urban green areas can provide rest and recreation for city residents. Urban planners and architects are becoming more interested in ways to relieve the stress of city living by offering urban dwellers amenities, because of the city's rapid population growth and urbanization.

  For example, the Dutch architect Aldo van Eyck designed hundreds of playgrounds between 1947 and 1978, which were innovative at the time in terms of utilizing residual spaces, as illustrated in Fig.9. The concept of designing spaces for children to explore was not only unique but also highlighted the involvement of visionary architects in fostering positive change and revitalizing the city. In this regard, van Eyck was interested in creating spaces that provide a sense of place. Above all, he wanted kids to feel like they belonged in the city and could enjoy places like public parks that make them feel like home.
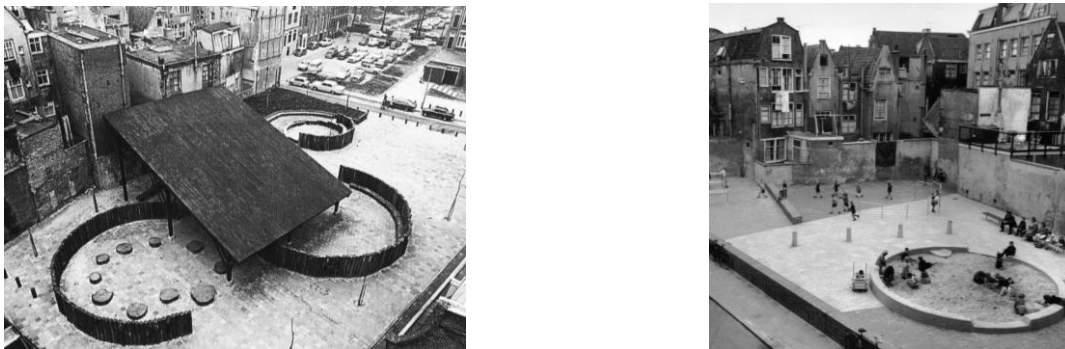

Fig.9: Models of playground design by Dutch architect (Aldo Van Eyck) in Amsterdam city [20]

5.2 Secondly: At the community level

Many social benefits of urban green infrastructure can be achieved at the community level, including:

5.2.1 Sense of ownership and belonging

Increasing a community member's sense of ownership and belonging motivates them to take specific actions, like advocating for the vision and taking on informal responsibility for parks, public areas, and other important landmarks. These initiatives can take various forms, where community members are encouraged to lead initiatives such as celebrations, festivals, carnivals, cultural activities, and shared interests like arts and sports, as illustrated in Fig.10 and 11. In the end, research has demonstrated the various benefits that placemaking and sense of place can have in reviving the weak urban infrastructure in underprivileged neighbourhoods (which include immigrant, refugee, and low-income families) and enabling those communities to reach their full potential as leaders in their communities [21].

Fig.10: Use of open spaces in Paris for selling art paintings [21]

Fig.11: Open space in Berlin hosting a Christmas market [21]

5.2.2 Safety and Economic Prosperity

Green spaces provide a greater sense of security and help reduce levels of domestic violence. Residents living near green spaces experience lower levels of crime, violence, and aggressive behaviours. Green neighbourhoods and safe areas enhance economic activity and increase retail sales, especially when street trees and urban green infrastructure are aesthetically integrated. For example, the value of properties on tree-lined streets can be up to (**30%)** higher on a broader scale than those on treeless streets. Urban green infrastructure initiatives have the potential to greatly enhance neighbourhoods, increase property values, and draw in investors. [22].

5.2.3 Good governance

Good governance is the goal of enhancing communities' capacity to cultivate an appreciation for and responsibly manage the shared assets of public spaces. The importance of good governance lies in achieving sustainable development. It ensures the reduction of corruption, gives voice to minorities and community members, and represents them in the decision-making process to meet the current and future needs of society, based on the principles of the United Nations Development Program [23]. Given that conflicts of interest can arise, ensuring democratic representation of all community members, coming to a consensus on decisions, and promoting transparency and accountability are crucial components of good governance.

6. Planning methodologies for determining the engagement levels of local communities in implementing urban green infrastructure projects

6.1 Top-Down Planning

Top-down planning is primarily characterized by predefined roles and the predominant involvement of government entities in engaging citizens in policymaking or service provision. Major city plans and overarching spatial visions have been developed by planners, professionals, and experts over decades to deliver services and allocate resources to citizens. Successful open green spaces may yield technical, aesthetic, urban, environmental, and economic benefits, but they may fall short of achieving social and

cultural benefits for the community they serve in reality. Because of this, this kind of planning primarily depends on top-down inputs (**City Planning**) and receives little to no bottom-up input from users[24].

The High Line Park project in New York City exemplifies a top-down planning approach. This linear elevated park, stretching 1.45 miles, was built on a historic freight rail line above the streets of the West Side of Manhattan. Urban planners, government agencies, landscape architects, and urban designers worked together on the project. [29].

Fig.12: High Line Park in New York City [29]

6.2 Down -Top Planning (Bottom-up planning)

In contrast to top-down planning, bottom-up planning has a collective or inclusive nature and is often carried out by a group of citizens in the local community seeking to organize themselves to manage community assets such as open squares. Instead of waiting to be invited to collaborate with the government, citizens proactively organize themselves to pursue governmental partnerships in projects, services, and ideas they deem beneficial for improving the current situation. By addressing community needs and enlisting volunteer support, they rise to the status of local influencers [24].

Built atop a Brooklyn building, the **"Brooklyn Grange"** project in New York City is acclaimed as the largest rooftop farm in the world. It all began as a brainchild of a group of residents who envisioned converting the rooftop of an abandoned building into a sustainable agricultural oasis. Through their concerted efforts, they secured the funding and support needed to bring their vision to life, collaborating with the local government and community to make it happen. What was once an empty rooftop has blossomed into a thriving urban farm that promotes sustainability and provides opportunities for the local community, all thanks to the community's dedication and partnership with the local government [30].

Fig.13:"The Brooklyn Grange" project in New York City [30]

6.3 Participatory Urban Planning

It is a process that must integrate with the community and stakeholders. City planners need to start paying attention to blind spots and risks associated with top-down planning, considering the prevalence of this model in many cities. There are several ways to involve citizens and cooperate with the government, including committees, citizen charters, and participatory planning. Participatory planning is considered an effective approach to engage communities in decision-making. But from the beginning of the planning process onward, it necessitates a readiness to build a lasting relationship with the community [24].

Through the above, we find that participatory urban planning enables local knowledge to influence the basis of planning solutions, i.e., allowing the community to contribute and make decisions. However, power dynamics and differing degrees of civic engagement are two fundamental ideas of participatory planning that city planners must consider.

6.4 Spatial Planning (Place making)

Place making can be described as the collaboration of individuals residing in the same neighbourhood to reimagine their surrounding environment and repurpose living spaces to shape a unique identity for the place and community[25]. Green infrastructure constitutes a versatile category of infrastructure, indicating that any public and collectively shared space can meet the criteria for urban green infrastructure interventions through placemaking mechanisms. Urban placemaking processes have the potential to yield numerous benefits, one of which is the greening and use of these urban spaces as common assets [26]. Table 3 illustrates the four types of placemaking identified **by Wyckoff et al. (1997).** The standard type makes up the majority, but there are three specialized types that are intended to accomplish particular objectives [27].

6.5 Government-Led Planning

Government-led planning intentionally involves citizens' participation. Community initiatives can collaborate with government officials. Planning authorities can gain from community collaboration in two ways:

First of all, urban renewal projects, which are usually difficult for institutions with a bureaucratic culture, can benefit from the innovation and creativity that community initiatives can bring [28].

Secondly, community initiatives contain a wealth of knowledge and skills related to their sites that planners may find valuable. Therefore, there is a need to reconsider the concept of

resources in planning. Planners typically interpret resources as environmental services, such as place, information, environment, and a good neighborhood), all of which are essential resources that people gather and seek. Community initiatives that support locally created urban solutions are therefore better suited to comprehend and make use of resources at a micro level [28].   The Housing and Development Board (HDB) program, managed by the Housing and Urban Development Authority in Singapore, is a highly successful initiative to revitalize aging public residential communities in the city. This program involves close collaboration among government entities, residents, and community organizations to identify priorities and suggest and implement neighborhood improvements. Through this program, the government demonstrates its dedication to working alongside residents by enabling them to actively participate in shaping the future of their neighborhoods. By utilizing the community's collective knowledge and inventiveness, government-led initiatives like neighborhood renewal can produce comprehensive, resilient, and sustainable urban revitalization results [32].

Table 3: Types of Place making [27]

Types of Standard Place Making	Classification
Standard Place making	This approach focuses on the physical care and maintenance of the built environment. Things like bike lanes, benches, and street lighting are among the necessary amenities it offers.
Strategic Place making	Focuses on planning new development using a top-down development approach and a measurable amount of investment at the neighborhood or city scale. This is frequently carried out by governments or private sector developers. It seeks to raise the standard of the built environment and add multipurpose spaces to draw in skilled labor and boost the economy.
Creative Place making	This approach focuses on using the arts to enhance the vibrancy and appeal of a place. This can be done in several ways, like incorporating art into the physical environment, holding events centered around art, and setting up occasions for people to pause and observe, like outdoor concerts, movie nights in parks, and the incorporation of children's ideas into project planning through artwork and the execution of public art projects.
Tactical Place making	Describes (bottom-up) planning approach led by community groups aiming to test, change, or improve aspects of their area and activate underutilized spaces. Simple methods and inexpensive, temporary materials are frequently used to complete it.

6.6 Tactical Urban Planning

It is a short-term strategy for long-term transformation. When beginning the implementation of urban green infrastructure projects using the Tactical Urban Planning methodology [12], stakeholders can refer to the following important points regarding these projects:

 1. **Targeting unused spaces:** In line with research by [12], space is considered a valuable resource for the community. The focus of tactical urbanism is on underutilized areas,

including surface parking lots, abandoned storefronts, overly wide streets, highway underpasses, and other disregarded public spaces.

2. Inclusive process: Tactical urbanism emphasizes achieving justice in line with the principles of participatory urban planning. by incorporating people from all age groups, including those who are marginalized.

3. Testing concepts quickly: Tactical urbanism gives people back their space, gives developers creative concepts that come from the community that is the focus, and allows governments to put these concepts into action right away.

4. Planting Creative Visions: Tactical interventions are never expected in a master plan, but they provide the desired element of surprise. It helps users and passers-by envision and experience a different future. The process of bringing about change that sets bottom-up methodologies apart can, in a sense, encourage creativity and an entrepreneurial spirit.

The pop-up park turned long-abandoned areas into green spaces in the middle of the neighborhood to improve the area and provide recreational opportunities. Residents of all ages, including marginalized groups such as low-income families and the elderly, were actively involved in the planning and execution process. The project aimed to showcase the potential of tactical urban planning in revitalizing urban spaces by ensuring diverse voices were heard and represented through the organization of community workshops, brainstorming sessions, and inclusive participation.

7. Principles and Strategies for Planning, Designing, and Implementing Urban Green Infrastructure UGI

Urban Green Infrastructure plays a crucial role in fostering sustainable development in urban areas. It forms a connected network of natural landscapes that support local green spaces, aid natural environmental processes, ensure air and water purity, and enhance overall quality of life. Consequently, many nations are emphasizing the importance of developing solutions and strategies to enhance the role of urban green infrastructure in cities. Presented below are some essential tactics and guidelines for designing, developing, and implementing sustainable urban green infrastructure [37].

Fig.14: Principles and Strategies for Planning, Designing, and Implementing Green Urban Infrastructure [29]

7.1 Integrating Urban Green Infrastructure with Grey Infrastructure

Organizing and integrating green urban areas with other infrastructure, like public facilities and transportation networks, is the idea behind green urban infrastructure planning. Roadside and railroad plantings, parks, and other multipurpose solutions are examples of how this integration can result in multiple benefits occurring at once. The goal of sustainable transportation is to build pedestrian-friendly urban areas and more aesthetically pleasing, environmentally friendly roadways by integrating greenery and vegetation cover into transportation networks [38]. By concentrating on green roads, cities can lessen the negative effects of climate change and create opportunities for relaxatión while also boosting aesthetic values, the urban climate, evaporation in the production process, and overall quality of life, sustainability, air quality, and environmental conditions [39].

A good example of this is found in Szeged, which is close to Hungary's southern border. Known as the **"City of Sunshine"** due to its high annual sunshine, Szeged is the third largest city in Hungary. As shown in Figures 15 and 16, the city has embraced green urban infrastructure and successfully integrated it with grey infrastructure in its planning.

Fig.15: Szeged's major challenges (from left to right): It is difficult to adjust the needs of the built environment to that of urban nature. Grey infrastructure, pavements, and roads may all endanger the life of trees [30]

Fig.16: Szeged's major achievements (from left to right): The renewed Szent István Square -A grassed tram-line [30]

7.2 Connectivity in Urban Green Infrastructure Network

The goal of urban green infrastructure planning is to build a network of interconnected green spaces that benefit people and support and safeguard activities and functions that isolated green spaces are unable to offer. Green spaces connected horizontally facilitate better air quality, better cooling in urban parks, and improved mobility between residential and recreational areas. The interconnected green spaces work to reduce environmental risks and mitigate the effects of climate change [41]. The communication between the various

components of green urban infrastructure is depicted in Figure 15. Achieving continuity and communication between the different components of green urban infrastructure across the whole urban area is essential for its successful planning.
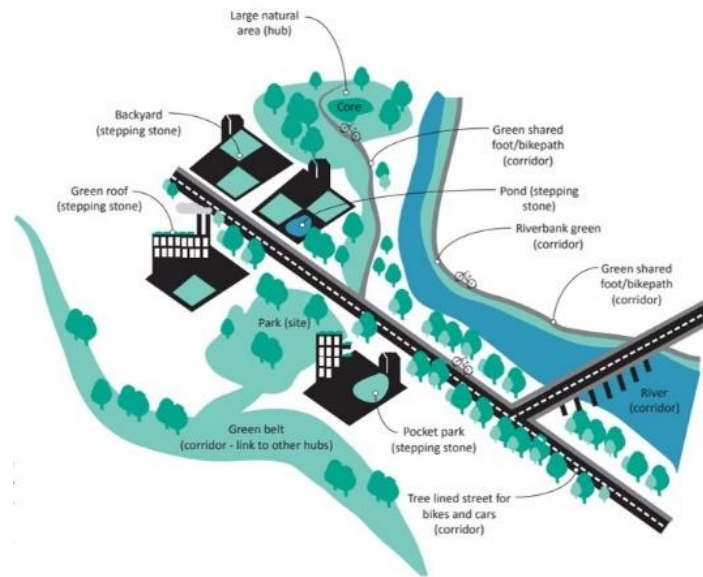

Fig.17: Diagram Illustrating the Communication Among Elements of Urban Green Infrastructure [13]: An urban green infrastructure network is made up of many elements that together facilitate movement through the city landscape.

7.3 Enhancing the Multiple Functions of Urban Green Infrastructure

Increasing green spaces' ability to offer a range of advantages. Harmonizing different functions and reducing conflicts are the goals of multi-functional planning. The ability of urban green infrastructure to provide a variety of social, cultural, economic, and environmental benefits is referred to as multi-functionality. Green spaces have several important and interrelated roles. They help with transportation, protect the biodiversity of the area's flora and fauna, improve people's health and well-being, and aid in air purification, noise reduction, urban cooling, and surface runoff mitigation. In addition, they offer services like raw materials and food resources [42].

A thorough investigation has clearly shown this, as Figure 16 in Malmo, Sweden illustrates. The goal of the project is to enhance biodiversity, the regulation of ecological services, and the social and cultural benefits of green urban infrastructure (such as mobility, natural beauty, and recreational activities). This is accomplished by controlling urban temperature, minimizing noise, and managing flow while considering the nearby agricultural areas [43].

7.4 Social Inclusion and Engagement in Urban Green Infrastructure Planning

Planning for urban green infrastructure that involves a diverse range of social groups, including the marginalized, is referred to as social integration. In urban green infrastructure planning, comprehensive social integration attempts to guarantee equitable representation and cater to the varied needs of different communities [44].

Fig.18: This plan of Bo01 diagrams the stormwater flow direction, the saltwater canal, and the smaller channels and basins that receive stormwater. Note the small aqua points in the interior of the project [31]

8. Analysis of projects based on urban green infrastructure

8.1 New Orleans City, Louisiana, United States of America

- **Project Location**

New Orleans City is located on the banks of the Mississippi River near the mouth of the Gulf of Mexico. It is the largest city in Louisiana.

- **Topography and Climate**

The city is surrounded by the Mississippi River, Lake Pontchartrain, and Lake Borgne, as well as swampland. It has an average elevation of six feet below sea level. New Orleans was built on low swamps along the Mississippi River, and a large part of its surrounding area is characterized by slopes and wetlands[32]. The city has a semi-tropical climate with long, hot, and humid summers, where temperatures range from (32 to 40 degrees Celsius, and short, moderate winters with light snowfall occurring only at Christmas. The annual rainfall averages 1590 mm per year, with the majority occurring in the summer due to tropical storms [33].

- **Climate Change in the City**

Hurricanes pose a significant threat to the city due to its lower elevation compared to the surrounding water levels. According to the Federal Emergency Management Agency, New Orleans is one of the most hurricane-prone cities and is particularly vulnerable to climate change hazards such as sea level rise, extreme heat, and heavy rainfall, leading to the deterioration of wetlands[34].

- **The Urban Green Infrastructure Project implemented in New Orleans**

The US Environmental Protection Agency has embraced a pilot project to implement urban green infrastructure in schools and public parks in the Lower Ninth Ward neighborhood, most affected by Hurricane Katrina, within the city. The project aims to support urban

resilience by educating residents and students on how to cope with heavy rainfall as a valuable resource rather than a threat. The project aims to utilize urban green infrastructure by explaining and demonstrating it in schools. One of the high schools that was completely destroyed in the hurricane, Lawless High School, was chosen for this purpose, as shown in Figure 12. This provides greater opportunities for raising awareness about the importance of urban green infrastructure practices in supporting community cohesion and providing ecological services. Additionally, it serves as an educational tool that can be replicated in similar locations, leading to a qualitative change in individuals' understanding of how to manage rainfall.

Figure 19 illustrates the condition of the school before the project began, as the Surviving trees were used as a fence for the courtyard. A recreational park was designed adjacent to the school, as shown in Figure 20 [35].

Fig.19: General site condition of the school before the project began[35]

Fig.20: General site for the urban green infrastructure project [35]
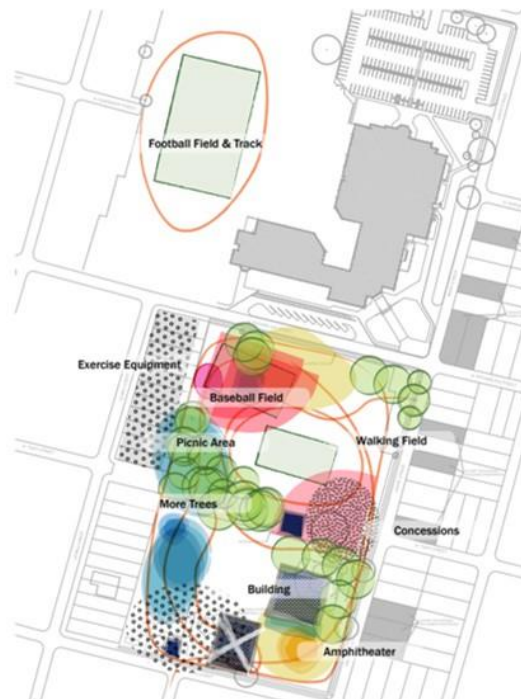1- School buildings & 2- School courtyard

Fig.21: Public location of the school and the attached amusement park [35]

8.2 Amsterdam, Netherlands

- **Project location**

Amsterdam is the largest city and the capital of the Netherlands, located in the northwest of the North Holland province, just 22 km from the North Sea.

- **Topography and climate**

The city covers an area of 219 km2, intersected by the Amstel River, from which numerous canals extend, flowing through the city's neighborhoods. Parks and nature reserves make up approximately 12% of its total area. The climate is cold, humid, and rainy in winter, and mild in summer, with an annual rainfall of 850 mm distributed between autumn and winter in intermittent showers. The winds are persistent and often strong throughout the year. Sunlight is scarce in winter months and limited in summer [36].

- **Climate Changes in The City**

The Netherlands is almost entirely located below sea level, making it vulnerable to flooding due to rising sea levels caused by global warming. The average temperatures in Dutch cities have increased by 1.7 degrees Celsius from 1900 to 2017. As a result, Dutch cities, especially Amsterdam, face coastal erosion and increased rainfall due to severe storms. According to a report by the Dutch Environmental Assessment Agency, 29% of the Netherlands is at risk of river flooding, while 55% of the country is at risk of being submerged underwater, making it flood-sensitive due to climate change [37].

- **The Urban green infrastructure project implemented in Amsterdam [38]**

The European Union has initiated efforts to encourage innovative solutions to address various urban challenges in collaboration with development partners in European Union cities. Among those solutions is the **Resilience Network of Smart Innovative Climate-Adaptive Rooftops** (**RESILIO**) project. It aimed to adapt to climate change by integrating nature (green and blue spaces) and smart technological solutions.

The project started by selecting the **Slotermeer** neighborhood. It is a residential neighborhood in central Amsterdam that includes a cluster of social housing buildings susceptible to damage, whether on roofs or drainage networks due to frequent urban floods, as illustrated in Figure 22.

The project involves creating rooftops above a specified number of buildings with the ability to store rainwater in special containers, as depicted in Figure 23, which shows the locations of those buildings.
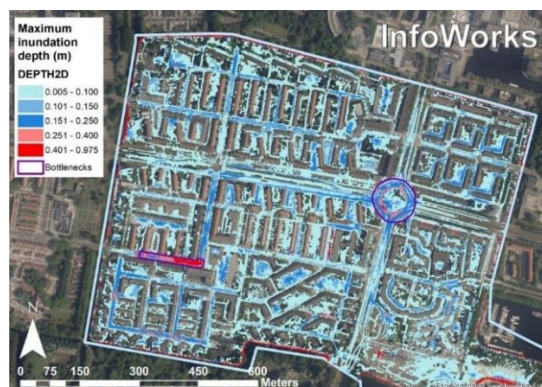

Fig.22: Flood depths and congestion sites in the residential neighborhood of Slotermeer [38]

Fig.23: Selected house rooftops in green color[38]

- **Integration of Green Rooftops and Smart Solutions**

Stakeholders in the **RECILIO** initiative have agreed to convert 10,000 m2 of residential building rooftops into green and blue roofs. One of their main functions is to absorb heavy rainfall and store it, as shown in Figure 24 **[39]** Additionally, they plan to equip rooftops with smart technology to maximize their benefits as follows[40]:

1. Innovative lightweight roof.

2. Devices for forecasting rainfall timing.

3. Sensor devices that measure the condition of plants and water levels in containers.

4. Smart valves can slowly discharge excess water before new rainfall occurs.

5. Microfiber optic pipes are used to irrigate plants with water stored in containers during periods of rain interruption.

6. Precise and sensitive devices are used to measure temperature and humidity in the soil and plants, as well as wind speed. Figure 18 shows the final appearance of one of these surfaces after completion [41].
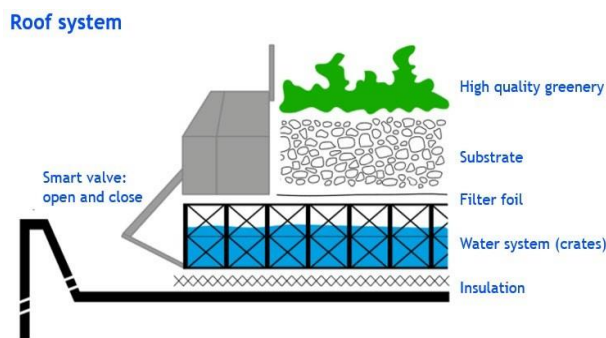

Fig.24. Schematic representation of a blue-green roof [41]

Fig.25: Final shape of one of the rooftops after completion [41]

8.3 Detroit, Michigan, United States

- **Project location**

Detroit is in North America, specifically in the state of Michigan, United States. The city has the longest border distance between the United States and Canada. With a population exceeding five million three hundred thousand people, it is one of the most densely populated cities in the state.

- **Topography and climate**

The total area of Detroit is 370.03 square kilometers, with water surfaces covering 10.67 square kilometers. The city has a humid continental climate influenced by the Great Lakes. The summer season starts in May and extends until September, with temperatures not exceeding 32 degrees Celsius. The average annual rainfall in the city is about 58 mm [42].

- **Climate changes in the city**

Recent studies indicate that severe heatwaves have become more frequent, with the potential to last up to 65 days of high temperatures exceeding 32 degrees Fahrenheit. This is an increase from the current average of 13 days during the summer season. This is accompanied by major power outages that could result in 1400 deaths in Detroit. During this heatwave, thousands of residents are at an increased risk of heat exhaustion and heatstroke [43].

- **The Urban Green Infrastructure Project Implemented in Detroit [44]**

   The Water and Sanitation Department in Detroit collaborated with Rosedale Grandmont Little League **(RGLL)**, Grandmont Rosedale Development Corporation **(GRD)**, and the city's Parks and Recreation Department in 2016 to reduce the amount of rainwater entering the city's sewage system. This was achieved by utilizing the parking lot at **Stoepel** Park #1 on Westwood and Minock Streets, as shown in Figure 26.

Rainwater was collected on a broad porous slope and then redirected back to the street to help reduce the temperature, as illustrated in Figure 28.

Fig.26: Current view of Stoepel Park No. 1 in Detroit [44]

Fig.27: Proposed locations of new pervious stone parking spaces (A) and bioretention areas (B) at Stoepel Park No. 1 [44]
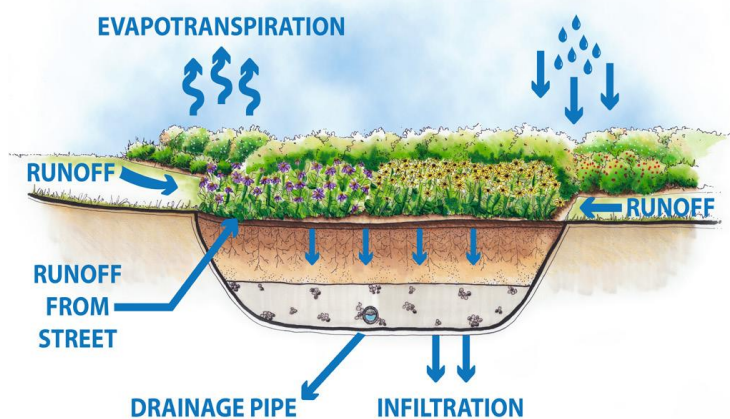

Fig.28: A view of how bioretention works [44]

8.4 SWOT Analysis of Urban Green Infrastructure Projects "Case Studies":

A SWOT analysis was conducted for the three researched projects, focusing on the components of the green urban infrastructure network. This analysis reveals the critical factors influencing each project and provides a comprehensive understanding of their strengths, weaknesses, opportunities, and potential threats during the development of green urban infrastructure. The results are summarized in the following table:

Table 4: SWOT Analysis of Urban Green Infrastructure Projects[35] [41] [44]

Element	Lawless High School, Lower Ninth Ward Neighborhood, New Orleans Project	Slotermeer Neighborhood, Amsterdam Project	Stoepel Park No.1, Westwood and Minock Streets, Detroit Project
Urban Patches, Urban Corridors, Stepping Stones			
Strengths	• Central location in the neighborhood, facilitating accessibility. • Direct links between the school and surrounding green areas.	• Providing central areas for gathering and social interaction. • The presence of effective links between green and gray infrastructure elements.	• Providing seating areas and social interaction in the park. • Seamlessly integrating green infrastructure with the surrounding environment.
Weaknesses	• Some pathways may be ineffective or narrow. • Challenges in designing connections between green infrastructure and adjacent buildings.	• Some steppingstones or areas may be unsuitable for public use. • Some central areas may be unstable or unsafe.	• Some steppingstones may lack an appealing design. • Challenges in designing corridors that blend well with the environment.
Opportunities	• Enhancing connectivity between the school and green areas to encourage outdoor physical activity and learning. • Promoting environmental and social awareness among students and the local community.	• Enhancing access to neighborhood central areas. • Drawing in visitors and locals to the central neighborhood areas for social interaction.	• Attracting residents and visitors to the park for social and environmental activities. • Hosting social and cultural events in the park to promote social interaction and integration.
Threats	• Inadequate green spaces to meet the needs of students and the community. • Limited resources for the long-term maintenance and development of green infrastructure.	• Community resistance to changes in central areas. • Inadequate funding for developing projects in central areas.	• Potential spread of pollution or noise from nearby areas. • Poor planning or inappropriate use of green spaces in the park.

8.5 Lessons Learned from Previous Projects

After reviewing previous projects, the following conclusions can be drawn:

Table 5 will showcase the achievements of the three projects in the principles and strategies of planning, designing, and implementing green urban infrastructure. This presentation is based on the project details and their SWOT analysis, providing a percentage evaluation for each project. The evaluation is based on the integration of green urban infrastructure with grey infrastructure, as well as the connectivity in the network of green urban infrastructure. The aim is to enhance the provision of multiple functions for green urban infrastructure and achieve integration and social participation in green urban infrastructure planning. Each project will be evaluated based on these strategies and assigned a percentage, as outlined in **Table (6)**. For each strategy, a maximum percentage of 100% will be granted.

Table 5: Accomplishments of the analyzed projects based on principles and strategies of urban green infrastructure planning, design, and implementation [39] [43] [44] [45]

Strategy	Lawless High School, Lower Ninth Ward Neighborhood, Project	Slotermeer Neighborhood, Project	Stoepel Park No.1, Westwood and Minock Streets, Project
Integration of urban green infrastructure with grey infrastructure	• The project focuses on utilizing green infrastructure in schools and public areas to improve flood management capabilities.	• The project aims to integrate green infrastructure, such as rain gardens, bio-swales, and permeable pavements, with traditional grey infrastructure.	• The project focuses on integrating green and grey infrastructure in the park to improve water management and enhance green spaces.
Urban Green Infrastructure Connectivity	• The green infrastructure elements are integrated with the existing infrastructure to enhance environmental flexibility.	• Improving Storm water Management and Reducing Flooding.	• Techniques such as constructed wetlands and permeable pavements are utilized to enhance environmental performance.
Enhancing Urban Green Infrastructure Multiple Functions	• Urban green infrastructure projects serve various functions, including environmental education, water quality improvement, and providing educational and experimental spaces for students to learn about the benefits of urban green infrastructure.	• The project provides multiple benefits such as improving air quality, creating green spaces for leisure and recreation, enhancing biodiversity, and managing storm water.	• The project provides multiple benefits such as improving air quality, creating green spaces for leisure and recreation, enhancing biodiversity, and managing storm water.
Integration and Social Engagement in Urban Green	• The project heavily relies on community involvement by engaging students, teachers, and	• Community participation is integral to the project, involving workshops	• The project is renowned for its effective community engagement through neighborhood associations

Strategy	Lawless High School, Lower Ninth Ward Neighborhood, Project	Slotermeer Neighborhood, Project	Stoepel Park No.1, Westwood and Minock Streets, Project
Infrastructure Planning	parents in the planning and implementation processes. Workshops and educational programs are conducted to raise awareness and enhance understanding.	and consultation sessions to enhance a sense of ownership among residents.	and environmental groups. They organize educational and volunteer events to encourage community involvement in the maintenance and improvement of urban green infrastructure.

Table 6: Percentage ratios of project implementing urban green infrastructure principles and strategies [45] [46] [47]

Element	Lawless High School, Lower Ninth Ward Neighborhood, New Orleans Project	Slotermeer Neighborhood, Amsterdam Project	Stoepel Park, No1 Westwood and Minock Street, Detroit Project
Integration of urban green infrastructure with grey infrastructure	90%	85%	80%
Urban Green Infrastructure Connectivity	92.5%	82.5%	82.5%
Enhancing the provision of multiple functions for the urban green infrastructure	90%	85%	80%
Integration and Social Engagement in Urban Green Infrastructure Planning	92.5%	82.5%	82.5%

Based on the information provided, Table 7 illustrates the level of implementation of integration strategies for green and grey infrastructure, urban green infrastructure network connectivity, and enhancement of multi-functionality of urban green infrastructure, and social integration and participation in urban green infrastructure planning for each project.

Table 7: extent level of each project in achieving urban green infrastructure planning, designing, and implementation principles and strategies [47]

Project	Integration of urban green infrastructure with grey infrastructure	Integration of urban green infrastructure with grey infrastructure	Integration of urban green infrastructure with grey infrastructure	Integration of urban green infrastructure with grey infrastructure
Lawless High School, Lower Ninth Ward Neighborhood, New Orleans Project	High	High	High	High
Lawless High School, Lower Ninth Ward Neighborhood, New Orleans Project	High	Medium	Medium	Medium
Lawless High School, Lower Ninth Ward Neighborhood, New Orleans Project	Medium	Medium	Medium	Medium

Consequently, The Lawless School project in the Lower Ninth Ward is one of the most successful projects in implementing urban green infrastructure strategies, making it the top project capable of meeting the social benefits requirements of urban green infrastructure. Considering the significance of securing adequate funding for such projects, as well as the necessity of utilizing technology to establish a database for support, development, and continuing reliance on urban green infrastructure as an environmental solution to combat climate change. Reviewing previous experiences, the final section of the research will address a set of requirements that need to be fulfilled to achieve the societal benefits of urban green infrastructure. This will serve as a reference for city planners, or any organization engaged in developing accessible public areas. Finally, a set of results and recommendations will be presented to enhance the capabilities of those working on urban green infrastructure projects.

9. Requirements for Achieving the Societal Benefits of Urban Green Infrastructure (UGI)

Conditions for Realizing Urban Green Infrastructure's Social Benefits. These requirements were formulated using two different methods: the first involved referring to a survey of the literature on urban green infrastructure, and the second involved analysing urban green

infrastructure initiatives to draw lessons from them. Considering the aforementioned, we see that the requirements put forward in this study are the result of a review of the literature and an analysis of related projects, **specifically:**
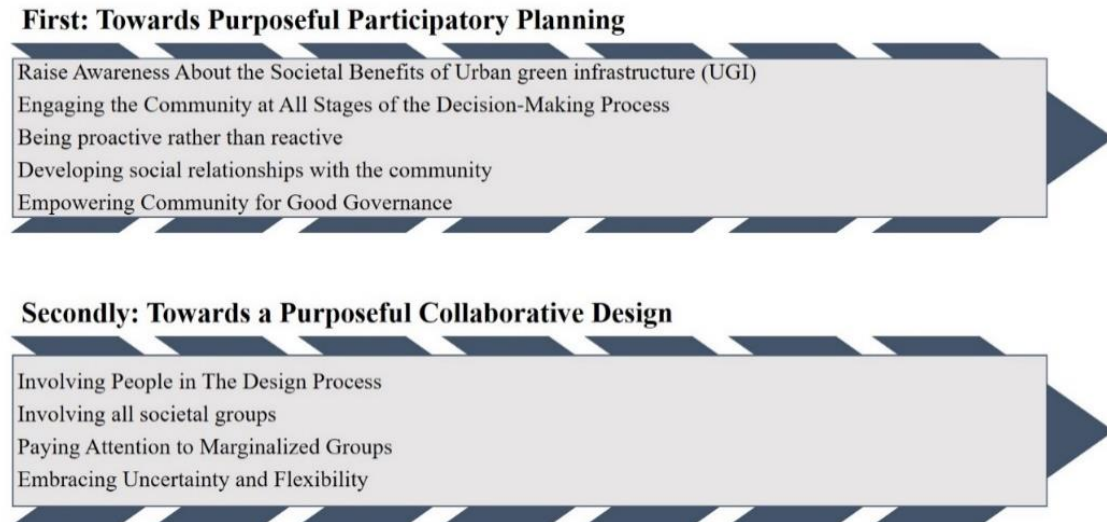
First: Towards Purposeful Participatory Planning

Raise Awareness About the Societal Benefits of Urban green infrastructure (UGI)
Engaging the Community at All Stages of the Decision-Making Process
Being proactive rather than reactive
Developing social relationships with the community
Empowering Community for Good Governance

Secondly: Towards a Purposeful Collaborative Design

Involving People in The Design Process
Involving all societal groups
Paying Attention to Marginalized Groups
Embracing Uncertainty and Flexibility

Fig.29: Requirements for Achieving the Societal Benefits of Urban Green Infrastructure (UGI) [48] [49]

9.1 First: Towards Purposeful Participatory Planning

As this study has shown, there are many degrees of citizen participation in participatory planning; therefore, it is important to determine which levels and procedures are most advantageous to communities. As a result, legitimate authorities should not lump together all types of social engagement under the general term "participation." There are different stages of participatory planning, and efforts should be focused on getting local communities more involved than just reporting or assessing their needs. The goal of this strategy is to guarantee a more accurate and deliberate implementation of participatory planning. **You can accomplish this by doing the following[48]:**

9.1.1 Raise Awareness about the Societal Benefits of Urban green infrastructure (UGI)

Community awareness of the importance of green environments, such as green urban spaces, plays a central role in sustainable urban development, as proven in research. These benefits can be presented through collaborative workshops, informational brochures, public signs, or media campaigns; however, direct communication with individuals is the most effective approach.

9.1.2 Engaging the Community at All Stages of the Decision-Making Process

Evaluating and meeting the needs of the community and involving it in the decision-making process are equally crucial. For local communities to work toward creating a sense of ownership over the project when they are consulted, this involvement needs to become a regular habit. Long-term community participation is anticipated. Furthermore, the best approach for community activists to communicate their views is to fully integrate them into society.

9.1.3 Being proactive rather than reactive

Offering services could, on the one hand, run the danger of reducing the part that reactive answers play in providing solutions. However, there are many chances for towns and cities to be proactive and creative in offering answers when they make use of community resources. As a result, the city should be understood as the outcome of many people sculpting it in their own unique ways rather than as the result of structural planning and social engineering.

9.1.4 Developing social relationships with the community

Understanding a community is the first step in identifying community resources. However, this process often requires stepping out of the comfort zone and routine. Conducting Community surveys can be more effective while walking around the neighborhood and getting to know the people. Using a straightforward technique, such as walking or moving around is an effective technique, as observation-based walking and urban exploration are identified as a branch of self-knowledge to better understand the physical and social context of the area and the spatial practices of the residents.

9.1.5 Empowering Community for Good Governance

Communities should be involved in the design and activation of public areas to enhance neighborhood safety. Residents are expected to be more vigilant when they have vested interests in a place and to protect it against misuse, destruction, and vandalism. Notably, well-designed public spaces are safer and more sustainable. The need to engage communities becomes more evident when vandalism becomes a widespread phenomenon. This is one of the most significant challenges facing authorities.

9.2   Secondly: Towards a Purposeful Collaborative Design

Expertise is no longer considered the only requirement for design when a collaborative approach is taken to the beginning of a design project. Localizing solutions through the integration of social and cultural factors-factors that are typically disregarded in traditional planning-makes collaborative design more democratic.

Thus, for specialists in engineering and design, co-design entails a total shift from viewing design as a finished product to viewing it as an ongoing process of change. **The following actions can be taken to accomplish this. [49]:**

9.2.1 Involving People in the Design Process

Engaging local communities in design can serve multiple purposes. It introduces people to the meaning of design and helps them gain a better understanding of design to solve problems. Collaborative design can provide an opportunity to exchange knowledge between experts and communities and vice versa.

9.2.2 Involving all societal groups

In line with the sustainable development principle of "leave no one behind," it is important to consider and invite all targeted community groups and individuals with special needs and

diverse priorities, especially marginalized groups, such as women, the elderly, youth, children, people living in extreme poverty, migrants, refugees, and people with disabilities.

9.2.3 Paying Attention to Marginalized Groups

The literature review on participatory planning discusses empowering communities and individuals and how this leads to good governance. Empowerment should be understood as a complex and relative concept according to each society. Participatory planning should not overlook the dynamics of social and political power within the community, which, in some negative instances, can be exploited to undermine and impede efforts.

9.2.4 Embracing Uncertainty and Flexibility

As part of the collaborative design process, one must acknowledge that the product is a moving target as opposed to the instant sensory fulfillment obtained by expert-guided traditional design methodologies. This adaptability goes beyond simply being ready to alter the design to accommodate new requirements; it also recognizes that some features might not be used as intended.

We can evaluate the researcher's recommended criteria for achieving the societal advantages of urban green infrastructure based on the previously presented facts. Table 8 outlines the study objectives and the techniques that must be identified to achieve these requirements, which form the basis of this assessment.

Table (8): Assessing the effectiveness of the criteria for achieving the societal benefits of urban green infrastructure [50] [51]

Requirements for Achieving Societal Benefits	Measurable objectives	Procedures
Raising awareness about the societal benefits of urban green infrastructure UGI	Increasing open green spaces in the city by 10% over the next five years	Organizing workshops and conferences to introduce the community to the environmental and social benefits.
Engaging people in the design process		Engaging residents in the design of green spaces.
Engaging all segments of society		Ensuring inclusive participation in area planning
Acting proactively rather than reacting passively	Reducing city-related greenhouse gas emissions by 15% over the next ten years.	Promoting initiatives that reduce emissions proactively.
Empowering Effective Community Governance		Enhancing policies supporting the shift to clean energy with community involvement.
Fostering social connections within the community	Increasing the number of people using public open spaces by 20% over the next three years.	Using green spaces to foster social bonds through community events.
Engaging people in the design process.		Ensuring community engagement in designing activities and programs.

Acting proactively rather than reacting passively	Improving air quality in the city by 25% over the next five years.	Applying proactive policies to reduce pollution "Implementing preemptive policies to curb pollution."
Raising awareness about the societal benefits of urban green infrastructure		Awareness campaigns about the benefits of clean air.
Raising awareness about the societal benefits of urban green infrastructure	Increasing the percentage of the population aware of the importance of urban green infrastructure by 30% over the next three years.	Extensive media and awareness campaigns
Engaging the community at all stages in the decision-making process		Ensuring community involvement in all project phases
Embracing uncertainty and flexibility:	Incorporating urban green infrastructure UGI elements into 50% of new projects in the city over the next five years.	Designing adaptable projects to accommodate future changes.
Engaging the community at all stages of the decision-making process	Developing green corridors connecting 70% of green spaces and residential areas within the next five years.	Ensuring the participation of all groups in designing the corridors
Paying attention to the marginalized		Ensuring that the green corridors are accessible to all groups.

10. Results

1. Adopting a collaborative approach and involving the community at all levels and with all individuals in the targeted community is essential for implementing the conceptual framework of Urban Green Infrastructure (UGI). This is achieved by ensuring community involvement in various stages, including needs assessment, design, and joint implementation.

2. Conducting a community needs assessment is fundamental in the initial stages of urban green infrastructure (UGI) projects, as it involves identifying the demographic composition of the community. This information may include, to name just a few, age, gender, income, employment, education, housing tenure, length of residence, etc.

3. By highlighting the societal advantages of urban green infrastructure (UGI) and outlining methods to achieve these benefits through planning methodologies of UGI projects, it can be argued that the societal benefits of good governance are paramount and requires considerable time to mobilize community and planners to sustain the direct and indirect social benefits of urban green infrastructure.

4. Local residents within an empowered community can plan and implement Future visions and creative area usage. They can host an event or activity within this area by engaging and debating planners and the project team of Urban green infrastructure projects

5. The participatory approach enables active stakeholders in the community, including community organizations, civil society organizations, and non-governmental and international organizations, to engage in the planning of UGI projects.

11. Recommendations

11.1 General Recommendations:
1. Entrepreneurs of urban green infrastructure projects should be delegated and empowered.
2. During initial meetings, planners must be encouraged to listen to the community's needs to reduce tension and raise awareness when initiating projects.
3. It is important for the planner to be aware of who holds the greatest power in the community and to plan sessions to accommodate differences in power balances by asking questions such as: Who benefits from this project? Is it all members of the community, some of them, or groups of them?
4. Beware of knowledgeable individuals in meetings who appear to dominate with their expertise and overshadow other voices. For example, depriving others.

11.2 Recommendations for Expanding the Societal Benefits of Urban Green Infrastructure Projects:
1. Achieving the societal benefits of urban green infrastructure projects requires clear and consistent regulatory frameworks. Collaborative efforts from various stakeholders are essential to gain an in-depth understanding of creating a sustainable future for upcoming generations. Several key points are essential for the success and realization of the desired societal benefits, including:

• Financing: Despite increased investment in recent years, green infrastructure projects still face significant challenges in meeting the demand for sustainable infrastructure. Governments, private sector investors, and charitable organizations need to collaborate to secure funding for green infrastructure projects. For instance, the U.S. federal government has initiated a trillion-dollar infrastructure plan, allocating funds for green projects such as clean energy, water infrastructure, and water management.

• Innovative Technologies: The adoption of innovative technologies is crucial for the success of green infrastructure projects. These technologies can enhance the efficiency, effectiveness, and longevity of infrastructure projects. For example, green roofs and walls can reduce energy consumption and improve air quality, while permeable pavements can mitigate stormwater runoff. Smart technologies, such as sensors and data analytics can also monitor and enhance the performance of green infrastructure projects.

• Community Engagement: Engaging the community is crucial for the success of green infrastructure projects. Projects should be designed with the needs and preferences of local communities in mind. This can be achieved through public consultations, community meetings, and the involvement of local stakeholders. For instance, in Toronto, Canada, the city initiated a program that involves local communities in the design and implementation of green infrastructure projects.

• Policy and Regulations: Policies and regulations play a vital role in the development and implementation of green infrastructure projects. Governments need to establish policies that encourage sustainable infrastructure development and regulations that ensure projects will meet specific environmental and social standards. For example, the European Union has adopted a circular economy package that outlines targets for waste reduction and increased use of renewable energy.

2. Service providers should utilize advanced methods and tools to analyze the performance of urban green infrastructure. There is a need to go beyond traditional engineering methods and integrate new approaches related to environmental management to acknowledge that the complexity of natural ecological systems may result in less accuracy.

3. Stakeholders should prioritize providing social support for urban green infrastructure and establish long-term alliances.

4. It is preferable to invest resources in developing new areas of expertise related to stakeholder partnerships and supporting community engagement. Development partners can expand the knowledge boundaries of the next generation in urban green infrastructure **in three ways**:

- Building capacities within organizations to understand the potential of urban green infrastructure.
- Utilizing assessment tools and methods in their internal operations.
- Investing in performance monitoring and disseminating results and experiences for project models that have adopted an urban green infrastructure approach to overcome knowledge gaps. gaps.

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اشتراطات تحقيق الفوائد المجتمعية للبنية التحتية الحضرية الخضراء

الملخص

لم يؤد التحول السريع للأحياء الحضرية إلى جانب أنماط المعيشة المتغيرة إلى حاجه المدن إلى التخفيف من الإجهاد المناخي فحسب، بل إلى تحسين رفاه السكان. فلقد وجدت الدراسة ان نسبة الغازات من صنع الانسان الناشئة من المدن بناءً على ماتم رصده في التقرير العالمي للمستوطنات البشرية لعام 2022م تتراوح مابين 40 إلى 70% ، وان احتمالية ارتفاع هذه النسب للترواح مابين 60 إلى 70% إذا ما استمر التقلص في المساحات المفتوحة والخضراء بشكل كبير وأصبحت الأماكن العامة هي البدائل المتاحة للناس للتفاعل اجتماعياً بعيداً عن مساكنهم المكتظة. لذا يتجه البحث لدراسة ادخال البنية التحتية الحضرية الخضراء في المدن وما يترتب عليه من تحقيق فوائد اجتماعية.

حيث يهدف البحث إلى التوصل إلى اقتراح مجموعة من الاشتراطات التي يجب توافرها لتحقيق الفوائد المجتمعية للبنية التحتية الحضرية الخضراء لتكون مرجع من قبل مخططي المدن وأي مؤسسة عاملة في إنشاء المساحات العامة المفتوحة من أجل تعزيز قدرات العاملين قبل وبعد مراحل تنفيذ مشروعات البنية التحتية الحضرية الخضراء. ويتناول البحث دراسة مفهوم ونشأة تطور البنية التحتية الخضراء، ومفهوم ومكونات ومنهجيات تخطيط ومعوقات واستراتيجيات البنية التحتية الحضرية الخضراء، بالاضافة الى دراسة تحليلية لمشروعات عالمية في هذا المجال. حيث خلص البحث الى ان التكامل بين عناصر المناطق الخضراء المركزية والممرات وعتبات الوثب مع استراتيجات البنية التحتية الحضرية الخضراء تعمل على تحقيق الفوائد المجتمعية لها فهي للمجتمع ومع المجتمع.

الكلمات الدالة المرشدة: البنية التحتية، البنية التحتية الحضرية الخضراء، البنية التحتية الخضراء، التغير المناخي، التخفيف.