Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 8, No. 6, 4825-4840
2024
Publisher: Learning Gate
DOI: 10.55214/25768484.v8i6.3047

Smart green zones: Review

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Abstract: Managing green spaces to become smart is an important factor, so the research focused on identifying the knowledge gap on how to manage smart green spaces. The importance of smart management techniques that rely on sensors, the Internet, and artificial intelligence in providing data for decision-making is highlighted, to enhance the life quality within green spaces and enhance their sustainability by adopting technology data to maintain and manage green zones. Despite the importance of green zones and their multiple benefits, many cities face significant challenges in managing them effectively and sustainably. These challenges vary between the lack of material and human resources, plant conservation problems and green infrastructure, as well as the unpredictability of future environmental needs. The research relied on investigating the concept of smart green zones, their characteristics, smart management concept, strategies and application to study situations to find ways and means of intelligently conserving and managing natural resources. The research recommends the need to strengthen studies and research and community participation in order to enhance the quality of green zones through technological development.

Keywords: *Resource management, Smart green zones, Urban management.*

1. Introduction

The goal of smart green zones is to balance the environment and urban infrastructure. Enhance the life quality in cities by integrating sustainable solutions such as smart irrigation systems, lighting, and the utilize of renewable energy. Garden, parks, and green rooftops are among smart green areas because sensors monitor air quality, temps, and soil moisture. By means of the data gathered, these areas may be efficiently managed to lower urban temps, enhance air quality, limit natural resource use, and so provide appropriate settings for leisure and well-being, thereby mitigating pollution. It seeks to understand the approaches of smart urban management (SUM) and their possible influence on green areas by means of better utilize of natural resources, enhancement of the quality of green zones, and application of community forces to raise the psychological and health condition of people and the surroundings.

Green zones and smart cities attract considerable attention from researchers following Bakogiannis and his team's 2018 study on the role of the information environment in the evolution of the smart city, a contemporary trend in urban design that leverages artificial and human intelligence capabilities. The research indicates that the smart city is a manifestation of the information revolution aimed at enhancing the effectiveness and efficacy of services, health, economic, social, and environmental dimensions within the urban context. Research reveals a deficiency in urban applications of the information environment inside smart cities, highlighting the requirement to examine the information environment's function in realizing the smart city program. The research further validates the significance of multidisciplinary information discourse in realizing the smart city

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ambition. Descriptive and analytical research was employed to examine the different factors involved in constructing the smart city. The findings indicated that the information environment is crucial for developing the smart city and for realizing the fundamental principles of pluralism, partnership, and sustainability of urban intelligence.

2020 research by Basnou and colleagues examines the significance of green space planning and sustainable landscape design in smart cities. Considering the diverse requirements of public green areas. The authors emphasize the benefits of public green zones, such as enhancing citizens' physical and mental health, mitigating the effects of the urban heating island, and enhancing the overall aesthetic of the city. The paper also emphasizes the significance of including sustainable design principles into the construction of public green areas, including the utilization of native plant species, and lowering of water use. The authors—Chondrogianni and Stephanedes, suggested enhancing biodiversity in 2020. Creating varied green areas that satisfy the many demands of residents including parks, gardens, and urban forests—should be the top goals in smart cities, the writers propose. Emphasizing the need for group efforts among many urban designers, landscape architects, and people in producing accessible and sustainable green areas in smart cities, the paper ends.

The research by Najah and Abdullah on urban land utilize changes and the effects of urban green space (UGS) conversion on Baghdad temp in 2022. The study primarily aims to investigate how urbanizing green areas affects the increase in city temp. The study also tackles the beneficial impact of green areas in controlling city temp and decreasing heating load. Analysis of changes in urban land utilize and their effects on heating islands in Baghdad was done utilizing descriptive analytical study. While green areas help to mitigate heating and control the city temp, the study found that turning green areas into urban environments results in an increase in the city temp and the development of heating islands. While keeping a balance between the environmental and economic elements of growing urban cities, the study advises the need to keep green areas in metropolitan cities and shielding them from conversion into urban spaces.

2. Theoretical Framework

2.1. Smart Green Zones:

2.1.1. The Concept of Smart Green Zones:

They are spaces that provide advanced integrated services, depending on communication and information technology (ICT) and smart (intelligent) utilizing of urban infrastructure to enhance the life quality of its citizens, through smart projects that should contribute to achieving an integrated vision capable of harmonizing the technologies used and the new services in the various fields of application that the smart city works on (Bašová, S., et al, 2017). The quality and capacity of green zones depend largely on human intervention and in an intelligent way, i.e. how natural capital is managed and cared for and how the general perception and attitudes towards the external and green urban environments are spatial impact management decisions. We find that one of the main considerations in identifying spaces can be considered the "communication triad" of social, environmental and technological systems. (Jopek, D, 2019) The principle that makes spaces smarter and more integrated can be represented by their ability to export themselves through fast media for transferring information, and their various means governed by a network of information and digital flows (the Internet). If spaces can penetrate this information network, and introduce technological-digital means into their work, management and monitoring, they will become smart spaces par excellence. (Shaheen, 2018) As for the temporal dimension provided by smart spaces, they provide their databases at all times of the day and night, holidays, all tourist seasons and others in a way that allows the user to benefit from services at any time he wants, as the intelligence of cities is based on the extent of their dealings with artificial intelligence means and applications in urban fields, and here it is possible to draw features of smart spaces by providing electronic accounts, creating communication within spaces, and providing digital data that helps spaces to break into the virtual world deservedly. And great speed, and enables it to impose its (smart), personality (Al-Jumaili, 2022) and that the goal of designing smart green zones to (Ismail, 2019).

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 8, No. 6: 4825-4840, 2024
DOI: 10.55214/25768484.v8i6.3047

2.1.2. Characteristics of Smart Green Urban Spaces

Smart green urban spaces are based on the principles and standards defined by the International Organization for Standardization (ISO) that smart spaces are a new model of spaces that adopt information technology (Internet, computers, digital data, virtual space, geographic information systems GIS) as an approach to planning, construction and urban management. The basic characteristics of the formation of sustainable smart green urban spaces and their multiple dimensions are linked to the establishment of these types of spaces. It is concluded that smart green zones are a concept developed on the basis of three main pillars: establishing economic growth, addressing environmental issues, and integrating social justice. Smart spaces are based on the utilize of the Internet and computing technology in an integrated manner, so spaces are created that are based on the Internet to sense, measure and transmit data in real time for moving objects because the function of computing is similar to the function of the human brain, as it is responsible for complex calculations, data analysis and pattern recognition, and it also provides remote monitoring, control and observations. The link between the different components of a smart city appears within an integrated framework, and the most important components of smart green zones are that smart spaces are integrated through the integration of cities and through three levels, which are (activities based on knowledge, problem-solving institutions, and digital communications infrastructure), (the researcher (and the factors that achieve smart green zones are involved in the Table 1, (Elshamy, 2019, pp. 115-117).

Table 1.
Characteristics of smart green urban spaces/ Researcher based on Elshamy.

Smart life quality (living)	**Smart Economy**	**Smart mobility**
- Good life quality in various social aspects (education, health care, public safety, and housing). - Obtaining good-health care services quality (including e-health or remote health monitoring, and electronic health record management) - Smart electronic homes, and smart services - Facilitating access to all social services electronically.	-Spirit of initiative and innovation -Great levels of productivity -Broadband networks available to all citizens and companies to support business opportunities -Freedom to choose the location, and the possibility of benefiting the population in rural areas -Electronic business operations (electronic banking services, electronic shopping, electronic tenders	- Accessibility - Safe transportation - Innovative technologies - More efficient and intelligent transportation systems - Effective utilize of mobility networks in the movement of vehicles, people and goods, to decrease traffic congestion - New social pattern: such as car sharing, diversity between car and bike use
Smart environment	Smart people (society)	Smart management
-Continuous monitoring of pollution -Utilizing sustainable technologies - Ability to benefit from smart ICT-based services -Environmentally friendly and sustainable energy usage -Decreasing energy usage through technological innovations while promoting energy conservation and reutilize of materials	- Social and human capital - Qualified, creative and educated citizens - Ability to benefit from smart ICT-based services - Providing a more consistent educational experience in both urban and rural areas	-Decision making -Social and public services -Transparency -Democratic processes and inclusion -Linking government organizations and administrations. -Enhancing community access to services

A unique feature of cities and a vital component of building culture are urban green areas. Consensus among experts is that green areas raise city appeal and enhance quality of living. Design

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of big, medium, and small cities depends on knowledge from green areas. For a sustainable city, they also perform many purposes. Integrated and sustainable urban development seeks to enhance integrated ecosystems and provide a spectrum of environmental services so that people could profit from them (Addas, 2023, p. 4).

2.2. Smart Urban Management (SUM)

2.2.1. The concept of Smart Urban Management (SUM):

Effective management of UGSs involves the utilization of data and technology to regulate and maintain metropolitan greenery. This policy aims to increase the accessibility of green zones and enhance their quality, consequently enhancing the environment and the well-being of urban residents (2021, Al-Khafaj, Hasan). Environmental management is a crucial concept involving the implementation of environmental principles and methodologies to regulate resources and promote sustainability. This encompasses sustainable landscaping, water conservation, and integrated pest management, which may decrease the environmental effect of UGSs while enhancing their accessibility and quality (Huang, 2021, p. 2). Intelligent urban planning of green zones aims to enhance the life quality in urban areas and provide sustainable, healthy environments for residents. Proper controls and determinants will facilitate the effective and sustainable achievement of these goals. The effective execution of intelligent urban green zones management (GSMs) relies on local needs and specifications; hence, it must be adaptive and flexible to ensure the achievement of long-term goals (Mohandu, A., & Kubendiran, M.). SUM Standards are explicit principles and criteria designed to facilitate the efficient execution of SUM techniques in cities globally (Sikora). The formulation of SUM standards is a collaborative endeavor with several stakeholders, including governmental bodies, industry representatives, academic institutions, and civil society. These guidelines are intended to be flexible and adaptable, allowing communities to modify their strategies for SUM according to their unique requirements and goals. Table 2 (Wang, 2022, pp. 417-429) presents the primary indicators for each criterion delineated in the literature study pertaining to SUM of green areas:

Table 2.

Criteria	Key indicators
Energy efficacy	• Utilizing renewable energy sources • Optimizing energy usage. • Energy-saving lighting and equipment
water conservation	• Smart irrigation system • Water Saving Fittings • Rainwater harvesting
Biodiversity	• Selection of native plant species • Providing habitats for wildlife • Eco-corridors for wildlife movement
Accessibility	• Provide safe and easily accessible corridors and entrances • Involves people with disabilities or limited mobility • Accessible amenities such as benches, bathrooms, water fountains and drinking sources
Data traffic	• Utilizing data analytics for maintenance and management • Decision making for management • Predictive analytics for maintenance and management Real-time monitoring of green zones
Skilled workers	• Skilled individuals and cadres are qualified for data analysis and decision

Edelweiss Applied Science and Technology
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	• Making trained cadres to operate and maintain technology and systems
Privacy and data	Compliance with data security regulations
Data security	• Transparent data collection and management • Secure data storage and management • Protect personal information

2.2.2. Urban Management Strategies for Smart Green Zones

Intelligent green zones formulate their strategy by utilizing information and communication technology across several domains, including economics, environment, mobility, and governance, to convert infrastructure into smart infrastructure, therefore mitigating adverse environmental impacts. The essential strategies are:

1- Smart Management: Smart management denotes the evolution of urban administration through artificial intelligence, emphasizing the establishment of a novel urban management framework via the utilization of advanced information technologies, including mobile technology, the Internet, and computing, wherein secure, resilient, and sustainable cities are pivotal and essential. Management is characterized as the process of creating and sustaining an environment conducive to individuals, encompassing five administrative functions: planning, organizing, recruiting, commanding, and controlling. Diverse stakeholders from various urban organizations and disciplines—such as urban planning, architecture, engineering, geography, sociology, economics, and finance—must collaborate at all levels of the system to effectively address urban challenges and repercussions (Wang, 2022).

2- Economic development strategy: The objective is to bolster the economic growth of nations through the execution of various development plans, advancing societal progress by employing a series of effective economic strategies. Societies endeavor to augment their economic capacity to leverage the wealth present in their surroundings, particularly in regions plagued by a lack of economic diversity that adversely impacts the local environment overall. Economic development fosters the advancement of sectors that promote economic growth, including education, healthcare, and the workplace environment, among others. It is a technological economic measure aimed at transitioning from one economic state to another to enhance its condition, such as shifting from an agrarian economy to an industrial one, or from a commercial economy to a technology-driven commercial economy (Farraj,2022).

3- Urban design strategies: It involves the utilize of comprehensive urban development plans that are concerned with housing, transportation, infrastructure and public services and by focusing on sustainable development goals, and aims to create a sustainable urban environment in line with the needs of the population and involves several elements (sustainable planning, transport-oriented development, diversity of uses and spaces, flexible and adaptable design, community participation, and the application of this strategy creates environmentally friendly city spaces (Haytham, 2024). We conclude that the introduction of green zones within urban designs and plans can provide parks in contemporary and new cities in the future and encourage developers to establish green zones within residential and commercial complexes. Moreover, the utilize of sustainable design techniques from planting roofs and pavements.

4-Water management strategy: urban water management is one of the vital elements that achieve sustainable development and involves important principles that enhance water management through distribution, conservation, management and use, and involves the development of plans and management of water resources through regular periodic evaluation of groundwater and surface water, and modern technologies such as sensor techniques and systems (GIS) can be used and the development of emergency plans that involve acute water shortage, pollution, and how to provide it correctly and safely, as well as monitoring and controlling water distribution through smart control systems, which Decreases water scarcity and relies on water reuse, treatment and recycling for utilize in irrigation and agriculture through awareness, education and training programs

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5- Electricity and communications strategy: involves many aspects aimed at meeting the needs of the population, through integrated planning for the development and renewal of energy and communication infrastructures and through the utilize of technology to enhance the efficacy of electrical energy and its distribution to achieve balance in demand and supply, including sensors, energy management Solutions and new control systems, and by providing a means of communication, 5G networks and the Internet of Things (IOT), enhancing their efficacy, and encouraging reliance on solar, wind and hydro energy sources to decrease carbon emissions. (Al-Hiti, Al-Dulaimi, 2018, 165).

6- Transport strategy: It is to develop plans to enhance the efficacy of transport systems by developing transport systems from buses, vehicles and bicycles, encouraging the utilize of public transport, developing mobility paths for pedestrians and bicycles, decreasing dependence on cars, applying speed decreastion policies and utilizing plates to identify the road, and through the utilize of smart systems and smart control to decrease congestion and encourage the utilize of electric vehicles to decrease carbon emissions, establish electric charging stations and decrease the utilize of private cars. (Al Ahbabi, 2011, 12)

7- Housing Strategy: It aims to provide the population's housing needs in a sustainable manner by developing studies and analyses based on demographic, economic and social data through establishing projects in a balanced manner with the environment and with fair distribution without affecting public spaces and developing plans that involve the utilize of green construction by relying on environmentally friendly materials and providing financial support to specific groups to achieve integrated housing that meets the needs of society and enhances the life quality in contemporary cities. (Al-Khafaji, 2015).

8- Heritage preservation strategy: It is an important part of urban management and involves the restoration and protection of spaces and buildings that enhance the city's identity and thus enhance tourism and contribute to enhancing the economic level through inventorying public places that have historical value and documenting them digitally through photography and 3D scanning and relying on the iInclusion of laws and legislation and imposing penalties on violators. However, providing funding and government budgets through building investment projects without paying attention to the city's spaces was due to the lack of organizing awareness campaigns for people. It is preferable to utilize the promotion of spaces in order to enhance the city's cultural tourism and organize events and exhibitions in public spaces to enhance people's awareness and attract their attention to the identity of their city (Al-Ahbabi, 2011, 15). We find that the transformation of unused and neglected urban areas into green zones and parks can achieve an increase in green zones.

9- Solid waste strategies: It is a strategy that aims to manage solid waste and involves decreasing its production, then recycling it, utilizing it in a beneficial way, and disposing of it in ways that do not affect spaces, and through biological or chemical decomposition of waste or burning it in environmentally friendly ways that decrease emissions and toxic gases to decrease the negative environmental Impact (Mustafa, 2016).

10- Sanitation strategies: These are measures aimed at treating water by collecting it and directing it to discharge points and drainage networks to decrease water pollution and the spread of waterborne diseases, through primary treatments, then cleaning and recycling it for irrigation and industrial purposes to decrease the demand for new water resources (Al-Hiti, Al-Dulaimi,2018,162).

11- Learning and awareness-raising strategy: It focuses on spreading concepts and educating the individual by achieving purposeful guidance for the information he acquires or understands to activate the feature of participation between society and management and the exchange of opinions and ideas contributes to increasing the level of awareness and interaction with city spaces in a better way. (Al-Ahbabi, 2011, 10) Encouraging communities to participate in agriculture, maintenance and sustainability within volunteer programs.

12- Health and Environment Strategy: It aims to achieve a balance between the health of individuals and the environment in order to decrease pollution, provide potable water, encourage walking, utilize renewable energy sources such as the sun and wind, and manage waste in a way that contributes to enhancing public health and achieving a suitable environment for present and future

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generations. (Haytham, 2024, 1108), Preserving and protecting the environment, avoiding its conversion or development into residential and commercial areas, are crucial. As for SUM strategies and their relationship with green zones, they rely on these strategies, utilizing technology, sensors, and data analysis to sustainably monitor air, soil, water quality, and land distribution and usage through GIS. Additionally, artificial intelligence is used to analyze environmental patterns and identify the best proposals for enhancing and developing green zones. Furthermore, employing smart incentive techniques such as tax exemptions and digital rewards is essential.

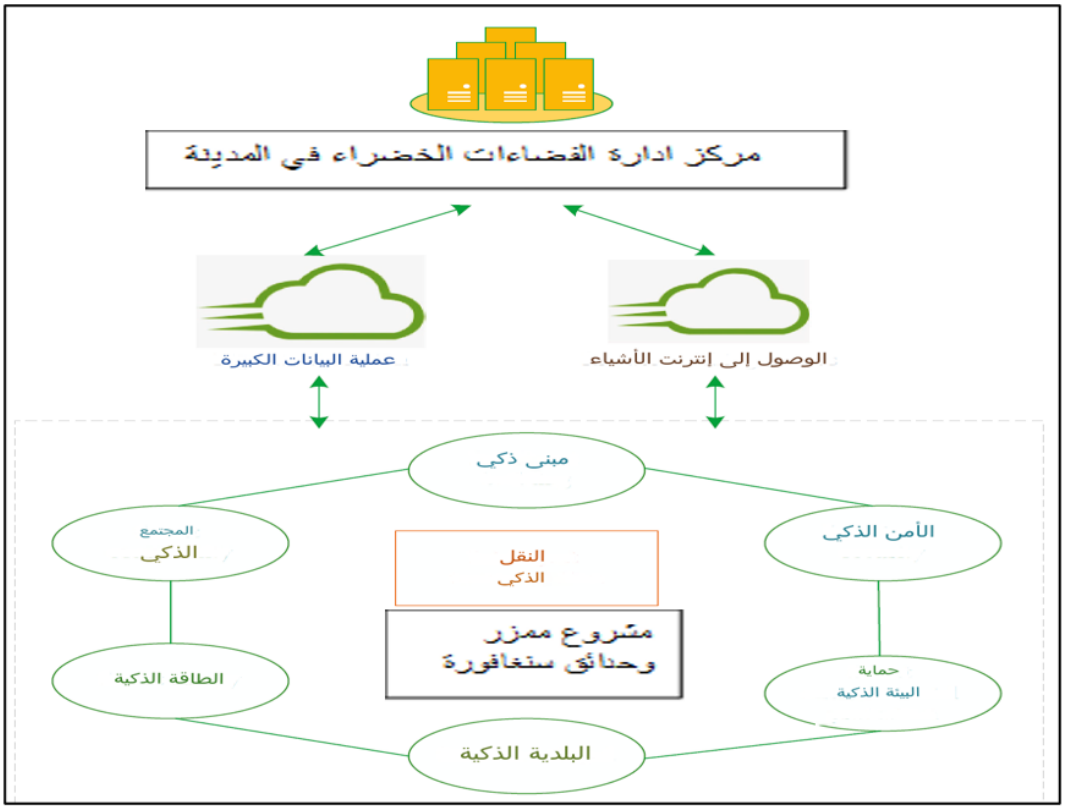

Figure 1.
Activation of technology in managing urban spaces resources (Juan, 2021, p. 3)

2.2.3. Challenges And Solutions Facing the Management of Smart Green Zones

The execution of intelligent GSM poses challenges for urban areas owing to several considerations. The issues encountered by cities in Table (3) involve the following (Rachmawati, 2019) The Internet of Things (IoT) and contemporary technologies may be amalgamated to create an extensive smart landscape. The database may adeptly link individuals with the natural environment, facilitating reciprocal induction, comprehension, and connection between humanity and nature (Juan, 2021, 4).

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ISSN: 2576-8484
Vol. 8, No. 6: 4825-4840, 2024
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Table 3.
Challenges and solutions for managing green zones - sources in the table.

The challenge	Facing the challenge and the solution
Limited materials	Implementing intelligent GSM necessitates substantial expenditures in technology and infrastructure, posing a challenge for communities with constrained financial resources (Economic aspect).
Technical Expertise	Effective GSMs necessitates technical proficiency in data analysis and sensor technologies, equipping personnel with the requisite skills and knowledge for successful system implementation.
Data Management	Cities must invest in management systems and software for effectively utilizing the data generated by sensors and monitoring and evaluation systems (Masik, 2021)
Privacy & Security	The deployment of sensors and related technologies for the GSMs engenders privacy and security apprehensions, since the data gathered from these systems may involve personal information. Cities must guarantee that systems are constructed to safeguard privacy and security (Q. Liu et al., 2020)
Community Engagement	Effective GSMs requires community engagement. Cities may have difficulties in engaging with communities to address their needs and viewpoints in planning and decision-making.
Maintenance & Sustainability	Effective GSMs requires ongoing maintenance to ensure systems remain functional over time. Cities have to prioritize the long-term sustainability of GSM systems and guarantee their resilience to technological and environmental changes (Afriani, 2022).

The design and implementation of smart green zones reflect a superior life quality, characterized by a car-free, resource-efficient, energy-conserving, and aesthetically pleasing environment. Smart spaces need to maintain minimal distances between facilities to facilitate essential existential tasks inside a single region, including habitation, employment, leisure, resource provision, waste management, education, communal living, and transportation participation. Intelligent green zones provide a significant function as areas devoid of consumerism. (Addas, 2023, p. 13).

3. Case Studies and Examples

There are examples that apply SUM to green zones, including:

3.1. SUM of Al Mamzar Park in the United Arab Emirates

It is the first smart park in Dubai, with an area of 106 hectares on the golden sands of Dubai and five extended beaches open to the public. The park has three entrances, two for pedestrians and one for cars. This park is located only five kilometers from the Hamriya Port turnoff, and connects the natural environment with artificial intelligence technologies, and by adopting a package of different smart services, it provides entertainment, safety and security so that technology and smart services become part of the daily life of everyone in society. The park seeks to advance multiple domains and must align with global technological advancements by consolidating efforts and embracing innovations that will enhance strategies for delivering superior quality standards in public services to ensure citizen satisfaction and comfort (Al-Sabai, 2021).

The park combines sandy beaches, green zones, recreational areas, and sports areas, providing a variety of activities for residents and visitors. The park involves shaded areas with large umbrellas and areas designated for barbecues and family picnics. Among the most prominent smart services are smart rescue services, swimming sprinklers, seating and umbrellas, and children's play services. The park provides a chalet rental service that contains 15 units, in addition to the utilize of smart chairs that operate on solar energy, smart gates, smart containers, virtual learning and smart containers

(https_dubaiofw.com), Smart seats can recharge your phones, supported by Wi-Fi 4 technology, USB ports, digital clocks that give the hour and day, provide weather information, as well as LED lighting, solar-powered shades that produce drinking water, and a mobile app to book event areas! All of this can be found in Al Mamzar Park, and the site is aesthetically pleasing, with over 55,000 square meters of green zones, 300 coconut trees, 1,500 palm trees and many types of green zones planted, These landscapes look lively and lush, and the "virtual world VR" service was applied through the virtual environment feature on the recreational and educational tracks, and it was applied during the simulation experience to grow vegetables, trees and fruits, and irrigation by answering several questions in an interesting and fun way. Due to climate change, great temps and great humidity, green zones need ways to enhance air quality, so the utilize of the virtual world by painting the floors of walkways and roads with (smart paint) works to purify the air. (travelplandubai.com) Figure 2.

The smart oasis in Al Mamzar Park operates on solar energy, provides a shaded area, and is equipped with a system that converts atmospheric humidity into fresh water for drinking and other purposes, as it is environmentally friendly. 90 liters of potable water are produced daily, and the oasis provides a charging source for smartphones, and a cooling system for seating areas utilizing mist technology. The oasis is characterized by vertical farming and relies on filtered moisture water for irrigation. The garden uses drones as a smart surveillance service to decrease or monitor thefts, crimes, or drowning cases and communicate with the person by voice until the rescue teams or police arrive. It is called the smart rescuer service of devices and equipment. The smart scanner monitors the plants and trees in the entire garden and keeps them under control by drawing thermal maps, analyzing aerial images, and carbon emissions quotas. (Al-Sabai, 2021).

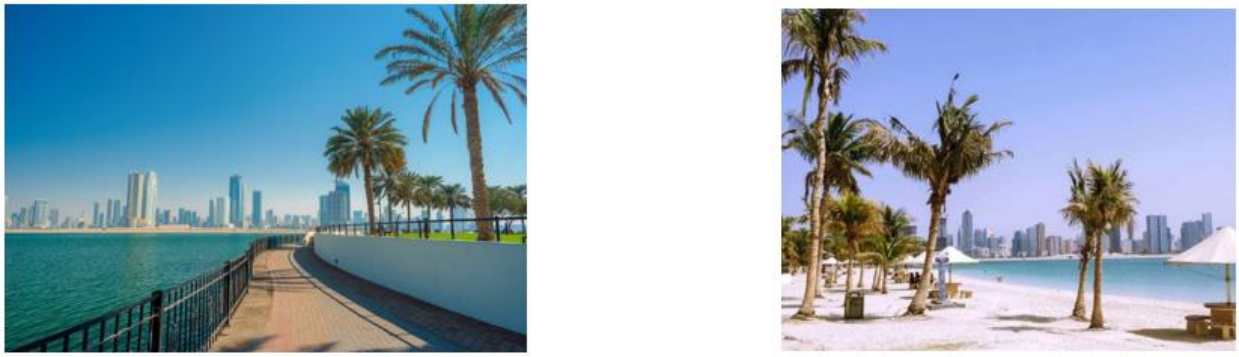

Figure 2.
Smart paint.

The Smart Band tracking app, which comes with GPS, can be used so you can track young children. As for waste, it is recycled through applications that adopt and send alerts when it is time to remove or collect and sort garbage, it is a smart park in the world that has its own mobile application and the Al Mamzar Park application can be downloaded for free on Google Play and provides information about the park and its facilities. You can utilize it to book a chalet, event space or sports area. It also provides a virtual tour of the entire park (https_dubaiofw.com) and we conclude this in Table (4):

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 8, No. 6: 4825-4840, 2024
DOI: 10.55214/25768484.v8i6.3047

Table 4.
SUM of the park (travelplandubai.com).

Factor	The idea	Factor	The idea
Biodiversity	Various local plants are available that are suitable for the desert environment.	Green space design	Linking the natural environment with technology to serve humanity
Irrigation	Smart systems that utilize sensors to monitor air and soil humidity and drip irrigation	Space of spaces	Playgrounds, restaurants, chalets, beaches and shaded areas
Lighting	Providing light intensity sensors based on natural lighting and movement to save energy	Water	Recycling and rationalization of usage for irrigation and drinking to preserve natural resources
Organic farming	Utilize vertical planting on walls and facades Natural and organic fertilizers to preserve the soil	Security and safety	Monitoring air quality, pollution and climate variability -Drone surveillance
Education and culture	The park offers educational lectures to maintain awareness for visitors.	Social interaction	Sports and recreational activities and events, swimming Utilizing applications to communicate between place and person
Waste	Collect, sort and recycle	Movement	Design of paths and walkways for moving and transportation as well as bicycles and desert buggies for recreation

3.2. SUM in Gardens by the Bay in Singapore

The master plan by Grant Associates developed the gardens via the combination of nature and technology, utilizing environmental management and a holistic approach to mitigate urban heating islands, enhance air and water quality, and augment biodiversity in the city. Central efforts in this strategy involve the establishment of public green zones, parks, and natural areas, the utilize of advanced irrigation technology and organic fertilization, as well as the enhancement of air quality via the installation of air filtration systems along roadways and buildings. Singapore exemplifies the utilize of intelligent urban management to save the environment and enhance urban living standards. Q. Liu, 2020, p. 360 This encompasses the novel utilize of advanced technology in urban planning and natural resource management, including solar energy, vertical wells, compact desalination facilities, and water mist systems as alternatives to air conditioning. Singapore's smart city incorporates a comprehensive strategy for environmental conservation, encompassing the design of green zones, parks, and gardens; the implementation of advanced irrigation and organic fertilization methods; the natural management of diseases and pests; the augmentation of biodiversity; and the enhancement of air and water quality within the city. (Chang 2020, 425–440).

The city of Singapore ranks sixth in the classification of cities in terms of environment through the classification of green areas and in 2013 Singapore celebrated the fiftieth anniversary of the greening of Singapore and Singapore focused in the design of green zones on the following: (Participation of communities in creating a greener Singapore, enhancing the competencies of the landscape and

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ISSN: 2576-8484
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horticultural industry, preserving biodiversity in the urban environment, creating world-class and smart gardens, enhancing and renovating urban spaces and paying attention to the roads leading to them, Gardens by the Bay is one of the largest garden projects of its kind in the world. Eventually, the site will total 101 hectares comprising three distinct parks – Bay South, East Bay and Bay Central. (Chang 2020, 425–440) Located on reclaimed land in the center of Singapore's new city at Marina Bay, the site will provide a unique entertainment destination for local and international visitors. Smart parks provide a pleasant and easily accessible approach for individuals to be active and involved with their community, with amenities like walking and cycling trails, outdoor workout equipment, sports grounds, The capacity of smart parks to support sustainability and conservation adds even another benefit. Smart parks may create their own energy and lessen their dependency on conventional energy sources by including renewable energy sources as solar panels and wind towers. Smart gardens may also save water usage and waste by utilizing sophisticated irrigation systems and water management technology. Smart gardens are, all things considered, a significant advancement in the development of urban green areas. These gardens provide many advantages to the surroundings as well as the people they assist by including cutting-edge architectural ideas and sophisticated technology. As shown in Figure 3, smart parks will become more and more significant in determining the urban environment and advancing a sustainable and healthy future for everybody as cities keep expanding and developing (Park, 2019, 115–135).

There are eleven trees in the gardens, some of which contain photovoltaic cells on their umbrellas to store solar energy, and the gardens have a smart environmental infrastructure, and with the help of smart solutions, a suitable climate is created in the glass roofed areas for the cultivation of plant species, and it also provides entertainment and education to users. In the gardens, there are sensors and stations to monitor environmental parameters important for vegetation growth, as well as those for plant monitoring and irrigation, which are also installed in the garden. A central dashboard displays data related to irrigation monitoring, lake management and visitor management. They utilize automated vehicles that spray fertilizers and pesticides, which decreases people's physical labor and costs. As in Figure (4) (Chang 2020, 425–440).

Sensors monitor pollutants in the lake, which can destroy the ecosystem. The application of smart lighting, lighting management and garden cleaning is particularly important. With the help of sensors, the lights are automatically turned on, and the stunning architectural structures are combined with a variety of horticultural displays, daily light and sound shows, lakes, forests, event spaces and a range of dining and retail offerings. The entire plan features smart ecological infrastructure, allowing endangered plants that cannot normally grow in Singapore to flourish, providing entertainment and education. (Q. Liu 2020, p360).

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Figure 3.
Gardens by the Bay / Grant associates (Park, 2019, 115-135).

Figure 4.
Gulf Gardens: (a) Super trees; (b) flower Dome.

Figure 5.
Shows the integration of nature and technology in the Gardens by the Bay / Grant Associates project.

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DOI: 10.55214/25768484.v8i6.3047

The urban management in Singapore has used several strategic guidelines to increase green zones and manage them intelligently, which can be summarized as follows:

- Protect the city's biodiversity.
- Consider biodiversity issues in policy and decision-making and enhance knowledge of the biological and natural diversity of city dwellers.
- Promote education and public awareness of the conservation of green areas
- Enactment of Tree Act and Legislation، to provide for the planting and maintenance of trees and plants within national parks and nature reserves. Moreover, planting of trees along roadsides, parks and nature reserves.
- Conservation, protection and propagation of trees، plants، animals and other organisms in Singapore.
- Recreational and educational utilize by the public as shown in Figure 5.

4. Comparing the Two Case Studies According to the Components of Green Zones, Their Characteristics and Management Methods, in Table 5 Analysis of Two Case Studies According to the Components of the Spaces and the Method of Applying Management in Them

Table 5.
Results of the analysis of the study cases / the researcher's conclusion from extracting the study case review.

The standard	Case Study 1 : Dubai City	Case Study 2: Singapore
Energy efficacy	Uses solar powered irrigation lighting and energy saving LED lighting.	Utilize solar panels to generate power or energy-saving LED lighting.
Water conservation	Automated and intelligent irrigation systems, sensor-based monitoring of soil moisture levels, remote monitoring and controlling irrigation systems	Rainwater harvesting system
Biodiversity	Selecting native plant species for public parks and other green areas, nature reserves, and providing the necessary spaces for wild animals and plants.	Large-scale vertical gardens
Accessibility	Accessible passageways and entrances, for people with special needs or limited mobility	Inclusive design for people with special needs or limited mobility
decision making	Predictive maintenance analytics	Optimization and maintenance planning
Securing data storage and management	Personal information protection	Personal information protection
Skilled individuals	Trained staff to operate technology	Skilled data analysis personnel and qualified personnel for maintenance and decision-making
Privacy and data	Data Collection Transparency	Data Security and Protection Compliance Management and Regulations

The study indicates that both studies involve many criteria for the SUM of green areas. These case studies demonstrate the prospective advantages of utilizing SUM methods for green areas.

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 8, No. 6: 4825-4840, 2024
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5. Discussion and Conclusion

One of the most essential issues with which cities should give careful thought is enhancing their green areas. Implementing SUM techniques presents difficulties like great costs, insufficient data and knowledge, and possible stakeholder opposition that should be understood. Still, the advantages of wise urban design of green areas exceed these difficulties. They promote economic development and innovation, help to lower resource utilize and waste creation, therefore enhancing the standard of living for the people. By means of smart urban design, enhancing green areas in cities helps to enhance air quality and offers chances for leisure and exercise, therefore enhancing the life quality for the people living in such areas. One way smart green cities could support sustainable urban growth is via Cities may lower their environmental impact and support a more sustainable and resilient urban environment by managing natural resources sensibly and utilizing sustainable landscaping techniques. Consequently, we should concentrate on raising awareness of the factors and guidelines of smart urban development as well as their effect on urban green areas. Development of smart solutions to enhance green areas in cities depends on support of research and technology. When utilizing SUM plans, we have to consider the difficulties related to this method and solve them responsibly and sustainably.

6. Recommendations

Smart urban design may help to enhance green areas in cities by means of the following suggestions:

- Strengthening research and development in SUM; understanding of the determinants and standards of SUM and its effect on UGSs should be increased. Technology and research may assist in creating clever ideas to enhance metropolitan green areas.
- To better manage green areas in cities, collaboration among many players including government institutions, businesses, civil society and citizens should be reinforced. Cooperation ought to involve the sharing of knowledge, experience, data and technology as well as the provision of the required people and financial resources.
- Utilizing the information at hand to monitor environmental conditions and control resources like water can help enhance the quality of the green areas in cities. Natural plant and tree growth may be encouraged by cities, therefore enhancing air quality and offering other environmental advantages.
- Modern and sophisticated technologies should be utilized for the GSMs in cities to raise their management efficacy and thereby enhance the life quality for the citizens. Technology may be utilized to track environmental conditions, control resources, examine data, and create smart apps to assist in the GSMs in metropolitan areas.

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ISSN: 2576-8484
Vol. 8, No. 6: 4825-4840, 2024
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Edelweiss Applied Science and Technology
ISSN: 2576-8484
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