MSA UNIVERSITY ENGINEERING JOURNAL

The impact of smart technologies on the design of public parks

[1]Ahmed Nabil Ashry Elnahas, [2]Mohsen Aziz Botros

[1]Phd Candidate at department of Architecture, Faculty of Engineering at Shoubra, Benha University, E-mail: ahmeddashrry@gmail.com
[2]Professor at department of Architecture, Faculty of Engineering at Shoubra, Benha University, E-mail: drmohsenaziz@yahoo.com

Abstract

Smart technology is one of the most important elements of development in all areas of life and the basic pillar of quality of life. The study aimed to monitor the impact of the use of smart technologies on the design of public parks. The analytical descriptive approach was followed by analyzing the effects of using smart technologies in public parks as the most important element in the urbanization system, as it works to improve the environment, health and safety and helps to psychological stability of the human being, thus confirming the quality of life. The research was also able to analyze the pros and cons of using smart technologies by analyzing six main elements represented in the landscape, irrigation, furniture, urban facilities, activity spaces, lighting and digital technologies.

The research concluded that the use of smart technologies is an inevitable necessity and represents a positive element. The research also concluded to identify the points that have a positive impact and represented a percentage of 82%.

Keywords: Smart Technologies, Public Parks, Design and Urbanization System, Quality of life.

1. Introduction

Smart technology is one of the most important elements of development in all areas of life and the basic pillar of quality of life in an era that is devastated by all that is traditional, so that these technologies almost control the life of the individual, society and even the world with its impact in exchange for smart performance that emphasizes the automation of everything, and there is no doubt that the urban environment, including its Societal, economic, environmental, logistical, living, legal, administrative, political and life activities of individuals have been greatly affected by these smart technologies, but have become inevitable to improve the quality of life. These smart technologies greatly affect the provision of the most vital sources of energy and water.

Research problem

The research problem lies in the lack of a mechanism to monitor the positive and negative effects of using smart technologies such as scanning devices and electronic control methods necessary to build an information base, robots, the accompanying electronic interactive activities, and internet networks and other smart water-saving technologies such as smart irrigation and adapting to weather and conditions, climate and soil sensors, as well as smart energy-saving technologies, the use of clean and renewable energy, in addition to automated mechanization, saving effort, time and cost.

Objective

The research aimed to Monitoring the impact of using smart technologies on the design of public parks.

Methodology

The research follows the descriptive approach to determine the nature and methods of smart technologies. The research then moves to the deductive approach to elicit effects through comparative analysis of local, regional and global models of traditional and smart parks that use or not use smart technologies and identify the negatives and positives related to smart technologies to determine its affection towards the design of public parks.

2. The role of public parks in the urban fabric

Cities are becoming more creative and innovative, thanks to urban public parks, and cities today are more congested and polluted than ever before. For all so it is not surprising that cities are seeking innovation and creativity in planting not only urban public parks but also gardens that are emerging on the rooftops of

buildings and suspended on skyscrapers, to the hanging gardens designed above railway tracks and pushing towards the emergence of greener cities. This confirms the importance of establishing and activating public parks in the urban fabric, which requires the allocation of green spaces commensurate with the increasing number of residents, because of their role in achieving ecological balance [1].

The role of parks in the urban and urban fabric can be clarified through several concepts that justify the importance of allocation. These concepts constitute the integrated ecological complex of any park, and the role of any of its components cannot be underestimated. These concepts can be identified in four concepts (geographical, environmental, economic, and social planning), as follows:

2.1. Geographical concept

This concept is concerned with the geographical determination of the locations and places of distribution of land uses in the city, including public parks, their functions, and the size and quality of the beneficiaries. Given that the parks meet some social services, hence, the fulfillment of this social service part of the public services that individuals cannot provide themselves with. Since the provision of public services is a basic requirement for the development of modern societies, those are typically the responsibilities of governments, such as education, health, roads, but there are other types of services such as housing, public transport, public parks, and public libraries. Those are basic needs provided by the countries to their societies according to their ability, while other countries are limited to providing them to only limited areas that need them more urgently than others.

The state's intervention in the provision of public services is very important to improve the quality of life, especially in enacting its own legislation and regulations, whether these services are provided by the state or the private sector. Governments' aim from this is to ensure that the levels of services provided fall within the national goals that must be achieved and that they are provided to all residents with the required specifications.
Therefore, the lack or absence of these urban services (public parks) means an imbalance in the installation of infrastructure first. Secondly, there are problems associated with the implementation of development plans, Last but not least, the insufficiency of urban services leads to a slowdown in the process of economic development and the consequent lack of job opportunities against the numbers of people growing [1].

The mere presence of overcrowded cities does not mean urbanization, but there should be a balance between indicators and components of urbanization functions and stages of development. When the urban literature confirms the strong and positive relationship between urbanization and most of the criteria used in measuring development -such as consistency in the distribution of land use and the

presence of recreational services such as public parks- the establishment of parks as public facilities is included in urban planning is an essential element within any new urban plan to finally strike a balance between the elements of urban design [2].

2.2. The concept of sustainable environmental protection

Parks are one of the elements of urban infrastructure, as they are the outlet that is equivalent to the rest of the city's components of residential buildings, industrial areas, central markets, streets and squares. Thus, they perform a range of functions, including the recreational function, the function of maintaining environmental balance, the health function, the cultural and social function and the scientific function.

It is known that the limited green spaces and crowding in some cities and villages is so random that people suffer from a high rate of pollution to the point that life in those areas becomes seriously threatened. This situation is almost completely changed by the presence of green areas and water, where water bodies absorb the temperature and store it in an image latent energy used during its evaporation, and this makes the energy balance positive and the air temperature moderate. As for the role of vegetation and green spaces, it enriches the city's air with the element of oxygen necessary for the health of living organisms, and robs it of carbon dioxide for use in its photosynthesis.

In other words, a person (one person) needs (12 m3) of air per day and requires a green surface of (150 m2) to replace the oxygen consumed by living organisms and the various combustion processes. Also, cities with less green spaces have a percentage of the concentration of sulfur oxide in the air is higher than in those with large green areas.
Therefore, in order to limit the exacerbation of the phenomenon of pollution in its various forms, several preventive measures should be taken like the creation of large green spaces within cities as well as green belts surrounding cities in order to preserve the urban environment [3]. For example, the capita share of gardens in the city of Cairo is 0.75 square meters, and in Makkah Al-Mukarramah the per capita share of green spaces (public gardens) is more than (5 square meters), which is a good area judging by the conditions of the natural environment in Makkah Al-Mukarramah. The capita share of green spaces in the city of Baghdad does not exceed (0.49^{m2}/person), which is a very small ratio in comparison with other global cities such as Britain (23^{m2}/person), the former Soviet Union (46^{m2} / person) and Australia (162^{m2} /person) in the largest city "Sydney") [2].

In addition to seeking a plan and allocate green spaces, it should also strive to reduce pollution and negative environmental effects. Most environmental economists accuse the private sector of being the biggest abuser of the

environment. Would the profit motive tend to blind the eyes off the pollution, deterioration and imbalance their processes cause to the environment? This is only true if the matter is left to the people, yet the government should intervene to force the private sector to pay the costs of the environmental effects it causes, keeping in mind that some of these effects will become optimal.

The spread of green parks and the preservation of a clean environment in urban and rural areas enhances the goal of urbanization. This goal may vary from sustainability, construction, investment, to the generation of benefits from land, money and offspring. Security and social needs, the most important of which are the affirmation of belonging to the group and participating in its activities, the need for self-realization, and the need for knowledge and understanding. Development was also considered to be a series of sustainable and gradual interaction that takes place through the gradual exploitation of nature in quantity and quality, counting time and space as the basic wealth [1].

2.3. Economic concept

A park that is located in a large land comes with a high cost. If it is in a sensitive strategic location within the city, this sensitive location is exactly what gives the park its important role in recreation within a crowded environment witnessing a high population density. Thus, the municipalities must sacrifice and provide this service to the citizens.
One of the main concerns of economics is the trade-off between alternative uses of finite natural resources as society is constantly faced with different choices. Economists try to help decision makers, who must choose alternatives, by objective comparison of the public's evaluation of various services. Economists who are accustomed to comparing advantages and benefits in various investments during the past ten to fifteen years have increased the interest towards the cellular recreation [3].

Attempts to set monetary values against the benefits of recreation are controversial and opposed on the basis of three main factors:

- Critical evaluation is not appropriate due to the subjective criterion of the entertainment experience.

- Recreation may cause significant secondary benefits that the person himself may not realize in the context of his desire to pay the costs of these facilities.

- There is an argument that recreation is a required feature, just like education, which should be made available free of charge to all citizens, and this part comes as some kind of a social policy.

The presence of large parks within urban plans enhances the economy of service sites and urban functions of all kinds and levels, because of their attractive effect and a sense of balanced spatial development. As the severe population concentration, high land prices, and traffic congestion, destroying the attractive force to urban centers. Metropolitanism, the emergence of urban structures in the suburbs, and the shift to a policy of decentralization to achieve spatial balancing of economic development.

What was mentioned in both the schematic geographical concept and the environmental concept is sufficient to explain the importance of establishing parks. Also, stated that the opportunity is available to the private sector to meet the vital community need for parks through any of the available allocation methods [4].

In urban economies, infrastructure in cities represents the engine, if not the wheels, of economic activity. Many studies are trying to find a link between the total expenditure on infrastructure and the growth in the gross domestic product, which reflects the total return.

2.4. Social Concept

The importance of the parks can be summarized in representing public places where many social and cultural activities can be practiced. The effect of privatization is that these facilities will provide activities to special segments of society due to their class, as well as providing special cultural and social activities, considering the identity of the investor, unless they are taken into account. The sensitivity of the internal ethnic, religious and political conditions, also the standard of living of most segments of society during the formulation of privatization contracts should be taken into consideration. Although the welfare state promotes the equal right of citizens to obtain public services and the minimum level of a decent life, yet privatization in some forms entrusts this to the welfare of private capitalism [3].

Recreational activities are imprinted in the imaginations of millions of residents who prepare to spend their vacations in certain parks and resorts because of their reputation for providing services at an appropriate level. The primary desired benefits of recreation are shrouded in varying subjective considerations and, therefore, are not necessarily subject to material standards.

Public parks should be a stage for the activity of social bodies that provide scientific, cultural, sports or civilized services to the community. Examples of these bodies are universities, scientific societies, professional syndicates, sports clubs, antiquities and civil tourism bodies. In order to ensure their continued development within the prevailing political and social system, it is expected that these social bodies will establish buildings for various cultural events such as theaters, museums, public libraries, conference centers, meeting and event halls. This proposal falls within the principle of doubling the use of land, which is a well-known principle in urban economics.

3. Types of parks

Public gardens and parks differ in terms of area, elements and design style. They are mainly categorized according to the functions performed by the park and the categories of its users. Therefore, Public Parks are classified into several types, the most prominent of which are Residential Neighborhood Parks. As for the rest of the Public Parks, the types are divided into the following [3].

3.1. Residential Park

The residential neighborhood park is designed to meet the recreational needs of all ages in one residential neighborhood in general and for children of primary school age in particular. Its location is next to a primary school so that school's children can use it.

3.2. City Park

This park is at the city level and large areas are allocated to it. The visitor finds complete freedom in it to roam its landscapes. People spend the day in groups in this type of garden, so it must have all the comfort factors such as places to sit, drinks and various means of entertainment.

3.3. National Park

This type of park, outside the city's cordon, is characterized by its large area and the availability of many services, in addition to the wide area of green areas and the diversity of trees, shrubs and flowers. You'll also find places for sitting and rest, places for children's games and some other entertainment means such as restaurants, cafeterias and others.

3.4. Public Park

Other public parks (such as zoos and botanical gardens) are represented in zoos that contain many wild, aquatic, amphibious, reptiles and birds. The garden

may also have green areas and various types of trees, shrubs and flowers with the availability of entertainment, street gardens and roads prepared for picnics and parks. It is mostly in line with the coordination of the streets or roads; yet, if these gardens are aside and adjacent to the beach, they are safely planned and provided with lighting poles and benches in addition to the green areas.

4. Parks Design Styles

Parks design methods include the geometric style, The Natural style, The Mixed style, and finally The Modern style. These methods can be clarified as follows:

4.1. Geometric method

This method is also known as the symmetrical method, and, in which, regular, straight or round lines play an important role in its planning. Its coordination is symmetrical in many parts of the garden, and this method is characterized by the following [5].

- The paths inside the garden are often straight or geometrically curved.
- Flower beds are rectangular, circular, or any other only-geometric shape.
- Trees and shrubs that are planted in them are selected from species that have a regular shape (from trees that grow vertically or conical).
- Some trees or shrubs that can be organized or trimmed are planted and take geometric shapes such as conical, pyramidal, cylindrical or spherical.
- Aquariums are regular in shape or contain fountains characterized by some symmetry.

The geometric-style parks are common in small plots of land because they are usually defined by straight sides. Therefore, it is necessary to follow the geometric method in their planning. It is easy to plan the smaller spaces, but it gets more difficult to plan as the spaces grow larger.

4.2. Natural method (organic)

It is called the asymmetric style. This type is contrary to the geometric style, as the plant basins are surrounded by irregular, non-geometric, zigzag lines without order, and so on in all parts of the garden where there are no geometric lines or symmetrical shapes. Everything in those gardens mimics nature (organic)

in its presence until the garden as a whole becomes a microcosm of what we find in nature.

Trees and shrubs in this style of garden are planted without symmetry. Some shrubs are planted grouped in dense masses, while others diverge individually to be similar to their presence in nature. Expansive lands and large gardens, where the symmetrical lines become distant, not easily noticeable, and the engineering style in general does not seem comfortable to the soul, but rather seems boring [6].

4.3. Mixed method

It is the mixed style between the engineering and natural style. In this type there is a tendency to construct engineering water installations, fountains, canopies and benches. As for the bridges, they are built naturally from tree branches or in regular shapes of iron or wood. The green surface is often left exposed without defining its edges with the abundance of tree groups.

4.5. Modern Style

It is called the European style or the North American style. Its basis is extreme simplicity, which is the hallmark of the modern city. In general, this system does not adhere to the known coordination rules such as axes and symmetry. The plants are distributed in small numbers in order to be chosen as individual models with special characteristics in order to compensate for their deficiency in the garden.

5. Theme Park Elements

The components of gardens can be divided into plant elements, footpaths and children's play areas, lighting elements, cosmetic elements, garden furniture elements and finally public services elements [7].

5.1. Botanical Elements

God has singled out every environment with a set of types of plants that live and grow in a natural way. Although by providing the appropriate environment, any plant in the world can live when the factors of its ideal environment are available, yet providing the ideal environment requires a lot of effort and money and cannot be applied to the scope of establishing gardens. In desert areas, for this reason, specialists must choose the types and varieties suitable for the desert climate and environment for two purposes. First: These selected plants will grow naturally in such climates. Second: to reduce irrigation and maintenance costs. Accordingly, the selection of varieties that are resistant to environmental conditions

and are considered a key factor when choosing types of plants suitable for desert areas.

Through experiments, it was found that in the gardens of desert areas it is necessary to make fences - of dado onia trees or sapphire jasmine - around each basin or green sitting area. Leaving places for gates from the trees themselves, the same area can be divided into several sections in case it is large in order for a larger number of individuals to benefit from it. Other types of shade trees can be chosen, which are suitable for the atmosphere of the desert areas - such as bass us, Parkinsonia and eucalyptus -. They be planted inside the green areas and at a distance of 2 meters from the green fence. This allows room for other services (such as lighting and water networks) in order to mediate the green area while leaving room for the sun to permeate those flats. The sides of the corridors must be planted with those trees to shade the seating area. The plants used in gardens can be divided into the following:

- **The Trees**

Trees are used to obtain shade and as windbreaks. Flowering trees are also used extensively to compensate for the lack of flowers in the gardens. They are also used as plant curtains. In desert areas, environmental conditions and the suitability of trees for the hot climate must be taken into account. When trees are used for shading, the calculation of the shade of the tree with the movement of the sun must be taken into account in order to give the required shade in the specified places. In case of planting trees next to the building, it should be 1.5 meters away from the building so as not to affect it, and it must be planted at a distance of 3 meters from the walkways.

- **Bushes**

Shrubs are one of the most important botanical groups in landscaping and have many uses, as follows:

- Shrubs are planted in small gardens where their size is commensurate with the space and they must be planted in a regular manner, such as surrounding a walkway or at the entrance to the garden.

- They are planted as leaf or flowering plant curtains in front of the fences and under the trees. It is also easy to form them into many shapes, which gives the garden an expressive view.

- Some shrubs are used as natural hedges without cutting and forming.

- **Climbers and outriggers**

- It is used for climbing on entrances and pergolas. It may also be planted as plant hedges and used to cover walls or buildings overlooking the garden in order to serve as an extension and hide the neighbor's walls.

- **Green landscape**
  - In addition to the role of green spaces in addressing the climate, they perform functional purposes in the garden. For example, covering the area leads to linking the different parts of the garden together and achieving unity and interdependence between the parts of the garden.

- **Flower Beds**
  - It is taken into account that they are spaced so that they appear independent from the other in order for the garden appears spacious. It is simple in shape, exposed to the sun, and the width of the basin is not less than 70 cm.

- **Group of perennial herbs, annuals and flowering bulbs**
  - Herbs represent the beauty of nature, yet some of them need little care and some have an aromatic smell. Flowering bulbs are used for cultivation in ponds, as well as being used as cover plants on slopes and places with little care. They are also used for cultivation in rock gardens.

5.2. Pedestrian Paths

Constructing the pedestrian paths, it is noted that there are several important considerations that must be taken into account in the pedestrian paths, represented in the following [6].

- The inclinations of pedestrian paths and roads usually range between 1-5,1% in a longitudinal or transverse direction.

- The maximum permissible inclination in the case of not using a handrail 8%, and in case of using (Handrail), the inclination can be increased up to 15%, works only for short distances.

- The width of the corridors should not be less than 60cm for each person, 120cm as a whole, in order to achieve ease of passage.

- Pedestrian traffic always tends to take the shortest path between two points, so this must be taken into consideration when locating pedestrian paths.

- Paying attention to the visual aspects on pedestrian paths, especially those at eye level, to give a variety of interesting visual sequences.

- The materials used in the floors of pedestrian paths and roads include the use of concrete that takes different shapes and sizes in addition to the diversity in texture, color and final shape. Stones and bricks are also used, which gives a strong surface resistant to climatic factors, and their maintenance requirements are fewer when compared to other materials. Tiles are also used in pedestrian walkways, but it is noted that their texture in general does not fit well with external coordination, especially in planted places and large squares.

5.3. Children's play areas

Play areas for children must be provided in the gardens. The planning standards specify the space needed for children's playgrounds on the following basis [3].
A pre-school play area of not less than 1,000 square meters in large residential communities and entertainment centers in residential neighborhoods.

- The areas of public children's playgrounds, large public parks, and school playgrounds with an area of no less than 2023 square meters per 1,000 children.

- Children's playground areas in the gardens and parks of residential neighborhoods, parks and public parks, the proposed area is 6091 square meters per 1,000 children (these rates also include parks and gardens that serve residents of cities and large parks).

Based on the previous rates, children's play areas must be designed so that toys are provided for all ages, the safety factor must be taken into account during the design and implementation, and they meet the physical and mental needs of children.

5.4. Lighting Elements

In addition to the importance of the lighting element in giving a sense of safety, it contributes to emphasizing some aesthetic and plastic elements such as plants, fountains, and plastic formations in addition to buildings. As for lighting garden corridors, the height of the lighting source should not exceed four meters, with a special need to lighting the areas that include stairs. In general, the elements and systems of gardens shall take the following into account:

- Defining and clarifying the identity of the corridors and the place by controlling the intensity of the lighting system.
- Providing adequate lighting at pedestrian crossings.
- Focusing lighting on distinctive and attractive formations and indicative signs.
- Remove all sources of reflection and light dazzle.

- All elements and materials used should be compatible with the hot environment.

5.5. Water elements and fountains

What is meant here is the water elements, fountains, shapes and aesthetic formations. It is difficult to imagine a garden or a public square without benefiting from the water elements. They can either go naturally through natural waterfalls or ponds, or in an architectural form such as fountains and various water formations. Water elements are considered a main attraction in these places. The importance of using water elements and fountains in gardens is due to their aesthetic and functional effects through the shape of water formations and the sound and movement of water, in addition to the important role they play in softening the atmosphere in hot and dry areas [8].

Aesthetic shapes and formations are among the important elements in coordinating the place. In addition to the technical and aesthetic aspects that they give to the place, they give a distinctive mark to the place in which they are placed.

5.6. Garden furniture items

There are many elements of garden furniture, the most important of which are the seating areas. The quality of the seats used is of great importance in studying the functional and aesthetic aspects of the pedestrian axes and squares.
In addition, the following must be observed:

- In hot areas, one must take the protection of sitting places from the sun's rays into account and the use of materials appropriate to the climatic conditions.

- It is preferable in hot areas to use concrete, wooden or stone seats. Although wooden seats are the most comfortable of these types, they are more in need of maintenance. In this case, the seats can be protected by shading.

5.7. Elements of public services

It includes the provision of the necessary toilets, a buffet to provide food and drinks, a prayer hall, the work of fences and entrances that are used for various purposes. Last but not least, including achieving privacy, protection and security reasons. The materials that the fences are built with are either iron, concrete, bricks, stones, or plants. In this case, the appropriate plants must be chosen. As for the entrances, they must be in suitable places and not less than two entrances to the garden. The entrances must be proportional to the rest of the elements and can be made of iron or wood while protecting them from weather factors [8].

6. Analysis of the pros and cons of smart technologies used in public parks:

6.1. Smart applications in Landscape:

6.1.1. Automatic lawn mowers

Automatic, or robotic, lawn mowers are autonomous, self-moving machines that cut the lawn, controlled through programming, sensors, and sometimes remotely. It can be powered by electric and clean energy, mostly battery-powered and must be charged via a charging base connected to an electrical outlet, although some models can be solar powered [9].

6.1.2. Near Infrared imaging

Near-infrared photography, in pictures, reflects light that falls outside the visible light spectrum, or what humans can see. Near infrared light on the electromagnetic spectrum has wavelengths longer than visible light but slightly shorter than medium or far infrared. Photosynthesis plants absorb most visible light and reflect near-infrared light. Thus, the near-infrared image can visually show the regions of high or low temperatures of photosynthesis, an indicator of the plant's health. Photographs can be taken with a near-infrared camera or by purchasing a traditional digital camera change kit. Post-processing software on the image can be used to analyze the plant's health.

6.1.3. Green Roofs

Green roofs are large or dense areas located on the roof of buildings. Roofs are designed to hold up to a certain weight, which affects the type of green roof that can be installed. The overall green roof is the lightest and requires little maintenance, relatively shallow soil build-up, and no permanent irrigation system.

6.1.4. Green Walls

Green walls, substrate or soil based, is a planting system that enables vegetation to cover a vertical structure, such as the facade of a building. Green walls are similar to green roofs, but they are normally installed vertically rather than horizontally [10].

It can be soil based, climbing or hydroponic. Soil-based walls (also called substrate) use lightweight containers filled with soil or other growing substrates attached to the wall, and include permanent systems for irrigation and drainage [10].

6.1.5. Air purification in plant containers

Air pruning plant containers are temporary planters that are designed to encourage a healthy root growth before permanent planting. Containers force the root tips that reach the perimeter to be exposed to the air, signaling dehydration and forcing them to split and turn inward. These can be canvas bags, containers with holes, or plastic containers specifically designed to improve root growth. It can be purchased or created as a do-it-yourself strategy. When the plant is grown in a conventional pot, roots grow towards the container then downward over time, this results in root rotation or a thick tangle of roots around the circumference of the pot, with relatively little root infiltrating into the center and this can kill plants if not replicated in a larger container Air pruning encourages Bigger, healthier root systems that increase the entire growing area within the pot [8].

6.1.6. Sifting seeds and pollinators

Vibrating pollinators are battery-operated hand tools that vibrate near the same frequency as pollinator wings to stimulate plants to release pollen, so that they can be pollinated manually. In nature, when a pollinator visits a flower and activates the release of pollen, the pollinator becomes encased in pollen. The pollinator transfers the pollen grains to the next plant it visits, fertilizing it. However, in greenhouses and areas where the number of pollinators has decreased, pollinators of interest can be used to increase crop yields. Special purpose vibrating pollinators can be modified to match the frequency of specific pollinators, such as those required by many edible plants, including tomatoes, peppers, squash and berries. The effect of using smart applications in the landscape can be determined in Table (1) as follows:

Table (1): The effect of using smart applications in Landscape [5].

The point of evaluation	Access Method	Social Consensus	Health	Security	Flexibility	Water	Power	Operation & Maintenance
Automatic lawn mowers	●	●	●●●	●	●	●	●●●	●●●
Near Infrared imaging	●	●	●●●	●●	●●●	●●●	●	●
Green Roofs	●	●●●	●●●	●	●●●	●●	●●●	●
Green Walls	●	●●●	●●●	●	●	●●	●●●	●●
Air purification in plant containers	●	●	●	●	●●●	●	●	●●●
Sifting seeds and pollinators	●●	●	●●●	●	●●●	●	●	●

●●● Technologies with positive effect ●● Technologies with neutral effect
● Technologies are not effective

6.2. Smart applications in irrigation

Irrigation is responsible for about 70% of fresh water use worldwide, yet half may be wasted due to evaporation, run-off or infrastructure defects such as leaky pipes, water. This issue describes five smart garden technologies that can be

used to optimize irrigation and related equipment: smart water controllers, low pressure, rotating spray, subsurface drip irrigation, smart water meter and gray water recycling. Irrigation can complement other water saving options.

6.2.1. Smart Water Controllers

Smart water controllers, also known as timers, digitally manage sprinkler irrigation patterns and subsurface drip irrigation systems based on data collected through soil moisture and weather sensors. Soil-based sensors measure the amount of moisture in the ground and determine how much irrigation is necessary based on soil type, topography, and other conditions. Weather sensors in a garden or at a local weather station can determine how much irrigation is needed under current weather conditions (Temperature, wind, humidity, precipitation, etc.). Weather data collected by sensors not located in the park may also be transmitted wirelessly to the park control network via the Internet.

6.2.2. Low pressure and rotating water sprinklers

Innovations in spray nozzle design and operations improve water use and distribution on the ground:

- Low pressure sprinkler heads produce less fine mist than conventional heads to keep the wind out of the water.

- Reduced and operating pressure to allow water to penetrate the ground uniformly instead of running or windy [9].

6.2.3. Subsurface drip irrigation

Subsurface drip irrigation (SDI) uses embedded drip irrigation tubes (or "driplines"), pumps, water release spouts (exit openings along underground tubes), valves, and actuators to move water slowly and directly to the plant's roots. This is when the uptake of water and nutrients is at its highest degree; This differs from overhead and rotating sprinklers, which spray water in the air and then falls to the ground, leaves and stems of plants, compared to sprinklers, subsurface drip irrigation that produces more uniform water distribution and has less chances of evaporation and runoff. SDI systems require air release and system flow valves to reduce buildup equipment from soil, bacteria and other contaminants [9].

6.2.4. Smart water meter

Smart water meters combine physical water meters with digital communication components to measure water consumption and deliver data to utilities at regular intervals through wireless signals, power line connections, satellite, or the Internet. Utility personnel and others can access water usage data online and assume real-time control over meter readings and water flows.

6.2.5. Gray water recycling

Gray water is wastewater that was once used in showers, sinks, dishwashers, washing machines, or other appliances. It is distinct from black water, which is obtained from latrines. Gray water recycling is the filtering and usage of gray water instead of drinking water for non-receptacle functions such as watering and flushing the toilet. Gray water sources are often required to be labeled as unsuitable for human consumption, and gray water bearing systems must be designed to minimize exposure to humans and pets.

Gray water recycling treatments consist of several stages that mimic natural water purification processes (Artificial wetlands and other natural systems that filter water can also be included in the treatment steps):

- Pretreatment uses screens and mechanical filtration to remove solids and larger materials.
- Secondary treatment uses the reactions of oxygen and naturally occurring microorganisms to consume dissolved organic molecules.
- Additional treatments may use a combination of diffusion, ultraviolet light, chlorine, and/or sulfur dioxide to destroy residual organisms.

The effect of using smart applications in irrigation can be determined in Table (2) as follows:

Table (2): The effect of using smart applications in irrigation [5].

The point of evaluation	Access Method	Social Consensus	Health	Security	Flexibility	Water	Power	Operation & Maintenance
Smart Water Controllers	●	●	●	●●●	●●●	●●●	●●	●●●
Low pressure and rotating water sprinklers	●	●	●	●●●	●	●●●	●●	●

Subsurface drip irrigation	●●●	●	●●●	●●●	●●●	●●●	●●	●●●
Smart water meter	●	●	●	●	●●	●●●	●●	●●●
Gray water recycling	●	●	●	●	●●●	●●●	●●	●●●

●●● Technologies with positive effect ●● Technologies with neutral effect
● Technologies are not effective

6.3. Smart applications used in furniture and urban amenities

The smart technologies used in furniture and amenities include seven smart technologies. Those can help park managers in:

- Rethinking the design of urban furniture and amenities in parks,
- Eenhancing visitation for visitors and making maintenance and operations easier and more efficient

The 7 SMART technologies to be discussed are [9]:

- smart seats.
- solar-powered garbage compactors.
- Smart water fountains.
- Robotic bikes & Treadmills
- solar shade structures.
- toilet occupancy sensors.
- Digital signs.

6.3.1. Smart Seats

Smart seats are long benches, usually for multiple people, with technological features, that are powered by solar energy and contain USB charging ports for electronic devices, while others act as Wi-Fi hotspots, and these seats can contain sensors to monitor pedestrian activities, air quality, noise levels, and other useful park information, and conventional park seats can be modified to perform some of these functions.

6.3.2. Solar Shade Structures

Solar shade structures provide shelter from the sun while using solar panel technology to generate clean energy. The structures can be patio awnings, canopies over picnic areas, or larger solar structures over parking lots. Simple models incorporate a solar panel into a patio canopy, allowing users to charge USB devices from the front of the canopy. More complex awnings and awnings use sensors and

actuators to move with the sun's rays for maximum solar energy harvesting and cooling benefits. Some models of solar shading structures are portable, which creates more flexible use.

6.3.3. Solar powered garbage compactors

Solar powered garbage compactors crush and compress waste to put into compost bins for recycling and use clean energy produced from solar panels. Determine the appropriate time for emptying and follow up maintenance if necessary, and it is also equipped with a program connected to the Internet Wi-Fi to improve the methods of garbage collection.

6.3.4. Toilet occupancy sensors

Occupancy sensors appear in the bathroom when a bathroom is in use and provide information with colored lights (red for occupied and green for available) and the information is displayed in a (mobile) app for mobile users, or on a screen outside the bathrooms [11].

6.3.5. Smart Water Fountains

Technologies associated with smart water fountains include solar panels to cool or condense water from the atmosphere, filters to remove contaminants or improve service, amplifiers to engage visitors, and sensors to monitor water quality and alert staff when maintenance is needed.

6.3.6. Digital signs

Digital signs, such as LED screens or a new transparent LED is a film applied to glass surfaces, where images, texts and videos are displayed, updated from time to time, and placed everywhere, where they are used for advertising because they are constantly connected to Wi-Fi, and these signs Digital can be simple screens connected to a media player to display static information, such as a restaurant menu, more complex systems connected to a network over the Internet that can be dynamically updated and video integrated and displayed periodically, or dynamic signals that require either a third party service to manage and update the sign or position of employees and servers Online for updates from anywhere, all solar powered to reduce costs and save energy.

6.3.7. Automatic bikes and treadmills

Bicycle and pedestrian meters collect data about pedestrians in their various locations and activities and are battery powered and located underground, above jobs and activities, or at street level. It uses sensors, video cameras, amplified tubes or metal tapes (detecting bicycles or pedestrians passing over them) to obtain information and store it in a database that contributes to the development of future park design.
The impact of the use of smart applications in furniture and urban facilities can be determined in Table (3) as follows:

Table (3): The effect of using smart applications on furniture and urban facilities [5].

The point of evaluation	Access Method	Social Consensus	Health	Security	Flexibility	Water	Power	Operation & Maintenance
Smart Seats	●●●	●	●●	●	●	●	●●●	●●
Solar Shade Structures	●	●	●●●	●	●●●	●	●●●	●
Solar powered garbage compactors	●	●	●●●	●	●	●	●●●	●●●
Toilet occupancy sensors	●●●	●	●	●	●	●	●	●●●
Smart Water Fountains	●●●	●●	●●●	●	●	●●●	●●	●●●
digital signs	●●●	●●●	●	●	●	●	●●	●●●
Automatic bikes and treadmills	●	●●	●●	●	●	●	●	●●

●●● Technologies with positive effect ●● Technologies with neutral effect
● Technologies are not effective

6.4. Smart applications used in the spaces of activities

There are many smart applications used in park activity spaces that help promote health, educating users as well as increasing visitors to the parks. These applications can be identified as follows [5]

- Interactive play structures.
- Ozone pool.
- Swimming pools.
- Sports venues and high-performance track surfaces.
- Energy-generating exercise equipment.
- Outdoor DJ booths.
- Surface hardness testing equipment.

6.4.1. Interactive play structures

Interactive play structures are similar to traditional play structures, but they have an integrated computer and game system that children can interact with. The interactions can happen via buttons, sensors, lights, sounds, colors and images. It can also be programmed with one or more virtual games.

6.4.2. High performance track surfaces

High performance track surfaces are weather resistant rubber running tracks. They are made of two layers to provide efficient traction and shock absorption. Combining traditional tracks into one layer, because the top layer in high performance track surfaces is relatively hard. Runners' spikes do not have to penetrate the surface to gain traction and can be used with shorter screws. Shorter booms allow runners to transfer less of their physical energy to the track, resulting in more efficient running. As for low-speed activities, high-performance track surfaces relieve stress on the feet and joints, for they increase foot comfort.

6.4.3. Ozone Pool

Ozone pool is a water purification technology with two components: ozone generation and an ozone management system. Regarding the first component: ozone generation, it pushes ozone molecules into the water, a natural oxidizing agent that removes organic and inorganic compounds and sterilizes water (similar to chlorine), without causing health effects. The second element: the ozone management system dissolves ozone with water, so there is no excess of ozone gas outside the surface of the pool. This is beneficial for health because ozone controls water-damaging microorganisms, including Cryptosporidium and Giardia that can cause serious illness or infection to humans.

6.4.4. Energy Generating Exercise Equipment

The practice equipment generates energy during use, which is converting friction and other body heat, etc. into electrical energy via a generator to produce clean electricity. It can be used for on-site lighting, to charge devices, or sent to the grid for use by others. The average user can expect Generate 50 to 150 watts in an hour of cycling a stationary bike. This amount of electricity would be enough to power your TV for about an hour. This goes for any practicing equipment similar

to machines in gyms, knowing that power generation equipment is designed for durability and low maintenance.

6.4.5. Outdoor DJ booths

Outdoor DJ booths are robust structures that can be handled and loaded with music from interactive mobile phones. They are charged by solar panels installed over shade structures (booths), to provide “positive and creative spaces in the youth hangout. People can also connect DJ booths online, which allows viewing and monitoring user statistics. DJ booths are designed to be vandal-proof as well as dust-, snow-, and ice-resistant.

6.4.6. Surface Hardness Testing Equipment

Hard surface testing equipment is used to test the integrity of the hardness of surfaces under stadiums, rather than using "virtual testing" to assess surfaces or relying on destructive laboratories. It is designed to additionally test surfaces hardness using electronic sensors to imitate a child's head, providing accessible data on impact, velocity, and potential head injuries. The effect of using smart applications in the activity spaces can be determined in Table (4) as follows:

Table (4): The effect of using smart applications in the activity spaces [5].

The point of evaluation	Access Method	Social Consensus	Health	Security	Flexibility	Water	Power	Operation & Maintenance
Interactive Playing Structures	●●●	●●●	●●●	●	●	●	●	●●●
High Performance Track Surfaces	●●●	●	●●●	●	●●●	●	●	●●
Ozone Pool	●	●	●●●	●	●	●●●	●	●●●
Energy Generating Exercise Equipment	●●●	●●●	●●●	●	●●●	●	●●●	●
Outdoor DJ booths	●●●	●●●	●●●	●	●	●	●●	●
Surface Hardness Testing Equipment	●	●	●●●	●●●	●	●	●	●●●

●●● Technologies with positive effect ●● Technologies with neutral effect
● Technologies are not effective

6.5. Smart applications used in lighting

Lighting can help extend park use hours because it greatly affects people's willingness to visit the park after sunset. The combination of programming and lighting can increase park accessibility to suit the community and provide safety and health. Cities often implement programs to extend business hours in the park as it also appeals to families and visitors. While these programs face additional resources, lighting encourages the community to increase the use of park spaces and is a critical factor. The applications used in lighting can be identified as follows:

6.5.1. Motion Sensors

Kinematic sensors detect a kinetic stimulus, via microwave or ultrasonic energy, and then activate: mechanical (eg, opening a door), acoustic (eg, alarm) or visual (eg, light). The sensor responses sending a wave of energy, which bounces off the nearest object and reflects back towards the sensor. When someone switches to the path of energy emitted by the device, the sensor detects a change in infrared radiation, thermal energy, or the amount of reflected light. The response time is the timing of the sensor acting to the reflected light.

6.5.2. The art of painting with lighting and optical fibers

This section focuses on two different items. First, technologies that can be used to create lighting designs. LEDs (Optical Interferometers) are semiconductors that emit light when connected to an electric current. Second, lamps and optical fibers. Optical fibers are flexible fibers of glass or other transparent solid materials used to transmit light and telecommunications signals. Therefore, they can be used safely in wet conditions. They can also be used together: LEDs as a source of light, transmitted by optical fibers.

6.5.3. Off-grid Light Bulbs

Off-grid light bulbs, independent of local grid energy, they operate efficiently by renewable energy devices, including solar panels and wind turbines.

6.5.4. LED digital add-ons

A semiconductor chip converts electricity into light that illuminates LEDs. Each chip acts as a miniature microprocessor and the sensors can keep in contact with the circuit board. Other light bulbs do not have circuit boards and therefore cannot connect to digital technology, such as fiber optic sensors, Wi-Fi and routers. These digital technologies can still record and track light, noise, weather, water use and availability, air quality, pedestrian and vehicle traffic data, as well as helping to increase your internet connection.

6.5.5. Lighting Shields

Lighting shields are base player covers, often made of metal or plastic, that restrict the angle of brilliance of the light source. They do that by partially enclosing light bulbs. The illumination is less diffused and more focused, reducing light pollution by redirection. This provides increased illumination below, reducing the need for additional light sources, in addition to reducing glare, or light that is emitted horizontally from the source and irritate the eyes without lighting the ground. The effect of using smart applications in lighting can be determined in Table (5) as follows:

Table (5): The effect of using smart applications on lighting [5].

The point of evaluation	Access Method	Social Consensus	Health	Security	Flexibility	Water	Power	Operation & Maintenance
Motion Sensors	●	●	●	●●●	●	●	●●●	●●●
The art of painting with lighting and optical fibers	●	●●●	●	●●●	●	●	●●	●●
Off-grid Light Bulbs	●	●	●	●●	●●●	●	●●●	●●●
LED digital add-ons	●	●●	●	●●●	●	●●	●●	●●●
Lighting Shields	●	●●	●●●	●●●	●	●	●●●	●●●

●●● Technologies with positive effect ●● Technologies with neutral effect
● Technologies are not effective

6.6. Smart applications used in digital technologies "DIGISCAPES"

Applications of digital technologies point towards smart governance that can be used to enrich park access, safety, programming, operations, and interactions between park management and visitors. Mainly, it uses multiple communication methods from Wi-Fi, geographic information systems (GIS), software applications and sensors to networks and the Internet of things [6].

6.6.1. Wi-Fi

Wi-Fi allows personal electronic devices to be connected using the Internet without a wired connection. Network devices enable Wi-Fi by transmitting data from and to the Internet with Wi-Fi-capable devices such as smartphones, computers, digital audio players, cameras, watches, and printers. Wi-Fi can serve multiple people in large areas, called "hotspots", if used with routers, wireless access points (WAPs), and switches. It also allows multiple devices to connect to the Internet simultaneously through a single modem, that serves as a unit Decoder to translate the modem signal into usable data for a multi-device Wi-Fi network.

6.6.2. Geographic Information Systems (GIS)

Geographical information systems and services (GIS) use digital software to capture, store, process, analyze, manage and present a descriptive spatial database (GIS). It displays information as climate, air quality and human health in the form of individual-colored layers of information superimposed on top of a 2D or 3D digital map. Viewing the map on a computer screen, each visible\invisible layer may be switched so that all layers can be displayed simultaneously. By observing how the layers overlap, and by noting multiple informational measurements at a specific point on the map, potential trends and relationships can be elicited from land use, social, economic, environmental and other factors.

6.6.3. Software applications (applications)

Applications, short for "Software Applications", are programs that can run on computers, tablets, smartphones, or other electronic devices. They may or may not require an internet connection. Some of which work to retrieve data in real time and the user stores the required content. Some other applications enable two-way communication. There are numerous applications; they can perform almost every function, such as maintaining calendars, making phone calls, taking pictures, organizing data through spreadsheets, displaying maps, games and entertainment, and designing graphs.

6.6.4. Sensor Networks and the Internet of Things

Digital sensors can record, store, and wirelessly transmit information about light intensity, temperature, humidity, air and water quality, resource consumption, movement...etc. Multiple sensors may be interconnected, with or without wires, to create a sensor network that collects data on a wider area. Depending on the sensors used, the network generates different types of data, such as numbers, texts and voice, that the program can collect and analyze, [https://www.wikipedia.org/2019]. The impact of using smart applications in digital technologies can be identified in Table (6) as follows:

Table (6): The effect of using smart applications in digital technologies DIGISCAPES [5].

The point of evaluation	Access Method	Social Consensus	Health	Security	Flexibility	Water	Power	Operation & Maintenance
Wi-Fi	●	●●	●	●●	●	●	●	●●●
Services and GIS	●●	●●	●●	●	●●	●●	●●	●●
Software application	●	●	●●	●●	●●	●●	●●	●●●
Sensor Networks and the Internet of Things	●●	●	●●	●●	●●	●●	●●	●●●

●●● Technologies with positive effect ●● Technologies with neutral effect ● Technologies are not effective

6.6.5. Summary of the analysis of the impact of the use of smart applications used in the design of public parks:

Table (7) illustrates the results of the analytical study, which emphasizes the importance of using smart applications in public parks and their positive effects of using smart applications in public parks. (% calculated horizontally, the number of points for each face of the evaluation / 24 points total)

Application	Points of evaluation	Access Method	Social Consens	Health	Security	Flexibility	Water	Power	Operation &	Impact degree	Evaluation
Landscape	Automatic lawn mowers	●	●	●●●	●	●	●	●●●	●●●	%58	Positive
	Near Infrared imaging	●	●	●●●	●●	●●●	●●●	●	●	%63	Positive
	Green Roofs	●	●●●	●●●	●	●●●	●●	●●●	●	%71	Positive
	Green Walls	●	●●●	●●●	●	●	●●	●●●	●●	%58	Positive
	Air purification in plant containers	●	●	●	●	●●●	●	●	●●●	%50	Neutral
	Sifting seeds and pollinators	●●	●	●●●	●	●●●	●	●	●	%54	Neutral
Irrigation	Smart Water Controllers	●	●	●	●●●	●●●	●●●	●●	●●●	%71	Positive
	Low pressure and	●	●	●	●●●	●	●●●	●●	●	%54	Neutral

	rotating water sprinklers										
	Subsurface drip irrigation	●●●	●	●●●	●●●	●●●	●●●	●●	●●●	%88	Positive
	Smart water meter	●	●	●	●	●●	●●●	●●	●●●	%58	Positive
	Gray water recycling	●	●	●	●	●●●	●●●	●●	●●●	%63	Positive
Furniture and urban amenities	Smart Seats	●●●	●	●●	●	●	●	●●●	●●	%58	Positive
	Solar Shade Structures	●	●	●●●	●	●●●	●	●●●	●	%58	Positive
	Solar powered garbage compactors	●	●	●●●	●	●	●	●●●	●●●	%58	Positive
	Toilet occupancy sensors	●●●	●	●	●	●	●	●	●●●	%50	Neutral
	Smart Water Fountains	●●●	●●	●●●	●	●	●●●	●●	●●●	%75	Positive
	digital signs	●●●	●●●	●	●	●	●	●●	●●●	%63	Positive
	Automatic bikes and treadmills	●	●●	●●	●	●	●	●	●●	%46	Neutral
Activities Spaces	Interactive Playing Structures	●●●	●●●	●●●	●	●	●	●	●●●	%67	Positive
	High Performance Track Surfaces	●●●	●	●●●	●	●●●	●	●	●●	%63	Positive
	Ozone Pool	●	●	●●●	●	●	●●●	●	●●●	%58	Positive
	Energy Generating Exercise Equipment	●●●	●●●	●●●	●	●●●	●	●●●	●	%75	Positive
	Outdoor DJ booths	●●●	●●●	●●●	●	●	●	●●	●	%63	Positive
	Surface Hardness Testing Equipment	●	●	●●●	●●●	●	●	●	●●●	%58	Positive
Lighting	Motion Sensors	●	●	●	●●●	●	●	●●●	●●●	%58	Positive
	The art of painting with lighting and optical fibers	●	●●●	●	●●●	●	●	●●	●●	%58	Positive

	Off-grid Light Bulbs	●	●	●	●●	●●●	●	●●●	●●●	%63	Positive
	LED digital add-ons	●	●●	●	●●●	●	●●	●●	●●●	%63	Positive
	Lighting Shields	●	●●	●●●	●●●	●	●	●●●	●●●	%71	Positive
Digital Technologies	Wi-Fi	●	●●	●	●●	●	●	●	●●●	%50	Neutral
	Services and GIS	●●	●●	●●	●	●●	●●	●●	●●	%63	Positive
	Software application	●	●	●●	●●	●●	●●	●●	●●●	%63	Positive
	Sensor Networks and the Internet of Things	●●	●	●●	●●	●●	●●	●●	●●●	%67	Positive

●●● Technologies with positive effect ●● Technologies with neutral effect ● Technologies are not effective

100-55% Positive 54-45% Neutral 44-0% Negative

60% Positive

7. Conclusion

The analysis in Table (7) concludes that the positives of using smart applications in public parks are the dominant feature, as they amounted to 27 elements out of a total of 33 elements, i.e. (82%). The negative effects are unseen, and the neutral effects are on 6 out of the total 33 items. Assuming evaluation levels (from 0.0-44% negative impact, from 45-54% neutral effect, from 55-100% positive impact), it was found -by calculating the average percentages of all items- that the positive impact represents an average of 60%. Thus, confirming that the use of smart applications tests positive. Therefore, there is no doubt that smart applications are in constant development and should be used in traditional public parks to improve their performance.

8. References

[1] Stratigea, Anastasia. "The concept of 'smart cities'. Towards community development?." *Netcom. Réseaux, communication et territoires* 26-3/4 (2012): 375-388.

[2] Abu Dahab Mahmoud, Tariq Mahmoud Abu Dahab, design and landscaping, Arab House for Publishing and Distribution, Cairo, first edition 1998.

[3] Marwa Mohamed Abdel-Baqi, the foundations of the design of parks and public gardens, master's thesis, Faculty of Engineering - Cairo University 2003.

[4] Attalla, Hany, Mohamed Abdel-Kader, and Haitham Samir. "The Aga Khan multidisciplinary experience in Cairo, Egypt: a different view." Handbook on the Economics of Cultural Heritage. Edward Elgar Publishing, 2013.

[5] Food Outlook. Biannual report on global food markets Food and Agricultural Organization of the United Nations, 2019.

[6] China's Economy Accelerates for First Time in Seven Years, Arabic People, 2018. http://arabic.people.com.cn/n3/2018 (accessed Jan. 06, 2022).

[7] Hummer Turf Grass Systems: Design, Construction and Renovation of Natural Grass Athletic Fields and Turf Grass Production, Sports venue technology, 2017.

[8] The First Chinese Park for Artificial Intelligence to Fly to the Future, *Arabic News*, 2019. http://arabic.news.cn/2019-11/01/c_138520794.htm (accessed Jan. 06, 2022).

[9] The first of its kind in the world. Let us discover the artificial intelligence park in Beijing, *Arabic People*, 2018. (accessed Jan. 06, 2022).

[10] Basic Types of Green Walls, *Urban Greening*, 2017. http://arabic.people.com.cn/n3/2018/1116/c31656-9519151.html (accessed Jan. 2022).

[11] Alawadhi, Suha, et al. "Building understanding of smart city initiatives." International conference on electronic government. Springer, Berlin, Heidelberg, 2012