The Role of Green Architecture in Smart Cities

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ABSTRACT

Since the last few years, the concept of "smart cities" has become a widespread topic in a variety of fields. The practice of sustainable development is to thank for this rise in popularity. The philosophy, physics, and aesthetics of ecologically friendly building design and construction are collectively referred to as "green architecture" or "green building." The goal of green design is to reduce the amount of resources used in the construction, usage, and operation of a building, as well as the pollution, waste, and emissions that result from these activities. Design and construction of buildings generatorbaes waste that is harmful to human health and the environment. In order to minimize these resource-efficient structures and negative effects and build environmentally sound, it is necessary to introduce, define, understand, and practice green architecture. There is a word for environmentally friendly architecture. There are many benefits to adopting the principles of "Green Architecture" and "Green Building" in order to better utilize the natural environment and renewable energy sources, and then to creating standards for energy efficiency in buildings.

In this study better understanding about the relationship between green architecture and smart city concepts and their impact on each other have been studied, where this study focuses on the role that green architecture plays when planning and executing smart cities.

Keywords: Sustainable Development، Green Architecture, Smart Cities, Green Building

1. Introduction:

The United Nations predicts that by 2050, 66% of the world's population will reside in cities [1]. Most of the world's resources are currently used by cities, which account for 75% of global energy use [2]. Almost 80% of the greenhouse gases that have major environmental repercussions are generated by this constant energy demand. [3]

Because both business and academic experts feel that smart cities are the best answer to the problems caused by increasing population growth, urbanization, degradation of pollution of the environment, energy sources, etc., a smart city is the best option. But the needs, components, and characteristics of each smart city are not nearly as similar as they initially look. A wide range of smart cities may be assured of their quality, safety, and performance thanks to ISO standards, which are widely recognized around the world. Consequently. Many advantages can be gained from following smart city standards for the establishment of these communities and their administration, in addition to the ability to track their operations in real time. [4]

In recent years, the research community has developed a flurry of experimental and real-time smart city solutions because of the urgency and growing attention on sustainability. While a large portion of the suggested research is experimental, the majority of it takes place in a laboratory. Limitations such as lack of heterogeneity, lack of scalability, and lack of mobility make it difficult and time-consuming to install a test bed in a real-world context. When it comes to rectifying IOT device heterogeneity, scaling, and mobility in the Oulu smart city, the Oulu smart city architecture [5] only provides basic service provision and an experimental test bed.

Environmentally friendly structures are often referred to as "green architecture" or "green buildings." Consequently, the two terms are often used interchangeably to describe any structure built with environmental aims in mind, regardless of how well it actually performs in respect to those goals. [6]. Our planet's critical environmental, economic, and political issues are defined by sustainable design and green architecture [7]. By maximizing the use of readily available resources and lowering the amount of energy and development space consumed, green design seeks to lessen the negative environmental impact of construction [8]

2. Smart Cities

A "smarter city" concept is based on the widespread use of ICT (information and communication technology) in urban areas and the numerous advantages and opportunities it provides for cities and their residents. Sensor technologies, information processing systems, computational analytics, and communication capabilities now pervade the cityscape, making it more and more dependent on computing resources and services. [9]

Because of this, the concept of "smarter cities" is linked to the increasing and deeper integration of modern ICT into municipal operations, functions, and designs. A city that is a developing and future city rather than just an existing one is a smart city, unlike traditional smart cities. "Smart cities" are places where ICT "is interwoven with infrastructure, architecture, commonplace objects, and even our own bodies to address social, economic, and environmental concerns," as defined by the researcher. [10] City dwellers can take advantage of state-of-the-art services that enhance their quality of life, says the study's [11] lead researcher.

Smart cities, according to scientists, are ones in which every potential object or activity, including roadways and rail systems; water systems; buildings; appliances; and hospitals, is integrated with the next generation of information and communication technology (ICT)[12]. In terms of efficiency, livability, equality, sustainability and environmental friendliness [13], scientists have defined a smart city. Modern information and communication technology (ICT) can help us become more effective, sustainable, efficient, equitable, and well-off.

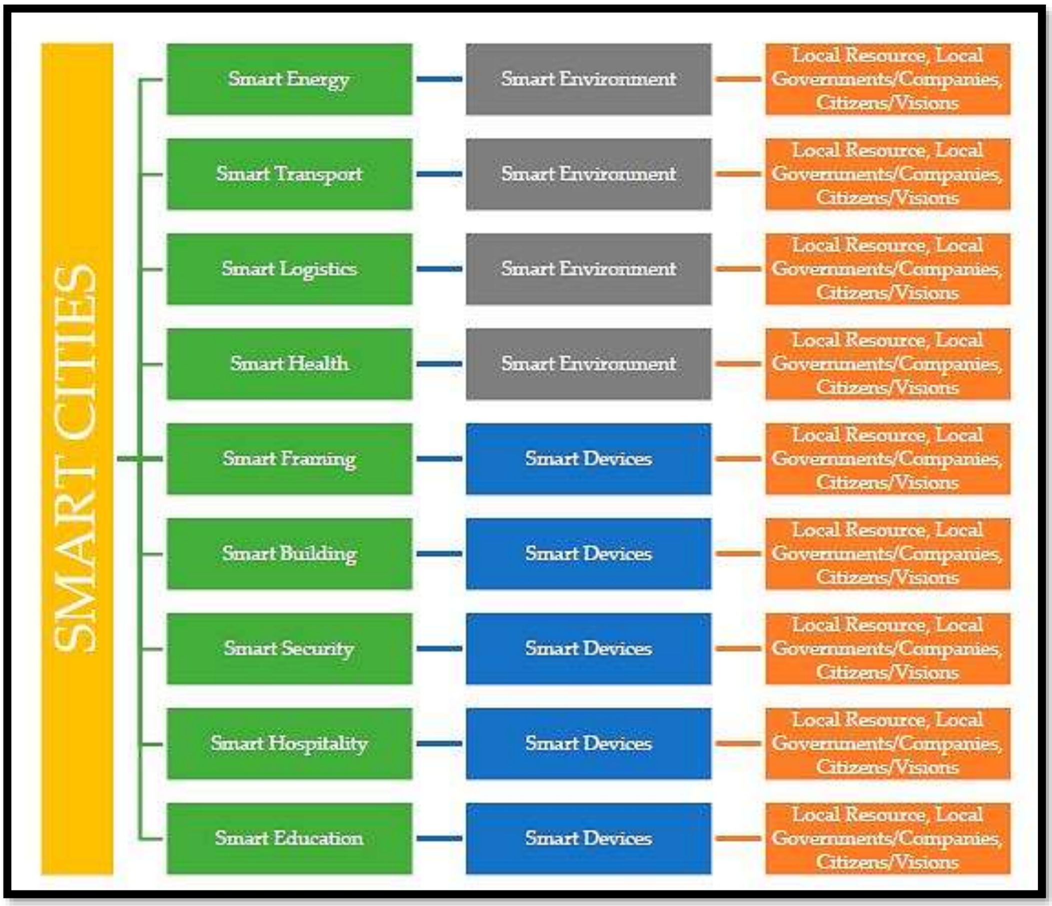
For the sake of sustainable development, we found that future smart cities are better equipped than current smart cities to do so. Big data analytics and context-aware computing are becoming more common in many urban areas and systems for a variety of reasons. [14]

Modern ICT (information and communication technology) can be used to improve efficiency, sustainability, equality, and livability at various spatial scales as well as urban planning methods. A city can be called smarter when all 14 of these systems are employed together.

Smart cities require the use of big data and context-aware cloud computing applications to keep tabs on what's going on in urban areas (such as events, activities, processes, and behaviors), to process and interpret the data, and to respond to the findings through decision-support systems and strategy. [15] Rather of focusing on the technology and efficacy of smart solutions, it's more crucial for sustainable development to focus on the outcomes. Environmental sustainability is no longer the primary goal of cities. [16]

2.1 Smart Cities Hierarchical Structure

Figure 1 depicts the application areas related to smart cities in a hierarchical framework. Table 1 also lists prior studies on EVs and GBs by various researchers. As these studies demonstrate, renewable energy plays an important role in the development of smart cities.)



(Figure 1).. Several types of smart city applications are shown in this diagram to illustrate the relationship between them. [17].

2.2. Urban Sustainability and Smart City Development

A basic understanding of sustainable urban development is necessary in order to fully grasp the term "sustainability"[18]. That's why we're always evolving [19], from resource extraction to investment focus to technological advancement to organizational shifts. An emerging idea of a "sustainable city" emerged during this time period to express the interdependence of economic, social, and environmental sustainability as assessed by many metrics [20].

Sustainability in urban development refers to achieving a balance between urban growth and environmental conservation, while ensuring that all residents have equal access to the same opportunities for economic prosperity [21]. It's no surprise that interest in smart cities and similar concepts has exploded in recent years due to factors such as climate change, resource scarcity, globalization, and an increase in global competition. Services in cities must be tailored to meet the demands of local residents [22].

In order to improve the quality of life for its residents, a smart and sustainable city aims to increase economic growth by providing more job opportunities; enhance the well-being of its residents by ensuring that its residents have easy access to social and community services; and establish an environmentally conscious approach to development[23].

Ecological concerns in smart cities are often focused on international resolutions as well as cutting-edge solutions to complex metropolitan difficulties... Four qualities characterize cities that are both smart and sustainable, according to the same author: Environmental stewardship, human wellbeing, urban planning, and intellectual prowess are all part of this. [24] All of these topics are explored in this context: economy, environment, and government.

Researcher [25] also discusses these challenges in their studies on knowledge-based urban growth and smart city development. Smart-eco city claims that cities should be utilize sophisticated technologies, and employ economically productive, ecologically healthy, and environmentally efficient enterprises while maintaining a physically appealing and functionally live landscape [26]

2.3 Smart city components

Here, some of the numerous elements that make up a "smart city" are shown in Figure 2. As part of a "smart" community, these include smart energy, transportation and healthcare options. But the smart city makeup differs from smart city to smart city depending on interest regions. A disaster management system, for example, may be considered by one smart city, while a trash management system is being considered by another smart city. Some of the following components are found in most smart cities, hence they will be discussed in the following sections.

2.3.1. Smart community: As a smart city, its ultimate goal is to improve the quality of life for its residents. Building automation, water management, and solid waste management are all included here. Everything from offices and schools to data centers and industrial plants and warehouses can be considered "smart buildings. The performance of a single component is limited. To get the most out of a smart city, a community's smart components are interconnected. Equipment and sensors for generic smart buildings are available, as well as software and hardware tailored to their individual needs. When it comes to energy management, smart and green buildings have a lot in common. On the other side, green buildings seek to maximize energy efficiency while simultaneously minimizing their negative influence on the environment. [27]

2.3.2. Smart transportation: Innovative modes of transport Humans have relied on transportation since the dawn of time. This criterion has been broadened by technical advancements to include land, marine, rail, and air transportation. The world's traditional modes of transportation were neither interconnected nor interdependent. Conventional transportation systems have been transformed into modern interconnected transportation systems by the concept of connecting ordinary objects. Because of this, today's transportation systems include a variety of communication and navigation devices. All particles of the same transport type are linked to each other. Diverse modes of transportation are linked together to provide a global transportation system by extending links within the same medium. The concept of intelligent transportation systems (ITS) drew a lot of attention to vehicular ad hoc networks (VANET).[28]

2.3.3. Smart healthcare: Integrated healthcare systems the modern world faces several healthcare difficulties as a result of the exponential rise in the globe's population. There are now so many people in the globe who need medical treatment that standard medical procedures are no longer relevant and outmoded. As the number of medical practitioners in the healthcare field grows at a slower rate than the population, the problem gets worse. An increase in improper medicine prescriptions, incorrect diagnosis, and misinterpretation of contagious or epidemic diseases are all possible outcomes. Due to the lack of resources and excessive demand, the gap between expectations and reality in healthcare grows. Smart healthcare systems have been offered as a method to bridge this gap between healthcare demand and supply while retaining efficiency, accuracy, and long-term viability of care. A new term for the integration of traditional healthcare methods with cutting-edge technologies such as sensors, wearable gadgets and emergency services is "smart healthcare." Modern intelligent healthcare services use sensor networks, cloud computing, ICT, smart phone applications, fog computing, and strong data processing techniques to meet customer expectations and improve service quality. [29]

2.3.4. Smart energy Intuitive power use any kind of operation requires a source of energy. Renewable and nonrenewable energy sources can both be included in a well-rounded energy portfolio. Non-renewable sources such as fossil fuels diminish with use; renewable sources such as solar, wind, and geo-thermal energy regenerate. Experts have been promoting "smart energy" [30], "green energy" [31], and "sustainable energy" [32] concepts over the past few decades in order to raise awareness and advertise the best practices for energy usage. The goal of green energy is to use energy in a way that has the least negative impact on the environment. Sustainability in energy is preserving nonrenewable energy sources for use by the present and future generations

A holistic approach to sustainable, green, and renewable energy makes the smart energy concept more appealing to others. To further explain, "smart energy" refers to a strategy for satisfying energy needs while at the same time protecting the long-term viability of nonrenewable energy sources.

2.3.5 Interoperability and integration: Integration and interoperability of the above-mentioned components is essential to the realization of a smart city concept. Improved efficiency, quality of service (QoS), and intelligent decision-making can be achieved through interactions between components. So, a smart community scenario might have an intelligent home interact with a smart grid and renewable energy plants to maximize the intelligent home's energy consumption.

This is similar to how DR and real-time pricing are handled by smart grids. As a result, in smart buildings in smart cities, wasteful energy usage is avoided. Energy conservation becomes a local, city, regional, national, and even global issue once this technique is implemented in all smart buildings. There are numerous components that must be integrated in order for a real world smart city to be implemented, and this can be the most difficult effort of all. Each part is made up of a plethora of different gadgets and sensors. Device heterogeneity is so great that it creates a slew of platform incompatibilities that make it difficult for smart city components to work together. Since smart city components must work together, it's important to address compatibility difficulties. We have proposed an architecture for smart cities based on the web of things (WoT) to improve interoperability between smart city components [33].

Fig. 2. Architecture of a smart city in a generic form.[33]

3. Green Architecture

It is a strategy to constructing that minimizes the negative consequences on human health and the environment. Eco-friendly building materials and procedures are used by "green" architects and designers to protect the environment [34].

An approach to construction that reduces environmental and human health impacts is referred to as "green building." "Green" architects and designers utilize environmentally friendly building materials and practices to protect the environment.

3.1 Environmentally Friendly Design and Architecture

"Green architecture" encompasses all types of environmentally friendly architecture and contains some consensus [35]. It could have any or all of the following features:

- Energy-efficient lighting and appliances
- Water-saving plumbing fixtures
- Ventilation systems designed for efficient heating and cooling
- Use of recycled architectural salvage
- Alternate power sources such as solar power or wind power
- Minimal harm to the natural habitat
- Non-synthetic, non-toxic materials
- Responsibly-harvested woods
- Adaptive reuse of older buildings
- Locally-obtained woods and stone
- Efficient use of space
- Landscapes planned to maximize passive solar energy

Even if most green buildings don't achieve all of these standards, the ultimate goal of green design is to be completely self-sustaining in the long term. Environmentally friendly construction is also known as ecological design.

3.2 The Advantages of Green Architecture

3.2.1. Social effects include:

- Aesthetic & physiological state improvement
- Heat Island Effect reduction
- Air Quality improvement

3.2.2 Development related effects include:

- Thermal insulation and energy efficiency
- Façade protection
- Sound barrier

3.2.3 Ecological effects include:

- Increasing biodiversity
- Health and wellbeing improvement
- Urban agriculture & Food production [36]

3.3 The Green Architecture Categories:

The following 15 categories of green architecture are derived from prior green architecture principles and ranking systems. Each category has its own set of design methods. The types of green architecture are as follows: [37]

3.3.1 Sustainable Site Planning: It is the goal of the Sustainable Sites Performance category to promote techniques that maximize land utilization while minimizing construction and operational consequences. When done correctly, site design can help reduce storm water runoff, encourage people to carpool and commute by bicycle, improve the amount of open green space in cities, and prevent severe disruptions to the terrain, vegetation, and wildlife habitats that are particularly vulnerable.

3.3.2 Water: Reduce the amount of potable water used in landscape irrigation and building activities while still achieving the same or better results to reduce the need for municipal infrastructure, on-site water harvesting and wastewater technology can also be employed to reduce water consumption.

3.3.3 Storm Water: The built environment has a multitude of negative environmental impacts, including stream degradation, the loss of aquatic species, flooding, and the 96 loss of groundwater recharge. At the municipal level, storm water management is likewise very expensive.

3.3.4 Sewage: Outfall An overabundance of sewage could cause current sewage infrastructure to become overburdened (either on-site, in the community or at a municipal level). As a result, the level of sewage treatment that can be funded is limited, or raw sewage spills straight into the environment is the only option.

3.3.5 Energy Efficiency: Non-renewable energy resources and their environmental implications, such as air pollution emissions, are the focus of the category on energy and the atmosphere. The use of environmentally friendly renewable energy sources is being promoted. Aside from lowering greenhouse gas emissions and ozone depletion, these measures are also encouraged.

3.3.6 Pollution: No ozone depleting compounds and low NOx emitting substances should be utilized in the construction of the building in order to address pollution levels in the design. Reduced peak surface storm water runoff rates should also be addressed in areas where storm water transports a variety of pollutants into rivers, lakes, and the sea.

3.3.7 Materials : Conservation of material resources and building waste is a primary goal of material conservation. Furthermore, it encourages the use of environmentally friendly building materials. Minimize construction waste by using recycled and salvaged materials as well as reusing the facade of the building. Conservation can also be achieved through the use of renewable building materials and the creation of long-lasting structures.

3.3.8 Resources: Building materials, water, and other natural resources all need to be conserved through methods such as reusing, reducing, and recycling.

3.3.9 Improving Indoor Air Quality: Occupants' health is negatively impacted by poor indoor air quality. It has a general impact on one's sense of well-being. Most individuals spend the majority of their waking hours at home or at work, therefore it's critical that these places promote good health. Volatile organic chemicals, airborne microbiological agents, inhalable dust, dust mites, nitrogen dioxide, and sulphur dioxide should all be considered when determining the quality of indoor air.

3.3.10 Occupant Satisfaction: Failure to produce an acceptable atmosphere is ultimately the primary goal of any PA structure that fails to satisfy its residents. Comfort issues such as aesthetic and thermal, as well as noise and health concerns, can drive buildings to be demolished and renovated prematurely if they are not addressed. In practice, this results in fewer environmentally efficient buildings.

3.3.11 Innovation: There are several different scoring systems, but innovation far outweighs any credit given for energy or water efficiency. In addition to acoustical performance, education of occupants, community development, and lifespan analysis, it includes tactics or measures that are not covered by other rating systems.

3.3.12 Waste: During the course of a building's lifespan, it is inevitable that waste will accumulate. There are many examples of garbage generated during building demolition, renovation, and construction such as bricks, metals, wood, and cardboard Landfilling building and demolition trash is a waste of valuable resources because it can't be used into new products. Paper, aluminum cans, and glass are just some of the materials that end up in landfills during building construction. Our landfills are overburdened, and we're wasting precious raw materials as a result.

3.3.13 Toxic Materials: Although toxic materials may be required during the construction process, it is vital to minimize their impact by following correct storage, use, and disposal guidelines. Pollution can be reduced by keeping hazardous materials out of landfills.

3.3.14 Transportation: The quantity of traffic generated by new development can be affected by the design of new buildings. Aside from the obvious harm to human health and the environment, this also has a severe influence on the economy. The number of cars on the road may be reduced by buildings that are built with pedestrians and public transportation in mind and that have a low number of parking places. It is also possible to design buildings to contain parking spaces 99 for carpools and car sharing, which encourages people to use other modes of transportation.

3.3.15 Environmentally: Neighborly Householder The use of poisonous chemicals and harmful herbicides, insecticides, and fertilizers is strictly prohibited by an environmentally conscious homeowner. Limiting the amount of yard watering, employing mulching mowers, or "grass cycling," a procedure that involves leaving grass clippings on the lawn after cutting so that they can serve as a natural fertilizer for the garden, are some of the new and better methods of lawn maintenance.

A list of fifteen key categories of green architecture was developed using current green architecture rating systems and checklists as a starting point. The principles of green architecture seek to balance the needs of both the natural environment and human habitation (such as energy, water, materials, the atmosphere, and land fauna and flora).

3.4 Green Architecture as a New Field of Sustainable Planning

Towards the dawn of the twenty-first century, the discipline of green building underwent a radical transformation into one that deals with far more intricate challenges. Beyond the traditional techniques, a multidisciplinary perspective has expanded the issues of green architecture theory and practice. The definition of "green architecture" has been broadened to include infrastructure, technology, ecology, and the integration of the arts into a single system. New design and urbanistic methods that are performance-based, research-oriented, logistics-focused, networked are the result of sustainable planning. [38]

When it comes to urban design, landscapes and ecosystems, rather than man-made structures and infrastructure, are the driving forces behind Green Urbanism, an emerging subject of planning and design. As a result of the increasing commodification of urban greenery as a cultural good, cities are becoming increasingly difficult to identify from one another. Many urban areas have long since lost most of their residents to their decentralized suburban environs, which have replaced regional and historical distinctions. People in Azerbaijan spend much of their time living in developed settings that are less dense, more accommodating to automobiles and have a lot of open space. A novel importance for green design has emerged in the horizontal area of urbanization in the setting of complex natural ecosystems, post-industrial sites, and public infrastructure [39].

Many of the "re"-derived terms used in sustainable planning include the terms rehabilitation, restoration, reclamation and recovery. Green structures and spaces in between them also feature prominently. Structures essential to green architecture can be seen throughout these places. Due to their size and construction, these structures dominate the land on which they stand. The qualities of green places vary depending on the level of urban activity.

4. Green Building

Improved occupant comfort and reduced environmental effect are at the heart of green building practices that span the whole life cycle of a structure, from conception to demolition, from operation to dismantling to recycling and composting. However, there are some minor discrepancies in the definitions of the terms "sustainable" and "environmental" [40].

Building green has many advantages, including lower operating costs, better indoor air quality, reduced health impacts on the environment, reduced storm water runoff, and a smaller heat island effect [41]. It can also increase productivity and use less energy and water, all of which lead to lower operating costs. Sustaining the built environment is critical to advancing the broader sustainability goals of sustainable design, planning, and construction. Those who practice green building frequently aim for a balance between a building's natural and manmade surroundings that is both ecological and aesthetically pleasing [42]. Sustainable homes and structures can look exactly like their non-sustainable counterparts, even from a distance.

Buildings that are environmentally friendly are referred to as "green." Their constructions last for a long time, which helps the environment. In addition to the term "green building," the term "sustainable building" can also be used. When it comes to the construction and deconstruction of the buildings, the resource efficiency extends to all stages. Green building construction calls for extensive collaboration between the design team, the architect and engineering teams as well as the end user throughout the course of the construction process as a whole (Figure 3). One of the primary goals of green building construction is to reduce the built environment's total environmental impacts on both human health and natural ecosystems. Using resources wisely and effectively is the way to go about achieving this goal. Reducing the amount of waste produced by employees and cutting down on the amount of pollutants that enters the environment. [43]

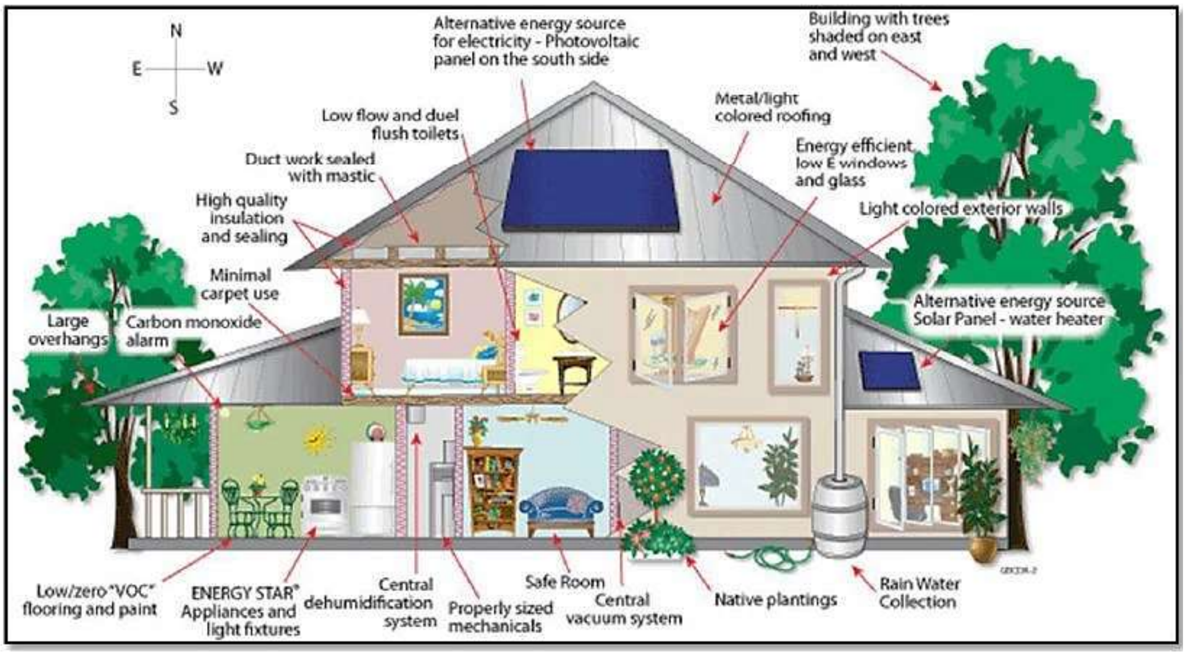


Figure (3): The Green Building Anatomy.[43]

4.1 Green building and Natural building

To be more environmentally friendly, both green and natural building techniques are employed. Despite this, there is a distinct difference in sustainability. . As a result, green construction is becoming increasingly popular among development professionals, who believe that it is both vital to protect the environment and beneficial financially. [44]

Regulation of green construction methods has been increasingly significant in recent years thanks to LEED standards developed by the U.S. Green Construction Council [44]. Whereas in a natural building project, local natural materials are utilized. It's easier to handle on a smaller scale, and it's better for the environment [45].

5. The Importance of Green Architecture in Smart Cities Design

Designing green, sustainable structures and items with consideration for their environmental impact, long-term economic growth, and societal well-being can be a cornerstone of smart city planning. There are six primary categories of sustainable building design in smart cities.

- **Building envelope responding to architectural form, climate and material**: Choose environmentally friendly, long-lasting building materials with a high percentage of recycled and renewable content, and plan your construction to use as few resources as possible, such as energy and water, by maximizing the use of efficient aesthetics and engineering, and minimizing the amount of waste generated during the process.
- **Energy use and dealing with passive and active systems**: Take advantage of natural systems' interconnectivity and use renewable and low-impact sources of energy. Maintain a focus on natural energy flows to reduce negative environmental impacts on all facets of the built environment, including but not limited to air and water quality, land usage, natural resource use and natural resource use. The

building's energy efficiency should be close to the level of a Net Zero building.

• **Indoor environment:** Healthy indoor air quality, ventilation and thermal comfort, as well as good acoustical control free of volatile organic compounds (VOCs) and other dangerous agents, are all essential components of a sustainable building design.

• **. Water and waste management:** Use potable water sparingly while increasing the recycling and reuse of rainwater, storm water, and gray water on the site and in the building to reduce waste.

• **Overall evaluation including Net Zero aspects:** Using formal grading systems, such as Energy Target Finder to establish minimal technical performance and then exceeding it through cross-checking basic manual calculations and computer simulations, buildings are evaluated for design and energy performance.

• **Site issues including site selection: Reduce** urban expansion, show sensitivity and respect for the land, environment, habitat, and green space, and promote high-density urban growth over low-density development in order to maintain important green space and environmental assets. Designers have the ability to limit site disturbance and regenerate and protect significant habitat, green space, and ecosystems.

An approach to design that values nature's role as a teacher and considers environmental, technological, economic, and social factors is informed by these six ideas. It is now common practice for designers to incorporate bioclimatic design into their projects, which incorporates advanced computer simulations and the study of natural processes (bio-mimicry). When it comes to building design, it's best to work with rather than against the laws of nature. [46]

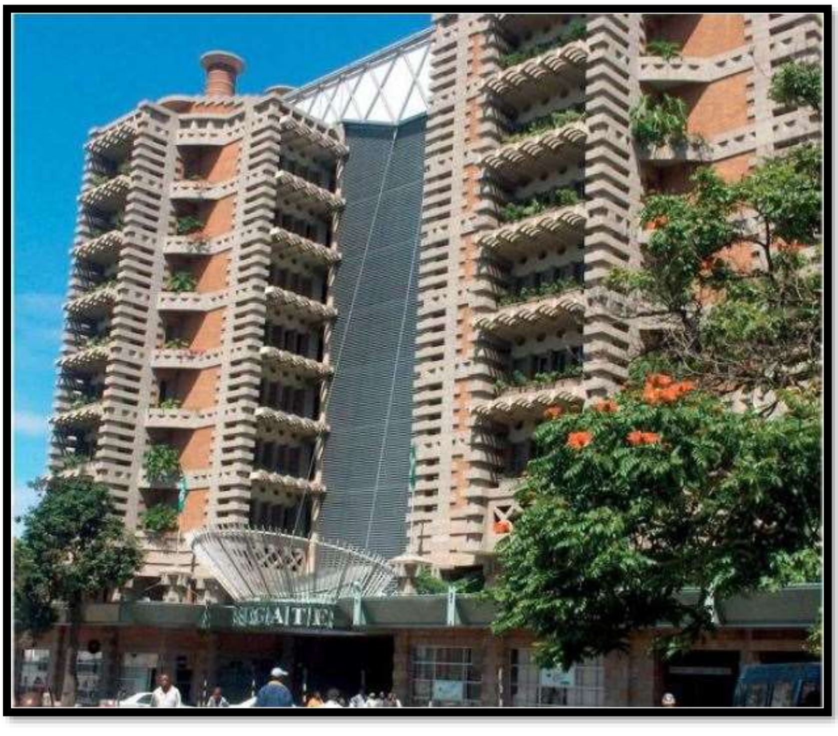


Figure 4 Office building East gate in Harare, Zimbabwe From the bio-mimicry of termite hills, an example of an environmentally friendly structure [46]

6. Major Benefits from Outcomes of Green Architecture in Smart City:

Some advantages can be more simply quantified than others (i.e. waste reduction, energy savings, reduced operating, decreased water use, and maintenance costs, improved indoor air quality). An increased occupant/well-being employee's and productivity can still be accepted intuitively even if it's tough to quantify. It is also becoming increasingly usual to track and appreciate these more qualitative rewards as research become more timely. [47].

As a result, one of the most recent and important driving forces behind green building is the fact that occupant health and comfort are greatly improved. As a result, the movement has moved beyond environmental concerns and is now focused on creating a sustainable model that encompasses all three pillars of society: economic, social, and environmental. Many of the advantages of green building may be seen by looking at the definition alone. To earn LEED (Leadership in Energy and Environmental Design) certification, a building must meet all six of LEED's performance requirements. A framework for debate will be provided by the following six LEED standards: 1. Eco-friendly locations 2. Water conservation Earth and its environment Resources and materials. The quality of the indoor environment is a fifth factor. 6. Design and innovation. In order to be given points in the grading system, students must demonstrate mastery of the primary characteristics and characteristics of each category. [49].

6.1 Sustainable Sites:

• Preserve green space/ open space/ habitat and reduce development footprint.

• Decrease storm water and sewer costs with management plan and system.

• Decrease impervious surfaces and replace with shaded, light-colored, or open-grid paving.

• Use site intervention as a regenerative strategy.

• Design of sediment and erosion plan to decrease erosion.

• Brownfield redevelopment.

• Site access/ close proximity to public transit.

• Benefits for alternative forms of transport (i.e. showers for bikers; preferred parking for hybrids and/or carpoolers etc.)

• Reduce light pollution.

• Incorporate ―green‖ roof (i.e. vegetated or high albedo)

6.2 Water Efficiency:

• Reduce use of city water for sewage.

• Use captured rain or gray water for irrigation.

• Reduce water consumption for irrigation.

• Treat wastewater on site to tertiary standard.

6.3 Earth and Atmosphere:

• Use best practice commissioning procedures.

• Optimize energy performance (i.e. efficient HVAC systems; passive-solar)

• Use on-site renewable systems or with a local renewable supplier.

• Provide building owner with a manual for recommissioning building systems.

• Utilize materials without toxins.

6.4 Materials and Resources:

• Provide area for recycling waste materials

• Divert construction, demolition, and land-clearing waste from landfill

• Use salvaged or reused materials

• Utilize materials made from post-consumer recycled content

• Use local building materials (within 500 miles)

• Use products certified under the Forest Stewardship Council-certified forests

• Reuse existing buildings whenever possible

6.5 Indoor Environmental Quality:

• Prohibit smoking in the building

• Install permanent CO2 monitoring system

• Design ventilation systems with adequate in air-change

• Develop an IAQ management plan

• Use materials with low volatile organic compound (VOC) content

• Minimize pollutant cross-contamination of occupied areas with design

• Provide individual controls for airflow, temperature, and lighting

• Maximize day lighting and views for all occupied spaces.

6.6 Innovation and Design Process

• Go above and beyond LEED requirements

• Have a LEED-accredited professional as a principal participant

7.The Process, Adaptation, and Renewal of Sustainable Strategies

- Sustainable urban ecology and design can invent new relationships between place and people, rather than simply corrective measures, so that green architectural projects become more about invention and programs rather than simply corrective measures. recognizing and interpreting the cultural and historic significance of the green architecture In order to establish sustainable plans to regenerate areas, five key criteria must be adhered to:

- Function well;
- be adaptable and long-lasting to new uses;
- be responsive to their surroundings;
- have visual coherence and create 'delight' for users and passers-;
- by be sustainable – nonpolluting, easily accessible, energy efficient, and have minimal environmental impact. These are just a few of the requirements for a successful redesign. It is crucial to preserve our industrial and commercial legacy by repurposing obsolete structures, and this is one way that green architecture accomplishes this goal. When it comes to improving the quality of the local environment, retaining uniqueness and drawing tourists and new businesses, regeneration may be a significant planning tool. To breathe new life into even the most run-down urban neighborhoods, design solutions that boost economic growth, social cohesion, and environmental quality may be used to maintain the spirit of the present site apparent. Local individuality, as well as new business to the area, making it quite popular with the local community. Preserving urban areas that have been neglected and deteriorated may be given a new lease of life with the help of design techniques that contribute to economic development, environmental quality, and social cohesion [50].

Generally, sustainable plans for abandoned urban areas have two primary characteristics. The primary goal of the first approach is to adapt and regenerate the current framework. The old buildings of the city's previous activity are repurposed as focal points or as a foundation for new activities. A public park is most likely to be built on the area where all of the buildings are situated when the land is restored. In order to generate new spatial organization, new patterns of activity, new spatial organization, and new vegetation tactics are all blended with the existing structures. This kind of strategy frequently reclaims industrial fabrics and manufacturing areas. The feeling of place could be readily maintained by the design approach if all of the structural features were preserved. The alternative option entails the complete demolition of the industrial activity pattern and the subsequent rehabilitation of the land in preparation for future use. It is common for landfills, deposition sites, and polluted regions to be viewed as a fresh surface that has to be cleaned. After a lengthy period of rehabilitation, the area is now ready for new uses and development to take place. Derelict industrial sites have been a key topic in landscape design in the early 21st century, and new design ideas have developed from substantial reclamation activities. A new path has been opened in landscape design theory and practice by all of these works. Reclamation works and design intelligence may be used to build more efficient, spatially planned public areas first. This means that reclamation is a crucial design consideration for which experts' expertise is necessary. All of those initiatives are also process-oriented. Planned, rather than compositionally focused design, requires four important modifications in technique. In the first place, the fluidity of the material calls for a focus on the design process rather than the ultimate shape of the landscape. It's not necessary to introduce new forms and reshape the site to accommodate them; rather, they are "discovered" and developed from existing systems. [50]

As a result, a change from producing compositions based on concepts of regularity, balance, and hierarchy to dealing with natural , systems and man-made, and the numerous ways in which they might be arranged and dispersed as fields and gradients. Another change in the design process is a greater emphasis on site planning than was previously the case with more formally focused methods.

Environmental considerations are only one part of a bigger range of issues that must be taken into account while developing a site. Besides noting what is currently there, site planning also examines how systems have grown and behaved through time, investigating how and why the landscape got at its present condition. As a third consideration, history is seen as an ongoing process rather than a static example of a particular design element or style. The site's observable attributes and accumulated histories are just as important to process-based techniques as the site itself. On top of all of this, sustainable process-based approaches are aware of the fact that they are just one part of a much larger process of progress in green architecture. An important consideration when developing a design is how it responds to changes in programmatic requirements and unforeseen disruptions, rather than focusing on long-term stability. [51]

8. Vehicular Ad Hoc Network (VANET) and Smart City

The number of vehicles on the planet has grown dramatically during the last several decades. There is a four-fold increase in traffic in India compared to population growth. For the last two decades, governments and automotive manufacturers have struggled with the issue of road safety. Companies, researchers, and organizations have turned their attention to improving traffic safety as a result of new car technology. Researchers have been able to establish communication networks that include autos because of the advancements in wireless technology. In order to facilitate communication between automobiles and roadside equipment, networks such as VANETs are developed. Using moving vehicles as nodes in a network to build a mobile network is called a vehicular ad hoc network (VANET). [52].

Vehicle networks have played a vital part in new concepts like "smart cities" and "living labs" that have emerged in the recent years. Traffic management and road safety are two of the most important areas where VANETs are being studied. Cities with growing populations and congested roads might benefit from lessening their transportation burdens. VANET serves to alleviate this issue by enhancing the mobility of cars and also contributes in the creation of safer and more advanced cities. When automobile technology first began to take off, the focus was mostly on improving highway efficiency and safety. The rapid development of wireless technologies and their integration into automobiles means that an Intelligent Transportation System (ITS) may be implemented, which will transform how we drive and assist life-saving emergency services in the future. Using VANETs, vehicles may communicate with one other and with permanent infrastructure more easily. This will not only make the roads safer, but it will also have business benefits. Reduced traffic, less pollution, and fewer accidents are all advantages of VANETs. The adoption of a functional VANET system will benefit both traffic officers and drivers. On-time traffic alerts and information on recent traffic incidents may help alleviate congestion in the city. Additionally, it aids in determining where traffic law violations take place. On the other side, real-time traffic notifications will reduce the amount of time and fuel needed to travel to your location. Because of this, it has a number of benefits. [53]

9. Conclusions

The Internet of Things (IOT) notion of a "smart city" was born. Among the many urban planning concepts that incorporate information and communications technology (ICT), digital city, green city, sustainable city, and intelligent city are some of the most notable for their all-encompassing outlooks. To put it another way, a "smart city" is a collection of many approaches to managing the urban environment. Definitions, norms, and implications of a smart city were discussed in this study. The elements and characteristics of a smart city are laid out in a clear and concise manner so that the concept may be grasped. After a detailed examination of the various proposed smart city architectures, the generic architecture of a smart city is defined.

There are many benefits to adopting the principles of "Green Architecture" and "Green Building" in order to better utilize the natural environment and renewable energy sources, and then to creating standards for energy efficiency in buildings. These "Green Architecture" technologies have been put to use in the United States, Europe, and Asia, proving their practicality and effectiveness. Famous "Green Designers and builders" contributions from around the world have made this sector even more promising for the future development of these successful concepts. They try to attain the highest possible level of environmental sustainability in these cities. Through the research, the role that green architecture plays when planning and executing smart cities.

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