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Towards a Model for Smart Sustainable Residential Communities in Egypt

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ABSTRACT

A future vision has been set for the capital of Egypt 2050 to be an environmentally smart and sustainable city that provides accessibility and able to attract business and investment. Therefore, this research will result in standards' matrix towards a smart sustainable model for residential communities in order to achieve Egypt's future vision. This study relied on the analytical descriptive approach of the reality of urbanization and housing sector in Egypt and the modern planning trends for the development of housing projects adopting the principles of sustainability within the framework of applying the future vision of Egypt 2050. The study will also emphasize that future urban tendencies depend mainly on the implication of sustainable smart systems. These smart systems are essential to cope with the expected technological development of the residential sector of Egypt in order to fulfill the populations' needs.

1. Introduction: Urban Trends and Approaches:

1.1 Egypt's vision for sustainable development:

The national goal of Egypt is to achieve sustainable development through faster economic growth and reducing the consumption of the natural and environmental resources [1].

The concept of a sustainable residential community is based on the application of sustainability standards with sophisticated smart systems and patterns in a coherent manner that supports each of them at the level of planning and design elements in residential communities (the general design of the community, the design of roads and corridors, the general perspective, housing, and the general division of the community).

1.2 Research Aims

Access to a general framework reference (a model for measuring the application of standards for smart and sustainable residential communities)

1.3 Research Importance

This research is an applied practical study to the sustainability of population in order to cope with the Egypt's 2050 future vision.

1.4 Problem of the Research

Absence of relational mechanisms between the different parties responsible for the development of new communities in Egypt and those responsible for the applications of housing sustainability.

2. Sustainable Urbanism Approaches of the Egyptian Cities

1. The ability to move population to new communities in light of socio-cultural dimensions, planning criteria of the local environment, and functional role

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of the desert cities—under the framework of the national development strategy.

2. Following the delicate balances of the desert environment in the planning of the new cities, by adopting the principles of environmental architecture, such as the compact city planning patterns.
3. The ability to afford economic housing and create urban patterns that suit the harsh environment and synthesize culture with new technologies.

d. Exploiting the information revolution and its huge data and modern means in urban and planning methods [2].

3. Smart Cities with Sustainable approach:

It is a city based on the use of information and communication technologies and other means to improve the quality of life and the efficiency of operations and services while ensuring that the needs of present and future generations are met [3].

1.3 Aims of Smart Cities

1. The ease access of smart city's residents to public services, electronic transactions, and various information data bases.

2. Improvement of the services' levels and increasing their effectiveness, as well as creating new job opportunities that align with the nature of the smart city [3].

4. New Urban Communities and Egypt's Vision:

The change in the lifestyle will be reflected on the shape of the local urbanism and the extent to which its sustainability and application of smart technology will be achieved. Therefore, this change requires executive planning actions that include: [4]

1. Study future directions and recent studies.
2. Stick to the local identity.
3. Adopting a phased settlement policy.
4. Dealing with future data.
5. Flexibility to accommodate changes and needs

5. Future of Urbanism in Egypt 2050:

It depends on reducing population density, urban sprawl, and the expansion of economic activity. A future vision has been developed for the capital of Egypt 2050 by envisioning it to be a safe, comfortable city for its residents, friendly to them, and welcoming to its visitors, and to be a green, environmental, and smart city [5].

6. Aims of Sustainable Population Development:

Emphasis on the concept of the residential group and social relations. Adapting to the environment while emphasizing the urban identity of the city [7].

7. Restrictions of Neighborhood in Light of Modern Approaches:

With the development of the modern lifestyle and the introduction of influences and factors that must be taken into account, such as sustainability as a basic aspect that effectively influences planning, it contributes to the development and strengthening of the integrated social residential environment. Hence, we find that the theory is the basis, but the application mechanism differs according to the temporal and spatial variable [6].

8. Basic principles in the formation of the residential Neighborhood:

1 - The compacted fabric model: This pattern is suitable for use in terms of scale, movement, and proportions of the voids. In order to suit pedestrian movement, as well as the voids' proportions (the height of buildings in relation to roads' widths) to take advantage of the available land areas and reduce the cost of infrastructure networks. This compactness helps in increasing social connection between population. It also helps in increasing the specificity of location and highlighting city's centers and services' concentration.

2- Mixed uses: a neighborhood with a high residential density and multiple use of spaces and sectors that contain groups of activities serves its residents. Movement between these activities should be facilitated for pedestrians. Also, the service center represents the focal point that distinguishes the community, and it also mixes with different and varied types of housing in size and density. Dorvin specifies that each neighborhood has a civil function or is related to the activities that serve the rest of the city.

3- Multiple means of movement and transportation: the neighborhood depends on the internal movement system, which is a multi-means system that gives an opportunity for the movement of pedestrians, bicycles, and cars. And the system of safe and appropriate movement between the neighboring parts is preferably closed and does not allow transit traffic, but gives priority to pedestrians, then environmentally friendly means of transportation such as bicycles and cars that rely on renewable sources of energy for the necessary services, then comes public transportation such as buses, electric and express trains, and the metro,

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while the private car comes In the last rank, cars should have a specific speed, while providing requirements for people with special needs (such as slopes and the absence of steps and obstacles).

4 - Responding to the environmental and cultural data: the neighborhood is compatible with the environment in which it is planned to respond to the urban and architectural character of the community with the development of studied strategies to reduce pollution and deal with waste. And to be continuous and integrated with the surrounding environment and to be linked to public spaces, gardens, recreational buildings, and community services [5].

9. General characteristics of smart sustainable residential communities:

Providing and diversifying sustainable housing models represents the key components of the smart growth program that supports various forms of housing and achieves the environmental, social and economic aspects.

9.1 The general design:

1- Reducing the entrances and exits to the gathering by having a main entrance and exit from the main streets, with a secondary entrance and exit from one of the secondary streets to achieve safety and privacy.

2- Designing the roads in a streamlined and gradual manner within the assembly and the extent of their connection to the main entrances.

3- Providing internal gardens between the dwellings, so that the dwelling has a facade on the road and a facade on the garden.

4- Directing roads and dwellings to benefit from natural ventilation in dwellings and spaces.

5- Encouraging communication with neighboring communities and achieving the connectivity factor through mobility services, while achieving privacy and security at the same time.

6- Dividing the land in accordance with the general design and the differences in the dwellings' size and the category of users.

7- An appropriate hierarchy of services according to the intensity of need (daily-weekly-monthly-yearly), starting with the neighborhood center and ending with its outskirts, and providing a main service center that includes all services.

8- Providing service centers and queues on the main streets and providing a major mosque nearby.

9- Integration of solar and renewable energy systems in lighting, ventilation, insulation and heating.

10- Waste management systems, recycling gray water, and water control systems. Using technologies and equipment that enhance the water rationalization process.

11- Directing and forming blocks and voids to achieve thermal comfort, ventilation and natural lighting [10].

9.2 The design of roads and paths:

1- Cars (reducing the total area by 10:15% of the total area of the assembly - using the discovery factor while creating distinctive areas for inference within the assembly and reducing the frequent visual extension - designing roads for cars to help reduce internal speed - reducing parking lots in residential and service areas focus on access to these areas on foot - landscaping on the sides of the road - the typical sequence of roads).

2- Pedestrians (providing shaded walkways - a pedestrian network to provide the closest and easiest ways to access services - taking into account people with special needs in movement within the assembly).

3- Providing a central area for public transport, with provision of public transport stations and electric transport stations, the walking distance to which does not exceed 10:15 minutes.

9.3 The general standpoint:

1- Unification of the style of architecture, landscape areas, and internal streets while providing different solutions.

2- Creating visual points by adding parks, services, and public gathering areas to the general line of the facades on the internal roads and distributing the housing according to its heights [8].

9.4 Housing units:

1- Coordination between the size of the dwelling and the land, and building the dwelling at the front of the land, so that the outer wall is dispensed with, which helps in defining the public space in a better way, and the land is exploited in a way that helps in future expansion, with defining car parks for one dwelling.

2- The use of materials and techniques that contribute to reducing costs such as (multiple use of spaces - benefit from external spaces - simplicity in design and implementation - optimal use of building materials - shrinking infrastructure extensions - housing suitability for the environment - roof cultivation) [7].

9.5 The general division:

1- Reducing unused areas and general percentages of uses (40:50% residential - 30:40% green spaces and services - 15:20% roads) [8].

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2- Providing a network of green fabric, trees and various plants, and creating urban gardens by forming a green strip in the middle of two strips of housing next to a central green area at the community level [7].

Through the above proposal, a referential framework was proposed for the standards of smart sustainable residential communities, which include (urban standards - environmental standards - economic standards - social standards - smart standards) in a coherent manner that supports each other. Taking into account that some of the elements of these standards are digital and others are non-digital. The proposed standards are of great importance as they are considered as an effective tool for determining the general objectives of planning the residential community under the framework of modern development and modern smart technology as a main criterion to keep pace with the life developments of the population.

These standards are one of the mechanisms that provide a normative perception of the state of development and follow-up realistic periodic changes towards progress or regression in achieving the goals of planning and development for new urban communities. It is also possible to make a comparison between urban agglomerations. Bearing in mind that these standards are indicative and not binding, and each local area has the right to add or amend according to its characteristics.

The referential framework includes 5 main criteria containing 53 sub-elements with equal relative weights in the evaluation, where the percentage of application of the element in the residential community is evaluated according to the information available about it. In order to know the percentage of application of the standard in the community, all the weights of the elements of one criterion are collected and divided by their number. The total percentage of the application of the standards in the residential community is calculated. The relative weights of all the elements of the standards are collected and divided by the total number of the 53 elements to recognize the total percentage of the application of the standards in the residential community.

10 Referential Framework for Implementing the Standards of Smart, Sustainable Residential Communities:

10.1 Elements of Referential Framework and percentage of its application

Table 1: Referential Framework for applying the standards of sustainable smart residential communities. / Source: the author

Elements of the Referential Framework	The percentage of applications in the case of the study
Urban Standard: 1-Each residential community has a function that serves the rest of the city. 2- Adopting the concept of the sustainable neighborhood unit as a basic planning unit when planning residential areas. 3- The clarity of the urban structure, the character of the place, the confirmation of the local identity, and the unification of the architectural style. 4- Mixed and multiple use spaces and sectors, and availability of services' centers and queues in residential communities. 5- Uses' percentages (40:50% residential - 30:40% green spaces and services - 15:20% roads). 6- Large divisions with high densities, and a reasonable walking distance of 500:800m for primary school children. 7- Coordination between the size of the dwelling and the land, and its position at the frontage of the land. In this way, the outer fence can be removed to help the horizontal and expansion, and the provision of internal gardens. 8- Distribution of housing units according to its height and exploiting its distribution visually. 9- Integration between land use and transportation planning, with an emphasis on public transportation and the provision of multiple transportation options. 10- Hierarchy of roads (main - sub) and the extent of their connection to the main entrances and providing stations for public and electric transport. 11- Designing cars' roads in a way that help reduce internal speed. 12- Giving priority to pedestrians and providing them with easiest way to access services. 13- Offering a car parking space for each dwelling. 14- Providing a central area, green areas, playgrounds and entertainment areas, especially for children, away from the traffic risk and noise.	urban standard By = 14/53 * 100 = 26.4% of the total percentage
Environmental standard: 1- Implementing principles of environmental architecture and taking into account the climatic determinants. 2- Designing the district and the roads, taking into consideration the prevailing winds to rely on natural ventilation in the housing, open spaces, and compacted fabric. 3- Integration with the natural surrounding and the exploitation of environmental and natural resources. 4- Confirming the borders of the neighborhood and locating it away from the exposure to natural disasters. Also, conforming to the building legislations, and the building percentage does not exceed 40% of the land.	environmental standard is 13/53 * 100 = 24.5% of the total percentage.

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5- Preserving open space, agricultural lands and environmental lands.
6- Establishing the basic infrastructure and the infrastructure for renewable energy and the use of afforestation and green belts.
7- Trees and vegetations on the sides of roads and paths as an aesthetic view and for shading.
8- Depending on environmentally friendly transportations that uses renewable energy.
9- Develop studied strategies to reduce pollution and wastes' disposal.
10- Exploiting open areas, forming natural environments that overlap with residential sectors, in order to provide shading and minimize exposed lands.
11- Using hemispherical housing shapes and employing domes and vaults.
12- Integrating solar energy systems and renewable energy sources in lighting, ventilation, insulation and heating.
13- Waste storage and recycling of gray water.
14-Create a network of green texture, trees and various plants.

Economic standard:
1- Activating the concept of the neighborhood as a basic planning unit and its economic treatment in order to achieve and reduce unused spaces.
2- Cars (reducing the total area to reach 10:15% of the total area—reducing parking lots and focusing on accessing services on foot).
3- relying on residential courtyards and facilitating pedestrian movement for economic suitability.
4- Sustainable, self-sufficient communities.
5- Using modules in planning.
6-The flexibility of the dwelling's spaces to enable the variations of their use, and benefiting from the external spaces.
7-The optimal use of local building materials and renewable. resources, especially those that contribute to costs' reduction.
8- Reducing the need for the expansion of infrastructure.
9 - Simplicity in the design of housing.
10- implementation of green roofs and adapting the dwelling to the surrounding environment and climate.
11-Using technologies that reduces water and energy consumption.

Economic standard: By = 11/53 * 100 = 20.8% of the total percentage

Social Standard:
1- Encouraging community participation in decision-making.
2- Using variety of land divisions that suits the size of dwellings and users' economic standards.
3- Emphasis on the concept of the residential grouping and not the single building.
4- Providing a range of housing opportunities
5- Encouraging communication with neighboring communities and through the connectivity and mobility services, while maintaining privacy and security at the same time.
6- Implementing the vocabulary of historical architecture and principles of green architecture.
7-Reducing the entrances and exits to achieve maximum safety and privacy.
8- Providing requirements for people with special needs (such as ramps, lack of steps and barriers to entry).
9- Exploiting open areas (streets, parks and intersections) to activate social communication.
10- Mixed-use development with overlap between residential, commercial, administrative and entertainment spaces to achieve an increased sense of neighborhood unity and belonging to the community.

social standard: By = 10/53 * 100 = 18.9% of the total percentage

Smart Standard:
1- The dwelling is the main communication base in addition to its original use.
2- Reliance on the principles of modern smart systems that are compatible with the environment in construction management and control of residential buildings through (energy efficiency systems - communication systems - safety systems).
3- Promoting open and green areas and linking public gathering places via communication technologies, Internet, devices and smart systems. These technologies will enable access to various information bases and control entry and exit from the dwelling.
4- Implementation of the smart envelopes of buildings to respond to climatic and environmental variables through building materials and smart construction systems.
5- The dwelling operates with electronic commands and is equipped with smart technical methods that enables it to change its behavior and to respond and adapt to its surroundings.

Smart Standard: By = 5/53 * 100 = 9.4% of the total percentage2

10.2 The analytical study of residential communities:

This part of the paper will analyze different models of Arab and local residential communities to examine the percentage of implementing the standards of smart sustainability through applying the following calculations:

a. Total percentages of application of the elements of one criterion = percentage of application of one criterion ÷ number of its elements.

b. Total standards application percentages = Standards application percentage ÷ Number of standards elements

c. The extent of application of the standard was classified through: 100 > Strong ≥ 70, 70 > Medium ≥ 50, 50 > Poor ≥ 20, 20 > None ≥ 0

11. An analytical study of the Arab experience:

11.1 An analytical study of the city of Masdar in UAE [7].

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Figure (1): General Perspective of Masdar City (Source: Applying Sustainability Concepts to a Residential Neighborhood in the Gaza Strip, Graduation Project, Ahmed Fouad, Ayman Rizk, Hamada Fayez, Muhammad Awad, and Yousium Anwar, Faculty of Engineering, Islamic University, 2008)

Figure (2): The Residential Part of Masdar City (Source: Application of Sustainability Concepts to a Residential Neighborhood in the Gaza Strip) Graduation Project: Ahmed Fouad, Ayman Rizk, Hamada Fayez, Muhammad Awad, and Yousium Anwar, College of Engineering, Islamic University, 2008

a. **Reasons for selecting Masdar City:** The city is a new addition to the future of cities and a direct application of the elements of sustainability, which supports the ideas of researchers and those aspiring to a better and less polluted life than the current cities, as it will be the first city in the world that is completely free of carbon emissions and waste resulting from fuel combustion, and depends entirely on energy sources

b. **Components of the project:**

1-Residential Masdar City (Residential Area): 30% of the area of Masdar City is allocated for housing. The city is built around narrow and shaded pedestrian paths that connect open public squares on the one hand and houses, schools, restaurants, theaters and shops on the other. The architectural design of the city was inspired by traditional cities and markets spread in the Arab world [7].

2-Business and Research District: 24% of Masdar City is allocated as a complex for advanced technology, 13% of Masdar City is allocated for commercial projects, including light industries, 6% of Masdar City is allocated to the Masdar Institute of Science and Technology, and 19% of Masdar City is allocated for services and transportation, where traffic will be prohibited. Vehicles inside the city, and instead, the use of the transit system in public mass transportation, and private express transportation, and allocating 8% of the area of Masdar City for city and cultural activities, including schools, restaurants, theaters, stores, and many other means of entertainment [7].

c. **Implementation of the project phases:** It will be built using the latest technologies in the clean industrial sector. The city of Masdar will be supplied with the necessary energy needed for its construction, using photovoltaic panels on its roofs.

d. **Services and infrastructure:** The city will include many public services, including power supply, cooling areas and water facilities (drinking water, refined water and rain water) [7].

e. **Roads and Transportation:** Paying attention to pedestrian walkways to encourage walking through paying attention to street design and furniture, and landscaping as a basis for establishing attractive and easy-to-use places, while paying attention to the hierarchy in the streets and planting them. The city will be free of cars and contain only pedestrian paths, each of which is not more than 200 meters away from the nearest transportation station or public facility. The rapid environmental train system is within the city as part of the master plan for the same system in Abu Dhabi [6].

f. **Among the future solutions in the field of transportation**: A rapid personal transportation system that guarantees privacy to travelers just like traditional private cars and parking lots for non-residents, in addition to parking spaces designated for visitors and residents of the city, next to a center for managing transport operations using environmentally friendly means. Energy sources (economy): a range of renewable energy sources are used, the most important of which are solar energy, wind energy, thermal energy, and hydrogen [7].

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g. Green fabric: Various strategies and new technology will be used through the green extension within the city, such as the harmony between the components of the open and covered external spaces of pedestrian paths, water, and plants that provide a comfortable natural atmosphere for the residents, and there is also a random extension of green plants (like green forests) penetrating the complexes. The housing units are in the form of a zigzag line, which in turn achieves a continuous harmony with the green fabric. There are regular lines similar to the framework that works to protect the residential communities from the desert environmental influences, which in turn enhances the biodiversity in the neighborhood [7].

g. Supporting the cultural heritage by preserving the heritage and passing it on to future generations and preserving the local identity to reflect the authentic Arab culture of the city [6].

h. Communication and information transfer: Information and communication technology is used in modern cities for two main reasons: to provide basic services in the most efficient and effective way and to raise the standard of living of the population. By allowing the provision and dissemination of more services with high efficiency (for example, managing appointments for rapid personal transportation as needed, scheduling the delivery of supplies according to the desire of the recipient, and advanced monitoring of facilities to rationalize energy consumption and moral value (for example, providing appropriate and accurate information to the population, enriching entertainment, and informing the population on progress in the environmental agenda) [6].

Table 2
Analysis of Masdar City according to the frame of reference or source: the researcher.

Framework of reference standards	application degree	
urban standard	%87	strong
environmental standard	%89	strong
economic standard	%79	strong
social standard	%69	middle
Smart standard	%55	middle
Overall application score	%80	strong

Sustainability standards have been observed in residential communities (environmental, economic, and social) with a strong percentage of environmental and economic standards and an average percentage of social standards, in addition to the application of urban standards at a strong rate and the application of the smart standard at an average rate, which led to an increase in the percentage of application of the standards of sustainable smart residential communities to a strong percentage with the highest application percentages among the study sample projects, where a weak or non-existent percentage appeared for one of the criteria.

j. Project strengths:

1-The division of the city into urban communities, each of which performs a special function for the rest of the city

2-Adopting the concept of a sustainable lime unit, applying the three dimensions of sustainability, and trying to reach self-sufficiency

3-Confirming the local identity and the architectural design emanating from it, taking into account the principles of environmental architecture and climatic determinants

4-Mixed use of lands, reducing the percentage of roads, their gradation, and their connection to entrances, and preventing cars from entering the city

5-Enhancing the high population density by dividing the land according to the density, securing the borders of the regions and neighborhoods, and submitting to the building requirements

6-Using the public mass transportation system, providing its stations, and enhancing pedestrian movement to access services

7-Providing central areas, green and recreational areas, and preserving open spaces and environmental lands

8-Establishing basic infrastructure and infrastructure for renewable energies and paying attention to afforestation

9-Develop strategies to reduce pollution, recycle waste, and use water and energy rationalization techniques.

10-Providing a wide variety of housing opportunities

11-Taking into account social dimensions, communication, social interaction, and the overlap between the residential, commercial, service, and entertainment sectors

12-Using information and communication technology and creating databases that can be accessed from the residence

13-Using smart principles and systems that are compatible with the environment

k. Project weaknesses

1-Non-compliance with the child's walking distance to the primary school

2-Not using domes and basements as architectural environmental formations

3-Inflexibility of residential spaces for multiple uses

4- Not giving priority to reducing infrastructure supplies

5-The community's participation in planning decision-making was not clear.

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6- Strategies to meet the requirements of people with special needs are not clear.

7- The lack of sufficiently intelligent systems to control the dwelling and the automatic response to the surrounding variables (control by electronic commands).

11.2. An analytical study of the local experience: The City of Al-Rehab

a. Reasons for selecting Al-Rehab City:

Al-Rehab City in New Cairo is considered a successful example in the housing and services sector, but without scientific investigation or testing of its causes and manifestations, especially from the perspective of the future vision of (smart, sustainable) residential communities.

11.3 Analytical Study of Al-Rehab Neighbourhood in New Cairo:

a. General Location:

Al-Rehab is a residential neighborhood located in New Cairo City, east of Cairo Governorate, Egypt. It is considered the first integrated residential city to be established by the private sector in Egypt. Al Rehab is located on the Suez Desert Road, 15 minutes away from Nasr City and Heliopolis. Each of them covers an area of 220 acres. Each stage presents two types of housing systems, which are villas and apartments, in a new part of the city. Both types are characterized by providing the highest level of engineering and architectural technologies. The city also enjoys a transportation network through the rings that transport the city's residents to and from many areas in Cairo, including the metro station, and each group of buildings is surrounded by green spaces in addition to a parking space, Each villa is designed to provide its residents with independence and privacy [9].

The city is characterized by vast green spaces and is called the Green City. The city also rises above the surface of the earth more than the height of al-Mokattam Mountain in Cairo, which accelerated the rate of air currents and enhanced the temperature of the city, especially at night [10].

The project has succeeded in forming a civilized urban community that raises the security and social level of the citizen and fulfils the desires of middle- and above-average-income earners [11]

b. Religious and educational services:

Each stage in Al Rehab City has its own mosque. The city also has a large church. Al Rehab City contains four private schools. Commercial services: The city has a large commercial market, as well as a restaurant area, two commercial malls, a banking area, an administrative building for offices and companies, and a medical center with medical clinics [11].

Al-Rehab City also enjoys a commercial area that has been carefully prepared to include shops that provide the daily needs of the city's residents. Other services: In the middle of the city is the Al-Rehab Sports and Social Club, which covers an area of 200 acres. Each stage has its own bus line, and there is an external bus line that goes to Saray al-Qobba and another to Nasr City. The city has a police station, a fire station, and a gasoline station. Al-Rehab City includes a tight security system that is considered one of the best in the city of New Cairo

c. General scheme:

1. Decentralization of services Flexibility and freedom of services Encouraging private investment services.
2. directing traffic to the outside, confirming the entrance to the project, with the possibility of entering the site from the main roads, and easy communication between the elements of high topography.
3. Topographically distinct areas suitable for distinct uses and easy topographical areas suitable for all residential and service uses.
4. The presence of a dense tree wall to protect from the Khamaseen winds The area allocated for housing is 50% (the building area is 40% of the allotment, or 20% of the project area), the area allocated for services is 8%, and the area allocated for roads and spaces is 32% [9].

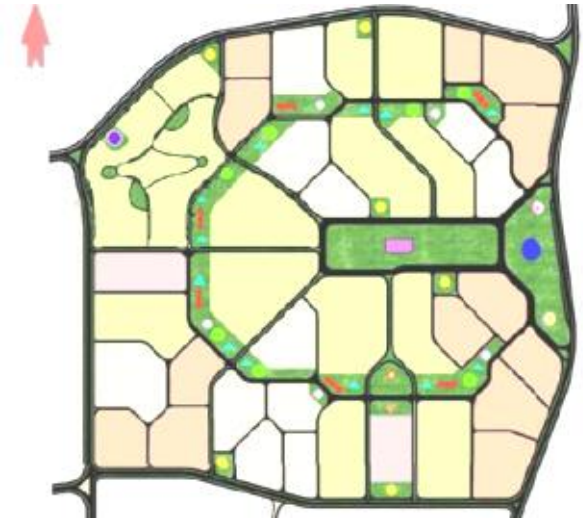

Figure (3): The general plan of Al-Rehab neighborhood (source: www.kutub.info 6768.pdf)

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d. Facilities and Infrastructure:

The facilities serve a distinguished network of facilities and are characterized by the presence of electric generators as an alternative to the public electricity currents. They are also characterized by the presence of water tanks to provide clean drinking water at all times [12].

e. Road network:

The city's road network includes main roads, arterial roads, assemblies, and secondary roads, in addition to pedestrian paths. Main Roads: The arterial roads branch out from Al-Rehab Street in a coordinated network system to the different directions of the city, with a width of 36 m. Sub-roads: a 24-m-wide aggregate road that works as a circular road on the inner perimeter of the city to facilitate linking the city, and pedestrian roads extend parallel to the arterial roads [12].

f. Site coordination:

1. Establishing squares, placing distinctive signs in them, and taking care of the corners of the outer perimeter for easy access.
2. Planting trees in a variety of forms in the green spaces on both sides of the road.
3. The presence of specific gates for entry and exit, equipped with offices for security, and the presence of the wall surrounding the city led to maintaining security, but entry into the city was restricted except for special means.
4. Planting and shading pedestrian paths, in addition to providing seats and umbrellas in close places for the convenience of pedestrians and encouraging them to practice walking.
5. Lighting all streets and pedestrian paths in a manner that achieves safety for pedestrians and vehicles [12].

Table 3
Analysis of a city according to the frame of reference / source: the researcher

Framework of reference standards	application degree	
urban standard	%64	middle
environmental standard	%58	middle
economic standard	%45	weak
social standard	%67	middle
Smart standard	%3	nil
Overall application score	%54	middle

Attention has been given to environmental, economic, and social housing sustainability standards in varying proportions, where social standards have been applied at a strong rate, environmental standards at a medium rate, and economic standards at a weak rate. Urban standards have been applied at a moderate rate, while smart standards have been applied at a non-existent rate. The low rate of application of economic and smart standards has led to a decrease in the percentage. The total percentage of standards for sustainable smart residential communities is medium.

Sustainability standards have been observed in residential communities (environmental, economic, and social) with a strong percentage of environmental and economic standards and an average percentage of social standards, in addition to the application of urban standards at a strong rate and the application of the smart standard at an average rate, which led to an increase in the percentage of application of the standards of sustainable smart residential communities to a strong percentage with the highest application percentages among the study sample projects, where a weak or non-existent percentage appeared for one of the criteria.

g. Project strengths:

1. Attention to the social dimension and the requirements and needs of the diverse population
2. Urban interest, architectural designs, and green spaces
3. Overlapping commercial and recreational uses and green spaces
4. Paying attention to the public transport network and its stations and teaching in the following ways
5. Attention to climatic determinants in the planning and exploitation of wind and natural ventilation
6. Confirming the borders of the assembly and securing it with a strong security system, in addition to submitting to the requirements of the Burmese
7. Provide a distinguished network of facilities and complete them with kindness and shading
8. Simplicity in design, implementation, and diversity in residential styles and architectural designs
9. The design is for the assembly as a group, not as individual buildings.

h. Project weaknesses

1. No job has been allocated for each neighborhood serving the rest of the community and the city.
2. The densities are medium, and the land division design was not related to the walking distances of the primary school
3. Not planning to create a distinct visual field within the assembly
4. Not developing strategies for pollution, waste, and grey water
5. Not relying on renewable energy sources and environmentally friendly technologies
6. Refrain from adopting the idea of self-sufficiency or relying on local building resources.
7. Not to use energy-saving techniques or roof cultivation
8. Lack of interest in community participation in decision-making

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9. The planning and design of the residential complex did not include any smart technologies or advanced modern means, whether in news, management, or communication.

10. Not to link associations and institutions with databases or electronic systems.

11. Not using historical vocabulary or applying the principles of green architecture

12. Not developing special strategies to meet the requirements of people with special needs

12. Results:

1. In the light of the analytical study of Arab and local projects, the strengths that achieved smart sustainable planning for residential communities were identified for application in future projects, as well as the weaknesses to avoid them

2. The extent of the success of residential communities and their achievement of the desired goals depends on the extent to which sustainability standards are applied and the use of smart technologies in planning and design. Development.

3. The provision and diversity of sustainable housing represent the key components of the smart growth program that supports housing in its various forms and achieves the environmental, social, and economic aspects through multiple principles represented in the following: mixed use compacted buildings have various positive effects: providing wide range of housing opportunities and establishing pedestrian neighborhoods; supporting distinctive and attractive residential neighborhoods; creating a sense of place Preserving open space, agricultural lands, and environmental lands Strengthening existing communities; Providing multiple transportation options Predicting development options; Encouraging community participation and decision-makers in making development decisions.

4. The Arab experience has produced strengths that mainly affected the extent of its success, represented in the application of urban, economic, and environmental standards in strong proportions, followed by a moderate percentage of smart standards between strong, medium, and weak, depending on the goal, capabilities, determinants, and vision of the project.

5. The local experience has produced strengths that mainly affected the extent of its success, and they were represented in paying attention to social standards in strong proportions, while urban and environmental standards were in a medium rate, economic standards were in a weak rate, and the lack of smart standards was in a weak rate, which led to the need to focus and pay attention to economic and smart standards.

6. The directions for preparing environmentally sustainable housing plans include taking into account the climatic determinants and dealing with them, exploiting the natural resources, emphasizing the unity of the neighborhood while achieving privacy, paying attention to social relations, and giving priority to pedestrian paths and green and recreational areas.

7. The modern basic principles for the formation of the residential neighborhood depend on the compact formation, the mixing of uses, and the multiple movement systems, in addition to responding to environmental and cultural conditions.

8. The development of modern residential neighborhood planning aims to create an integrated residential environment that meets the needs of the population in light of the new changes and to enhance the concept of sustainability (environmental, social, and economic).

9. The disadvantages of the new urban communities in the housing sector were mostly represented, which necessitated the approach to solving the problems of the housing sector through the future vision of urbanization in Egypt, which is based on the application of sustainability as an entry point for the establishment of sustainable urban communities.

10. The development of urban communities depends on benefiting from the information revolution, modern technologies, and smart systems and linking them to the local identity of the new communities. Their plans are characterized by flexibility and phased settlement in parallel with the infrastructure networks to reach a smart, green, sustainable city that attracts capital and investments.

11. Housing sustainability includes the concept of the residential group, the creation of social relations, adaptation to the natural environment, the creation of small, shaded open spaces, and the consideration of residential cities as an urban attraction that confirms the urban identity.

13. Recommendations:

13.1 Recommendations in the professional field:

1. Introducing the concept of sustainable smart residential communities to the Egyptian market to contribute to saving energy and preserving the environment

2. Benefiting from successful experiences and applications, reviewing models for smart residential communities, discussing them, and benefiting from them in a manner commensurate with the available capabilities and the extent to which these smart technologies can be used with the local reality, especially from an economic point of view

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3. The need for the urban and architectural work teams to communicate with specialists in smart technologies and systems

4. The planning and design solutions must be flexible so as to allow maximum benefit from the development of smart systems to meet future needs.

5. Commitment to achieving planning standards for smart, sustainable residential communities when planning new urban communities or evaluating existing ones, taking into account the renewal and development of these standards in accordance with future developments.

13.2 Recommendations for architectural education:

1. Developing educational curricula to keep pace with modern intellectual trends, anticipating the urban and architectural future, and emphasizing the field of sustainability and smart architecture

2. Inclusion of modern technological systems as basic study materials

3. Holding conferences and seminars that discuss the concept of sustainable smart residential communities and the mechanisms of their implementation

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