

**PROPOSED CRITERIA MATRIX FOR SUSTAINABLE SMART RESIDENTIAL  
COMPOUND URBAN DEVELOPMENT (CASE STUDY: THE NEW  
ADMINISTRATIVE CAPITAL IN EGYPT)**

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**ABSTRACT:** *The research adopts the descriptive analytic approach and is divided into three parts. The first part is an inductive theoretical analysis of urban orientations in light of Egypt's vision for the future 2030, which also examines sustainable development strategy. The second part explores the new urban compounds in light of future urbanization trends in Egypt, which include the establishment of a new capital city. This necessarily leads to studying the housing sector (housing is a consequence and not the aim of buildings capitals) and residential compound orientations from the perspective of sustainable and smart development to identify smart sustainable housing criteria applicable to realizing housing sustainability in Egypt. The third and final part of the research is an applied analytical study and an assessment, according to the measurement matrix, of housing sustainability in the new urban communities and includes a case study of the third residential district in the new administrative capital.*

**KEYWORDS:** Residential compounds, planning trends, sustainable, smart, the new administrative capital, Egypt

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## **INTRODUCTION**

Urban planning generally and the housing sector in particular face numerous challenges in the realization of sustainable urban development and superior quality housing projects. This research is a practical analytical study of housing sustainability indicators and criteria in light of the realities and requirements of urban planning; it applies the future vision for Egypt and respects the rights of future generations by not draining resources. A future vision has been conceived for the new capital of Egypt. It is to be a safe city that provides comfortable living conditions for its inhabitants, who will be identify with it, a green city that is welcoming to visitors and environmentally friendly. The new administrative capital of Egypt will also be a smart city where communication is facilitated that attracts capital and investments.

One of the important advantages of smart urban compounds is that they respect and abide by sustainable development requirements; they are greener and more sustainable. There is presently a need for applying the smart sustainable concept to the development of new urban compounds.

### **Aim of the Study**

This research study presupposes that residential compounds in Egypt face many environmental and urbanism challenges and suffer from the absence of an overall direction or strategy towards sustainable development. This research aims to identify indicators and criteria (the measurement matrix) for assessing smart sustainable residential compounds, to be used as a developmental approach for realizing residential compound sustainability in Egypt in the light of modern developments.

### **THE THEORETICAL STUDY**

#### *Urban Trends:*

Urban sustainability trends in Egyptian cities

- Possibility of relocating inhabitants to the new locations in light of the prevailing social and cultural conditions, and the functional role of the new desert cities within the framework of the national strategy for development
- Expeditious drawing up of a national urban development plan that creates structural changes in the distribution of economic activity and population across the national territory and contributes to breaking away from traditional urban patterns
- Determining the each new city's ideal size according to its individual nature, function, objectives, location, economic base, its relationship with the region in which it is located and the employment opportunities the plan expects to create
- Planning new cities in desert regions according to the delicate balance of the desert environment by applying the principles of environmental urbanization (such as compact structures) and planning criteria adapted to the local environment
- Provision of affordable housing and State subsidized housing and delegating the responsibility for other housing categories to the private sector; the State should provide credit facilities, construction materials and technical assistance and ensure compliance with building standards and laws – Urban patterns must be adapted to the environment and express popular cultures and heritage, while not abandoning modern technologies
- Making use of the information revolution and the wealth of knowledge and modern technologies it offers concerning urban planning and design methods<sup>1</sup>. In June 2013, the Heinrich Boll Foundation issued a book entitled *Smart Growth: the Green Revolution*. The principal premise of this study is that only smart growth is sustainable and that the primary criterion for smart growth is to ensure that energy production and consumption systems function more effectively<sup>2</sup>.

### **The Smart City Concept**

The term ‘smart city’ refers to cities where advanced communications services and information technology are available. This is based on connecting public places in the cities, such as airports, markets, hospitals, parks, recreational spaces and public assembly locales by using advanced telecommunications technology thus enabling smart city inhabitants to access the Internet using their portable devices and to contact all organizations, agencies and institutions in their cities and conduct their business online<sup>3</sup>.

The International Telecommunications Union underlines the fact that cities aspiring to become sustainable smart cities must be aware that building a sustainable smart city means embarking on a course of continuous overall enhancement and perfection; there is no definitive, final solution. The objective is to transform cities into more sustainable, smarter and more solid and resilient living environments, and includes the ability to combat natural disasters, decrease greenhouse gas emissions and provide better protection against crime<sup>4</sup>.

### **The Future of Urbanism in Egypt 2050**

In general, urban development in Egypt is directly related to decreasing population density, urban expansion and the extension of economic activity. The future vision for Egypt’s capital in 2050 entails a city that is safe, provides comfortable living conditions for its inhabitants, who will identify with it, a green city that is welcoming to visitors and environmentally friendly. It will also be a smart city where communication is facilitated that will attract capital and investments<sup>5</sup>.

We have selected the new administrative capital as a case study for new urban communities in Egypt. The U.S.-based “Business Insider” news website cited this project among eight mega-projects that are expected to transform the world’s largest cities by 2030, ranking it as the second largest mega-project worldwide (the list included mega-projects in China, France, Turkey, the U.S.A., Brazil, Japan and the U.K.)<sup>6</sup>.

#### **1.4. The New administrative Capital**

1. The Egyptian government plans to establish the new administrative capital as a new administrative and economic city in the Greater Cairo region. Located all along the Cairo – Gulf of Suez road, it includes a residential area, a commercial area and other service areas<sup>7</sup>.
2. The new administrative capital was designed as a new capital for all Egyptians; it will accommodate all sectors of the Egyptian population, regardless of social or economic status. The new capital will lay the groundwork for a new and great

beginning towards the realization of a promising, better future that provides better living conditions and decent means of livelihood<sup>8</sup>.

3. The total area of the new administrative capital is 184 thousand feddans, with the capital's "green belt" taking up 14 thousand feddans. The city, which can accommodate a population of about 6.5 million inhabitants, will have 20 residential neighborhoods with a total area of 51 thousand feddans<sup>9</sup>.



Figure 1: New Administrative Capital Master Plan Source: [https://real-estate-live.blogspot.com/2017/04/blog-post\\_12.html](https://real-estate-live.blogspot.com/2017/04/blog-post_12.html)

4. The new administrative capital project is above all a national project. It will yield various economic returns, ranging from the expansion of urbanized area and housing space to the creation of employment opportunities for youth and the building of a basic infrastructure that attracts investments. It is a modern project that takes into account the environmental dimension (green development) and it adheres to state-of-the-art scientific developments and technologies, as demonstrated in the smart city, academic city and new university projects<sup>10</sup>.
5. The objective is that all new cities become smart cities, in addition to introducing the "Internet of Things" and automated control services that make it possible to control household appliances remotely and improve people's quality of life<sup>11</sup>. The project aims to benefit over 20 million Egyptians by the year 2050<sup>12</sup>.
6. The reason behind establishing the new capital is Cairo Governorate's inability to absorb additional population growth. The State aims to relocate all government services to the new capital to combat overcrowding in Cairo and allow the city to breathe again, especially since government agencies are one of the main causes for the crowded conditions in Cairo Governorate<sup>13</sup>.

## Residential Compounds

### *The relationship between Housing and Sustainable Development*

Housing sustainability highlights the importance of the following:

- Privileging the concept of residential communities over single buildings for the creation of spaces that nurture and reinforce social relationships
- The importance of microclimates and adapting to the natural environment
- The importance of small open spaces and creation of shaded spaces
- The importance of developing and rehabilitating existing communities
- New cities should be conceived as urban nuclei that contribute to guiding urban expansion in the right direction while also highlighting cities' cultural identity<sup>14</sup>

**Residential Neighborhood:** The term 'residential neighborhood' refers to an inhabited area that consists of a group of housing units, their public utilities and services. Every residential neighborhood should have an elementary school large enough to accommodate 10% of the total number of neighborhood residents. The school should be located not more than 500 meters' walking distance for all neighborhood pupils. This distance is used to determine the geographic size of small residential neighborhoods<sup>15</sup>.

### **The Evolution of the Basic Parameters of Residential Neighborhoods in Light of Modern Planning Trends**

There is a need for change to adapt to new life styles and to the modern concepts of sustainability that are integrated into a comprehensive economic, environmental and social context. Low building density, for example, is no longer an objective and standalone individual public services have ceased to be the normal mode of operation. Instead, reasons have emerged for increasing density and encouraging the collective use of services – within limits that do not affect the primary objective of establishing a residential neighborhood and that reinforce social interaction, i.e. the school should be located no further than 800 meters from homes.

### **Key Elements in the Formation of a Residential neighborhood**

The great majority of references identify four key elements: the neighborhood should be compact, with a high building density; the nature of some services in the neighborhood must be varied or mixed; the neighborhood must have multiple means of transport and traffic and it must have the ability to adapt to environmental and cultural conditions.

1. The compact fabric model: Scale, transportation systems and open spaces in the compact model are designed for optimal exploitation; increased possibilities for pedestrian traffic, the proportions of open spaces (ratio

between building heights and street widths) allow for optimal use of available land space, reduced cost of supplies and backbone networks. Compactness contributes to integration and increases social attachment and harmony among inhabitants. Clear demarcation of the site's boundaries also helps to identify the neighborhood's center and concentrate activities there.

2. **Mixed/ Multiple Uses:** A densely populated neighborhood where open spaces are used in a variety of different ways; many non-housing activities are undertaken in various parts of the neighborhood and inhabitants can move from one part to another on foot; the services center constitutes the distinctive focal point of the neighborhood. The neighborhood also contains a mix of housing types (housing units of varying densities and sizes). Dorfman stipulates that every neighborhood should have a civic function, or a function related to activities that serve the city in which it is located.
3. **Multiple means of transportation and traffic:** The neighborhood depends on an internal system of transport, which includes different means of movement and transportation, including walking, cycling and driving. This transportation system should be safe; it should be limited to neighborhood traffic and closed to transit traffic. For vital services, priority should be accorded first to pedestrians, then to environmentally friendly means of transport, such as bicycles and vehicles powered by renewable energy (alternative fuels), followed by public transport such as high speed electric trains and metro trains. Speed limits must be imposed on private automobiles, which are accorded the lowest priority and facilities for people with special needs must be provided (appropriate inclines and no stairs or other barriers).
4. **Adaptability to environmental and cultural conditions:** The neighborhood should be compatible with the environment in which it is planned to be located and it should be able to adapt to the architectural and urban character of society. Well-studied strategies aimed at limiting pollution and waste disposal should be applied in the neighborhood, which should be connected to, and integrated with, the surrounding environment and linked to public spaces, parks, recreational buildings and social services<sup>16</sup>.

**Points to be considered when planning Modern Residential Compounds from an Environmental Viewpoint:**

1. The climatic conditions of the site (temperatures, wind direction and velocity, solar radiation density and path, humidity degrees and rainfall averages) must be taken into account when determining the urban fabric characteristics of

residential buildings and their orientation. It is equally important to make the most use of on-site natural resources.

2. Vertical expansion of buildings should be minimized in residential areas and horizontal expansion should be privileged.
3. Implementation of ecologically conscious architectural and building principles that aim at conserving energy consumed for cooling, heating or air conditioning housing units and public buildings. Employing compact architectural designs and construction materials with a large thermal capacity and making use of different climatic solutions (interior courtyards, air shafts, vegetation, water bodies ...) to create a clean climate that is suitable for family living.
4. All residential land areas should be provided with climatically treated shaded pedestrian walkways that connect to green spaces and recreational areas so that inhabitants may benefit from a positive ecological environment.
5. Facilitate movement between residential areas and service centers by planning short distance routes between them, thereby reducing traffic congestion and public transportation crowding, particularly regarding frequently used, heavy traffic routes, which will yield environmental benefits<sup>17</sup>.

**Points to be considered when planning Modern Residential Compounds from an Economic Viewpoint:**

1. Realizing economic sustainability by balancing costs, benefits and cost recovery – multiple studies have indicated that:
2. The general design of traffic routes affects their cost and maintenance. It is imperative to use the most economical infrastructure network option.
3. One study indicates that planning that includes interior courtyards is more economical and better suited to pedestrian movement and daily use.
4. Compact design is one of the factors that contribute to reducing the cost of housing urban development projects.
5. Architectural endeavors have begun to use the concept of the “traditional town lane” as a basic planning unit in land lots, housing models and the overall configuration, while adding economical modifications. Replication of neighborhoods is also possibility<sup>18</sup>.

6. Basic services constitute an integral part of a residential neighborhood; they must not be isolated and daily services should be provided economically and be easily accessible (a 5-minute walk away).
7. Provision of various means of transportation and promoting energy efficiency
8. Basing developmental decisions on current and future conditions<sup>19</sup>

**Points to be considered when planning Modern Residential Compounds from a Social Viewpoint:**

1. Reinforcing the idea of neighborhood unity to create small residential communities with close-knit social ties and economic interactions and promoting social cohesiveness by providing shared open urban spaces dedicated for use by a limited number of residential land plots in application of the “town lane” concept<sup>20</sup>
2. Providing various types of housing to suit different lifestyles and income levels
3. Using humane designs where buildings are close to one another, avoiding vast expanses between buildings
4. Simple planning and design of the site to facilitate its use by inhabitants and ensuring that it serves multiple purposes
5. Providing private and semi-private spaces and open areas to promote social activities and reinforce a sense of identification with the locale
6. Increasing the number of crossroads and intersections, avoiding massive housing blocs and providing daily recreational and sports services
7. Including architectural elements that ensure privacy in housing units and making buildings the same height, for the same reason
8. Limiting the number of closed neighborhoods and connecting neighborhoods in the same vicinity through the provision of better services
9. Creating neighborhood community associations that work on developmental and upgrade operations<sup>21</sup>

**Design Principles for Sustainable Residential Compounds Drawn from Previous Studies, Study Assessment Tools and the Relationship to Elements of Design**

I. Planning the General Layout of the Site



1. Protection of the natural environment and wildlife, assessment of flood risks and maintaining the natural topography
2. Wise land management that avoids overexploitation, minimization of thermal effects on external environments and making use of the plans of existing buildings or of the site's topography, planning land use to create functional flexibility and protection against noise pollution<sup>22</sup>
3. Minimizing the area of unused space and specifying percentages for used land areas (40% to 50% for housing, 30% to 40% for green spaces and services, 15% to 20% for road networks)<sup>23</sup>
4. Reducing the number of accesses to and exits from the compound for security and privacy purposes: a single main entrance and a single main exit, from one of the main roads surrounding the compound and a secondary entrance and exit from one of the side streets
5. Provision of semi-private gardens for groups of housing units in such a way that the front façade of each unit overlooks the street and its rear façade overlooks a garden
6. Allowing for the wind factor in the compound's design; the orientation of roads and housing units should be the same as the prevailing wind direction and natural ventilation should be used in homes and open spaces
7. Encouraging contact with neighboring compounds and reinforcing it through services and means of transportation while at the same time safeguarding the privacy factor
8. Land sub-division and design should be compatible with the general layout design and the needs of housing units and should be in keeping with the size of the units and the category of users<sup>24</sup>
9. Appropriate timing of services delivery according to need (daily, weekly, monthly, yearly), beginning at the neighborhood's main central services center and ending at its outskirts
10. Using both solar energy and renewable energy for lighting, insulation, cooling and heating
11. Waste storage, recycling grey water, providing water control systems from the closest possible water source, water conservation technology and equipment

12. Orientation and shaping of building openings to provide optimum natural thermal, ventilation and lighting comfort
13. Establishing a main services center that encompasses all public services (commercial, health ...)
14. Providing public service strips along principal roads; building a neighborhood mosque<sup>25</sup>
15. Provision of a complete range of public services, including public transportation and local amenities; developing communal facilities such as schools, parks, recreation spaces, commercial malls and cafes; provision of delivery services and other facilities
16. Community involvement: Raising awareness, engagement and dialogue on the local level, local demographic surveys, community participation in the review and judging of designs and plans<sup>26</sup>

### **Designing Roads and Paths**

1. Streamlined, flexible road designs that take into account road network scales within the compound and how they connect to the main entrances
2. Vehicles: Should not use more than 10% to 15% of the total surface area of the compound – use of speed detectors – spots in the compound for providing directions – minimizing monotonous views – road designs that help to reduce driving speed – minimal parking spaces in residential and service areas to encourage walking to these destinations – planting trees on roadsides for shade and aesthetic value – sequential road pattern (main roads and side roads)
3. Pedestrians: Shaded walkways and paths – a network of pedestrian paths that enables easy and fast access to services – pedestrian walkways that are suitable for special needs persons in the compound)
4. Create a central public transport hub, as well as stops for public and electric transport in locations that can be reached on foot within 10 to 15 minutes at most<sup>27</sup>
5. Street plans that are coherent – planning for public transport – merging plans for new road network with existing roads in the neighborhood – avoid undesirable traffic and upgrade the infrastructure of environmentally friendly transportation

6. Facilitate road traffic and minimize parking space – safe, attractive streets – provide protection against crime and traffic accidents – facilitate access to public transport<sup>28</sup>

### **Coordination of the Site's General Layout**

1. A clear comprehension of the overall plan objective, combined with a well coordinated site facilitates obtaining clear directions to streets and buildings, promotes the conservation of local character and the maintenance and upkeep of buildings and natural sites and creates an efficient and comfortable environment, all of which contribute to increased satisfaction within the neighborhood
2. Easy access to public open spaces that are designed to promote relaxation – reinforcing security and safety and danger management – provision of services and efficient management
3. Historic buildings: Natural and cultural heritage – reuse of existing buildings – conserving historic resources and managing their use
4. Conserving local climate in pedestrian spaces in the summertime by minimizing the nefarious effects of wind and sunshine – green open spaces<sup>29</sup>
5. Unified architectural style and making use of a variety of design solutions for open spaces and internal roads
6. Create view stops by adding parks and public service areas on the main routes of internal road networks<sup>30</sup>
7. Create a network of greenery, trees and plant varieties and urban parks or gardens
8. Distribute green spaces within the residential compound by creating a green band between two rows of housing units overlooking the green area in addition to a centrally located main green space for the entire residential compound<sup>31</sup>

### **Housing Units:**

1. Ratio between the size of buildings and land area – housing units should be built at the front of the land lot to do away with outer fences, which helps to identify sections of the general layout more efficiently and constitutes a better use of land that promotes future expansion

2. Specifying the number of parking slots for each housing unit<sup>32</sup>
3. Grouping housing units according to height
4. Using cost-effective materials and technologies (flexible, multi-use spaces, using external open spaces, simplicity of design and execution, optimum exploitation of construction materials, minimizing the length of water and wastewater pipelines and electricity extensions, ensuring that housing units are adapted to environmental conditions, planting rooftops ...)<sup>33</sup>
5. Optimal performance: Buildings to be awarded Green Building Certification (for highest rate of energy and water efficiency and sustainability)
6. Building orientation: Promote health and comfort by correct positioning of buildings in relation to the sun's path
7. Optimizing housing efficiency: Variety of housing categories, providing appropriate housing for different income and social levels – providing protection against noise, air pollution and earth tremors coming from outside of the location
8. Architectural features that give buildings a pleasing aspect
9. Façade design and placement of openings in facades: protect privacy and ensure safety and security
10. Interior design of architectural units: Interior spaces that are adapted to present day uses and that can be altered to satisfy future needs<sup>34</sup>

The above discussion proposes a criteria matrix for sustainable, smart residential compounds (architectural, environmental, economic, social and smart criteria) that form a cohesive whole where all the criteria support one another, although some elements of these criteria are numerical while others are non-numerical. The proposed criteria are important because they are the actual tools used to define the overall objectives of residential compound planning in light of modern developments. Technology and smart systems are the key standard for measuring the state of development and monitoring periodical changes on the ground that constitute either advances or retreats in achieving the objectives of new urban compound planning and development. These criteria can also be used to compare urban compounds. It is to be noted that the proposed criteria are indicative and not binding; individual sites are entitled to add to them or modify them to suit their specific characteristics.

The criteria matrix includes five principal criteria, containing 75 sub-elements with equal percentage weights in the assessment process. The assessment of any element in a residential compound is based on the information available.

**Table 1: Relative Assessment Ratings According to the Criteria Matrix**  
Source: Researcher

Criterion	Percentage of Application	Extent of Application	Criterion Application (Percentage)	Total Criterion Application
Sub-element	Percentage based on available information	80 – 100 Excellent 60 – 70 Very Good 50 – 50 Good 40 – 49 Satisfactory 0 – 39 None	Total of each criterion's percentage of application ÷ the number of its sub-elements	Percentage of criteria application ÷ number of criteria sub-elements (75)

Previous ratings were calculated according to the Egyptian Green Pyramid Rating System.

**Criteria Matrix for Application of Smart, Sustainable Residential Compound**

**Table 2: Criteria Matrix for Application of Smart, Sustainable Residential Compound**  
Source: Researcher

Assessment Criteria	Percentage of Application
<p><u>Architectural Criterion</u></p> <ol style="list-style-type: none"> <li>1. Each residential compound has a function that serves the rest of the city</li> <li>2. Adoption of the sustainable residential neighborhood concept as a basic component of residential area planning</li> <li>3. Clearly defined physical structure &amp; local character, emphasizing local identity and unified architectural style</li> <li>4. Multiple &amp; mixed use (flexible functionality) of spaces and sectors with creation of services centers and strips across residential compounds</li> <li>5. Overall percentages, types of use: 40% to 50% residential, 30% to 40% green spaces and services, 15% to 20% road networks</li> <li>6. Large land sub-divisions with a high building density so that distance walked by primary school children is between 500 and 800 meters</li> <li>7. Manage the ratio between building size and land area – housing units should be built at the front of the land lot to do away with outer fences, which promotes vertical expansion and future extensions – interior gardens</li> <li>8. Group housing units according to height, making it easier for users to get their bearings</li> <li>9. Integrating land use with transportation planning; promoting public transportation and providing public and electric transportation stops</li> <li>10. Sequential road pattern (main roads and side roads) within the compound, attention to their connection to principal and secondary entrances, provision of public and electric transportation stops</li> <li>11. Roads designed to reduce driving speed within the compound</li> <li>12. Priority is accorded to pedestrian paths, easy pedestrian access to services</li> <li>13. Specific number of parking spaces per housing unit</li> </ol>	<p><u>Architectural Criterion</u></p> <p>Percentage = <math>19 \div 75 \times 100 = 25.3\%</math> of the total percentage</p>

<p>14. Creating a public space and distributing green spaces all across the residential compound, providing recreational spaces and playgrounds at a safe distance from traffic and noise, particularly for children</p> <p>15. Clear design that facilitates locating buildings and roads and can be envisioned clearly</p> <p>16. Multiple housing styles suitable for all income levels</p> <p>17. Limiting the number of closed neighborhoods, increasing crossroads and avoiding huge balconies</p> <p>18. Interconnection of services between the residential compound and nearby compounds – provision of principal services in the community itself</p> <p>19. Integration of the residential compound with the city and easy access between the two</p>	
<p><u>Environmental Criterion</u></p> <p>1. Applying the principles of green architecture and making allowances for climatic factors</p> <p>2. Orientation of roads and housing units according to prevailing wind direction and use of natural ventilation in homes, open spaces and compact buildings</p> <p>3. Integration into the site’s natural characteristics and optimized use of natural, environmentally friendly resources</p> <p>4. Clear delineation of the residential compound’s perimeters – ensuring security by locating it at a safe distance from natural catastrophes – adherence to construction standards – buildings may not occupy more than 40% of the land area</p> <p>5. Conserving open spaces, agricultural land</p> <p>6. Establishing the basic infrastructure and the renewable energy infrastructure, planting trees and creating green belts</p> <p>7. Planting trees along the sides of roads and paths for shading and aesthetic purposes</p> <p>8. Make use of environmentally friendly means of transportation powered by renewable energy (for public services primarily, followed by regular transportation)</p> <p>9. Devise and apply thorough pollution reduction strategies and deal with waste disposal</p> <p>10. Exploit open spaces, create environmentally friendly zones amidst residential areas, uncovered open spaces to be reduce to the minimum and shaded</p> <p>11. In desert areas, privilege semi circular house plans and use domes and cellars, or use environmentally friendly house designs that are appropriate to the climate</p> <p>12. Merging solar energy systems and renewable energy sources for lighting, ventilation, insulation and heating</p> <p>13. Waste storage and recycling of grey water</p> <p>14. Create a green fabric network, plant trees and vegetation</p> <p>15. Safeguard natural preserves, the environment and historic buildings located in the site and protect them against natural elements</p> <p>16. Create the appropriate degree of shading for the climate, avoid strong sun rays (includes regulating thermal load)</p> <p>17. Using environmentally friendly construction materials and decorative elements</p> <p>18. Buildings awarded the Green Pyramid Certification</p>	<p><u>Environmental Criterion</u></p> <p>Percentage = <math>18 \div 75 \times 100 = 24\%</math> of the total percentage</p>
<p><u>Economic Criterion</u></p> <p>1. Adopting the “traditional lane” concept as a basic planning unit and adding economical modifications and minimizing unused space</p>	<p><u>Economic Criterion</u></p>

<ol style="list-style-type: none"> <li>2. Vehicles: only 10% to 15% of the total compound area for vehicle use, encourage walking to service areas</li> <li>3. Plans use interior courtyards in homes, reliance on walking for economic purposes</li> <li>4. Sustainable compounds that are self-sufficient as regards employment opportunities, services and materials</li> <li>5. Use of module units in planning</li> <li>6. Spaces in housing units are multi-use and flexible and exploitation of exterior spaces</li> <li>7. Optimal use of local construction materials and renewable energy, especially those that are cost-effective</li> <li>8. Minimizing infrastructure extensions</li> <li>9. Simplicity of housing unit design and execution</li> <li>10. Roof planting and adaptation of housing to the climate and the environment</li> <li>11. Using technologies that conserve water and energy</li> <li>11. Daily services can be accessed economically (within 5 minutes' walking distance)</li> </ol>	<p>Percentage = <math>12 \div 75 \times 100 = 16\%</math> of the total percentage</p>
<p><u>Social Criterion</u></p> <ol style="list-style-type: none"> <li>1. Encourage community participation in decision making during the construction phase</li> <li>2. Land sub-divisions vary according to differences in housing unit size and category of user</li> <li>3. Emphasizing the concept of housing community vs. individual buildings</li> <li>4. Adequate number of housing opportunities</li> <li>6. Using historical architectural terms to promote the application of green architecture principles while also conserving local identity</li> <li>7. Minimizing the number of entrances and exits to the compound to safeguard privacy and security</li> <li>8. Provide facilities for people with special needs (appropriate inclines and no stairs or other barriers in entrances)</li> <li>9. Exploit open spaces (streets, parks, intersections) for purposes of social interaction by establishing public and semi-public spaces</li> <li>10. Flexible development; integrating housing, commercial, administrative and recreational spaces to reinforce neighborhood unity and promote social attachment</li> <li>11. Housing unit buildings are open to the exterior and to nature, for the beneficial psychological effect</li> <li>12. Human scale sub-divisions where buildings are in close proximity with no huge spaces separating them</li> <li>13. Provide spaces for individuals and groups that they can control and use as they wish</li> <li>14. Create community associations or administration units to manage development operations, and support public services and maintenance in the compound</li> <li>15. Make it possible to modify or upgrade residential buildings to reinforce self-fulfillment and freedom of expression</li> <li>16. Encourage ownership of housing units</li> <li>17. Equal access to all public services and open urban spaces for all categories of inhabitants</li> <li>18. Safeguard security and oversight through designs, planning and the provision of external protection</li> </ol>	<p><u>Social Criterion</u></p> <p>Percentage = <math>19 \div 75 \times 100 = 25.3\%</math> of the total percentage</p>

<p>19. Safeguard the security of personnel during the construction and operation phases and compliance with safety and security standards in all buildings and open spaces</p>	
<p><u>Smart Criterion</u></p> <ol style="list-style-type: none"> <li>1. In addition to their primary function, housing unit buildings are equipped with a telecommunications base</li> <li>2. Using the principles of modern, environmentally compatible smart systems in the construction, administration and control of residential buildings (energy efficient systems, telecommunication systems, safety systems)</li> <li>3. Promoting open and green spaces; connecting public areas by using telecommunications technologies, the Internet and smart devices to enable inhabitants to access the various data bases and to control housing unit building entries and exits</li> <li>4. Use appropriate materials and smart technology in the outer casings of buildings so that they will adapt to climatic and environmental changes</li> <li>5. Housing unit buildings are remotely operated and are equipped with smart technologies that allow them to ‘think’, alter behaviors according to building needs and adapt to the surrounding conditions</li> <li>6. Residential buildings can repair themselves autonomously</li> <li>7. Building interconnection through smart and information technologies contributes to transforming their function, fulfils their needs and promotes optimal use of their possibilities</li> </ol>	<p><u>Smart Criterion</u></p> <p>Percentage = <math>7 \div 75 \times 100 = 9.3\%</math> of the total percentage</p>

**Figure 2: Capital Residence – Cairo Capital – Residential Zone 3, July2017** Source: Ministry of Housing, Utilities and Urban Communities

**DISCUSSION**

**Analytical Study of Housing Compounds**

**Case Study: R3 Residential Zone in the New Administrative Capital, Egypt**

1. Residential zone number 3 is the first neighborhood where operations began in the new capital. It contains 25 thousand 400 residential and commercial units<sup>35</sup>. Residential areas are of varying density and they are all located in prime geographic and climatic areas in the midst of green spaces and are equipped with sustainable and renewable systems for energy generation, waste recycling and desalination<sup>36</sup>.

2. Work in the residential zone began in May 2017. Four thousand villas and town houses (surface areas ranging from 205m<sup>2</sup> to 400m<sup>2</sup>) are being constructed<sup>37</sup>.

3. Residential buildings consist of a basement and seven floors; surface area of each floor is 580m<sup>2</sup><sup>38</sup>.

4. There are two residential apartments on each of the upper floors and each building is equipped with two elevators. The surface area of a Type A unit





(apartment) is 150m<sup>2</sup>, that of a Type B unit is 180 m<sup>2</sup>. The ground floor of the building is divided into three units (one 100m<sup>2</sup> apartment and two 160m<sup>2</sup> apartments). First quality porcelain tile is used for the flooring, high quality aluminum for all glass windows and the cornices are of excellent quality<sup>39</sup>.

5. Each apartment contains three bedrooms, a reception room, two bathrooms, a kitchen with a balcony and a master bedroom with its own bathroom<sup>40</sup>.
6. The company in charge, the Administrative Capital for Urban Development (ACUD), is offering multiple payment schemes in an effort to attract the greatest number of buyers.
7. The total surface area of the R3 residential zone is 1000 feddans, divided into 8 neighborhoods. There are 328 villas (328 housing units) in the stand alone villa area; 157 buildings are town houses (624 housing units); 699 residential towers hold 19984 housing units and 140 housing towers (3360 housing units) are located in the residential/commercial areas, in addition to 1120 commercial units. Public utility installation (water, sanitation systems, irrigation, road network, electricity, and communication systems) is underway<sup>41</sup>.
8. The residential zone is to be a fully serviced city and will have youth centers, private international schools and all the services needed by a residential community.
9. The basic services that will be available in the R3 zone include banks, commercial centers, a cultural and social center, a public library, a hospital, a mosque, a church, and the residential areas<sup>42</sup>.
10. Land sites have been prepared for the construction of eight schools suitable for all categories of inhabitants.



Figure 4: Road Network in Residential Zone 3, Source: Ministry of Housing, Utilities and Urban Communities

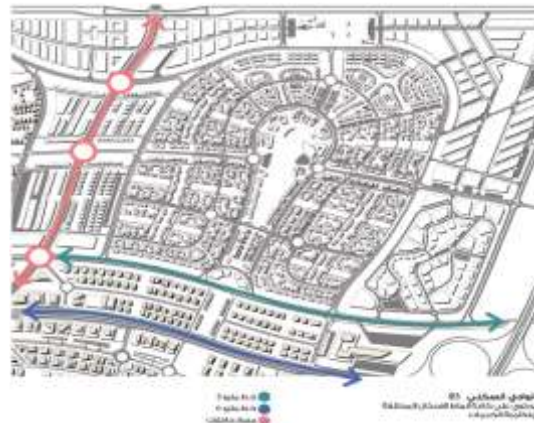


Figure 3: Residential Zone 3 in the New Administrative Capital, Source: Ministry of Housing, Utilities and Urban Communities

**Conditions for the First Phase of Construction in Residential Zones**

1. Construction conditions for residential towers

- Residential buildings may not take up more than 50% of the total land area
- Construction may not take up more than 45% of the total land area allocated to housing
- Building height allowed is one ground floor plus seven additional floors. A basement to be used for garages is allowed and 25% of the ground floor area is allocated to services. Building height conditions are set by the Ministry of Defense and must be adhered to.
- The distance separating the residential towers and the villas in any neighboring housing project must be at least 50 meters (including road widths and building front setbacks)
- The number of parking spaces must comply with the Egyptian garage code<sup>43</sup>



Figure 6: Housing Unit Types in Residential Zone 3  
Source: Ministry of Housing, Utilities and Urban Communities

2. Villa Construction Conditions

- Residential buildings may not take up more than 50% of the total land area
- Construction may not take up more than 40% of the total land area allocated to housing
- Building height allowed is one ground floor plus one additional floor. A basement to be used for garages is allowed and no more than 25% of the total area may be allocated to services
- Maximum population density: 45 inhabitants / feddan
- The number of parking spaces must comply with the Egyptian garage code<sup>44</sup>



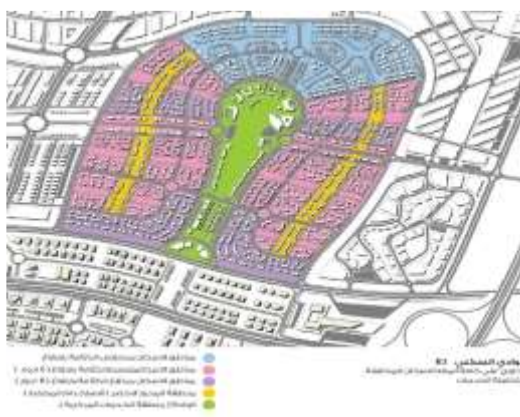
Figure 5: Public Transportation Routes in Residential Zone 3, Source: Ministry of Housing, Utilities and Urban Communities

3. Construction Conditions for Services Areas

- Land area allocated to services must be between 8% and 12% of the total land area of the project
- Services buildings (commercial, administrative, educational, health, childcare) not to exceed 30% of the area allocated to each service, 20% for social clubs, 10% for recreational activity areas and 5% for sports clubs.
- The number of parking spaces must comply with the Egyptian garage code
- Front setbacks on all sides must be 6 meters
- Building heights allowed for services buildings (commercial, administrative, educational, health) are one ground floor and two additional floors for each service, and a ground floor plus only one additional floor for services in social clubs and recreational buildings. For childcare services, the building height allowed is a ground floor to house the childcare center and an additional floor for the administration.
- Religious buildings must comply with construction conditions established by the competent Authority.
- The services area is intended to serve the project alone. Services that are provided from outside of the project or services within the project that are used by non-residents will be provided at a price to be determined by the competent committees.



**Figure 8: Housing Density in Residential Zone 3**  
Source: Ministry of Housing, Utilities and Urban Communities



**Figure 7: Neighborhoods in Residential Zone 3**  
Source: Ministry of Housing, Utilities and Urban Communities

- Maximum building heights established by the Ministry of Defense are to be adhered to and building height conditions established for urban investment projects may not be exceeded<sup>45</sup>.

**The Oasis in the R3 Residential Zone:** A cultural, sports and recreational center in the residential valley

1. In the middle of the Oasis lies a central park and an area allocated to services for the residential complex. The central park extends to the banks of the Green River without coming across any streets or traffic; citizens can safely walk from their homes to the river.
2. The design and execution of the Oasis and services buildings comply with the seven principles governing the planning and design of the city; sustainability, cohesive, integrated layout, a city for pedestrians, a city that welcomes all cultures, a green city and a business center that attracts investment).
3. The Oasis also contains buildings for a hospital, a home for the elderly, a public library, a cultural center, a commercial mall, an administration building, schools with upgraded new systems, a citizen service center (providing one-window services), a police station, a fire department, a mosque, a church, a social club and a control center for smart services. Residential and commercial buildings that overlook the Oasis Park come in all sizes, from small studios for young people to 280m<sup>2</sup> apartments. Road networks, parking spaces, bicycle routes and pedestrian paths along the banks of the Green River, public services and utilities networks are all designed to be smart and conserve energy (use of solar energy, waste and water recycling systems etc)<sup>46</sup>.



**Figure 9: The Oasis in Residential Zone 3**  
Source: Ministry of Housing, Utilities and Urban Communities

**Table 3:**

**Summary of the Analytical Study of Residential Zone 3 in the New Administrative Capital, Egypt (According to the Measurement Matrix)**

Measurement Criteria	Percentage Application	Application Rate
<u>1<sup>st</sup> Criterion: Architectural criterion, measured by:</u>		None
1. Residential zones of the new capital were not each assigned a specific service to serve remaining parts of the city; instead several public services are located in each zone	0%	
2. Adoption of the sustainable residential neighborhood concept that takes into account social harmony and the provision of services and different activities to achieve environmental, economic and social sustainability	90%	Excellent
3. Distinctive urban structures with designs inspired by downtown Cairo buildings to combine history with modernity and create a distinctive architectural style for the 3 <sup>rd</sup> residential zone (without making all buildings identical)	80%	Excellent
4. Integration of uses in the Oasis (the central area for neighborhood services) and allocating an area to provide a variety of services – no service strips were created at the residential zone level	80%	Excellent
5. Residential area in the neighborhood is 45% of the total area – in the city 30% residential, 20% roads, 15% green spaces	100%	Excellent
6. Building density (high density, average density, low density) differs among land lots and does not take into account the distance a child has to walk to primary school	30%	None
7. Correct ratio between housing unit size and land area, interior gardens provided and the possibility of adding or removing fences along land boundaries – possibilities and conditions for future expansion are not clear	80%	Excellent
8. Orderly layout of residential buildings, correct building orientation and appropriate heights according to prevailing wind direction, but optimization of vistas is not apparent	70%	Very Good
9. Integration of land use and transport plans, promotion of public transportation and provision of several transportation options	100%	Excellent
10. Sequential road pattern within the compound, attention to connections to roads outside of the compound, provision of public and electric transportation suitable for all categories of users	100%	Excellent
11. Roads are not designed to reduce driving speed	0%	None
12. Priority accorded to pedestrian networks ; 40% of the road network is allocated to pedestrians and bicycles and services centers are accessible on foot	100%	Excellent
13. Parking standards for vehicles adhere to the Egyptian codes, but the number of parking spaces was not specified for each housing unit	80%	Excellent
14. A central area (the Oasis), located at a safe distance from traffic and noise, houses all public services, social and recreational activities and green spaces	100%	Excellent
15. An easy, clear-cut design that the user can visualize mentally	100%	Excellent
16. Various housing unit styles to suit different income categories	100%	Excellent
17. Huge balconies have been avoided, large numbers of junctures connecting to the city's main thoroughfare, no enclosed neighborhoods	20%	None
18. All neighborhoods enjoy the same level / type of public services	100%	Excellent

<p>19. Excellent quality communications among neighborhoods and between them and the city</p>		
<p><u>2<sup>nd</sup> Criterion: The environmental criterion, measured by:</u>                  1. Sustainability principles were adopted during planning. Green architecture principles were not prioritized during building execution, but climatic factors were taken into account for the area as a whole                  2. Most designs prioritized ventilation and orientation in the direction of prevailing wind for buildings, roads and most open spaces                  3. Natural resources, renewable energy and solar panels were used and the natural features of the site were respected                  4. Neighborhood boundaries clearly delineated and safety of entry and exit ensured through advances smart technology systems. Construction conditions respected and construction area does not exceed 45% of the area allocated to housing                  5. Safeguarding open and green spaces and emphasizing the green city concept, avoiding agricultural land                  6. Establishing a unified digital infrastructure, smart operation / control networks for public utilities and the reuse of treated wastewater – prioritizing green spaces, but no strategy for planting trees and creating green belts                  7. Planting trees along roads and walkways is not apparent, but the concept of 15m<sup>2</sup> of green space per person is applied                  8. Plan for creating a smart, environmentally friendly internal transportation network that includes means of transportation that are suitable for all categories of inhabitants – pedestrian and bicycle paths are to make up 40% of the road network                  9. Adoption of strategies designed to reduce pollution, minimization of vehicle use, prioritization of green spaces, use of solar panels, recycling of water and waste                  10. Attention accorded to open areas, green spaces and central gardens and housing units overlook these spaces, but no plans were drawn up for shading and open spaces                  11. Designs are not semi circular, domes and cellars were not used                  12. Plans indicate that there are 11.5 km<sup>2</sup> of solar farm in the administrative capital and sustainable and renewable systems used for desalination, energy generation and recycling waste, but they do not specify how this will be applied to residential buildings or open spaces                  13. Recycling and using waste and wastewater                  14. Creation of a network of green spaces that reach the Green River, without specifying details related to tree planting and plant species                  15. Conserving the environment, protection from pollution, recycling of waste and grey water                  16. Climate and temperature factors were taken into account, but shading strategy not clear – solar radiation used to generate energy                  17. Environmentally friendly raw materials were not used – some local materials used                  18. The buildings were not awarded the Green Building Certification</p>	<p>50% 70% 90% 90% 90% 85% 50% 100% 100% 60% 100% 70% 90% 60% 80% 70% 40% 0%</p>	<p>Good Very Good Excellent Excellent Excellent Very Good Good Excellent Excellent Very Good Excellent Very Good Excellent Very Good Excellent Very Good Satisfactory None</p>
<p><u>3<sup>rd</sup> Criterion: The Economic Criterion, measured by:</u>                  1. The accessible “traditional lane” concept was not adopted in any clear manner, but economic factors were taken into account during planning and unused space was minimized</p>	<p>60%</p>	<p>Very Good</p>

2. Minimization of traffic, prioritization of pedestrian traffic, creation of bicycle routes with easy access to services – The standard of 10% to 15% of total compound area for vehicles respected	80%	Excellent
3. Pedestrian traffic was prioritized for economic purposes, but interior courtyards were not used	50%	Good
4. An effort was made to create a sustainable self-sufficient compound, but it was not successful on all levels; objectives achieved in some areas such as electricity (by using renewable energy) and wastewater recycling	60%	Very Good
5. Use of repeated module unit designs and radial planning in some parts of the zone	90%	Excellent
6. Exploitation of external open spaces, social interaction, mixed / multiple use of land, flexible housing units with relatively fixed functions	60%	Very Good
7. Use of local construction materials and resources such as rock and use of renewable energy to reduce cost and pollution	80%	Excellent
8. Limit infrastructure extensions through mixed land use and repetition in planning	80%	Excellent
9. Simplicity in planning and execution, both vertical and horizontal	100%	Excellent
10. Attention to the quality of the internal environment, roof planting and renewable energy sources in the city as a whole – housing zones located in geographically and climatically superior areas, equipped with sustainable and renewable energy generation systems, but no environmental standards were set out among the conditions for housing unit building	80%	Very Good
11. Wastewater treatment technologies, renewable energy sources and solar panels were used, waste recycling	100%	Excellent
12. Daily public services easily attainable, accessible on foot (walking distance not specified), equal services available to all inhabitants	70%	Very Good
<b>4<sup>th</sup> Criterion: The Social Criterion, measured by:</b>		
1. The new capital is being developed by a partnership between the private and public sectors. Leading architects participated in the contests organized for the planning and design of buildings in the capital and attention has been given to the smallest details in accordance with state-of-the-art architectural planning standards, but there is no apparent user participation in any of the phases of development	65%	Very Good
2. Different, varied land sub-divisions and housing unit styles to suit all social categories, with equal quality of services and living standards	100%	Excellent
3. The R3 residential zone contains 8 neighborhoods, each of which has commercial services, pedestrian paths and bicycle lanes. The neighborhoods are connected through pedestrian walkways. One of the construction conditions is that land sub-division is planned for buildings with integrated urban functions, emphasizing the urban compound concept. The Oasis (the central services area) is a part of each neighborhood.	100%	Excellent
4. Variety of housing styles and surface areas available (high, medium and low density housing)	100%	Excellent
5. Pedestrian paths and bicycle lanes connect the neighborhoods and the housing areas. Smart systems are used to control entry and exit and secure main gates, centralized services and central parks provided for each neighborhood, to safeguard privacy	100%	Excellent
6. Historical elements were not used in the implementation of green architecture principles, but planning is inspired by parts of downtown Cairo to ensure a mix of modernity and historical heritage	20%	None

7. Safeguarding privacy (entrances, exits, paths and routes) and using smart systems to provide security, two two-lane entrances to the area, installation and distribution of security cameras	90%	Excellent
8. No apparent facilities for persons with special needs, but planning was undertaken by leading architects according to the latest standards of urban architecture	50%	Good
9. Open spaces and passages used for pedestrian and bicycle lanes. The share per person is 15% of the total road networks and 40% of pedestrian and bicycle lanes, in addition to the 35 km long Green River flowing through the center of the city, interspersed with green oases (containing central parks and recreational areas) and located in residential valleys	100%	Excellent
10. The city was developed according to an integrated and comprehensive urban development plan, with mixed / multiple use of urban areas. At the center of each zone is a central space (the Oasis) housing buildings such as a hospital, a public library, a cultural center, a shopping mall, an administration building, schools, a social club, a smart systems control center and commercial / housing buildings.	100%	Excellent
11. Residential building planning and design is compatible with exterior nature and makes use of it	100%	Excellent
12. Design respects the human factor (buildings are close to one another) and avoids huge spaces	0%	None
13. No individual or group spaces that can be modified according to personal wishes are provided		
14. Central administrative unit responsible for maintenance, services and development of the city and of housing zones	100%	Excellent
15. Users were not given the opportunity to alter building or to express personal views during construction	0%	None
16. Encouraging ownership and providing payment facilities	100%	Excellent
17. Close (but not equal) distances between the various housing unit styles and public services	60%	Very Good
18. Strong emphasis on security and safety	100%	Excellent
19. Implementation of safety standards during operation and construction	100%	Excellent
<u>5<sup>th</sup> Criterion: The Smart Criterion, measured by:</u>		
1. In addition to its original function, the housing unit is a telecommunications base. Services (e-learning, on-line payment, supervision of utility meters etc) are connected to a main network	100%	Excellent
2. Use of smart systems that are compatible with the environment for management, control and operation of services, particularly public utilities & a unified digital infrastructure, with inhabitants being prohibited from exiting the system – however, no smart or environmental systems are apparent in housing units constructions	70%	Very Good
3. Smart sensors are used (security cameras – security and traffic control at main gateways – smart parking spaces – data center services for inhabitants) through connecting everything to a central network that helps inhabitants to access information data bases	100%	Excellent
4. No smart locking systems for building exteriors were installed	0%	None
5. Smart systems are meant to connect to housing appliances and improve the individual’s quality of life, but housing units are not equipped with smart systems to enable them to alter behavior or to adapt to surrounding conditions	20%	None
6. Buildings are not equipped to self-repair	0%	None
7. Buildings benefit from being connected via smart technology systems		



	100%	Excellent
<p><b>Application rate for criteria measuring sustainability in residential compounds was 'Very Good' (architectural criterion: 76%, environmental criterion: 67%, economic criterion: 76%, social criterion: 79%). Application rate for the smart criterion was 'Good' (56%), which raised the application rate of sustainability and smart criteria in residential compounds to 73% (Very Good). The principal factors that contributed to these results were the use of the latest smart technologies and systems to apply sustainability criteria.</b></p>		

### Key Strong Points of the Project

1. Adoption of the sustainable neighborhood unit concept and application of standards and rates that comply with most sustainability criteria and modern planning trends led to successful comprehensive, environmentally friendly urban development.
2. Different housing styles for all categories of inhabitants, mixed / multiple use of land, minimizing the relative surface area allocated to roads, and the provision of parking space in accordance with the Egyptian Code.
3. Promoting high and medium population densities while sub-dividing land according to population density, safeguarding neighborhood boundaries and respecting construction standards and conditions.
4. Making use of environmentally friendly public transportation and electric means of transportation and prioritizing pedestrian traffic.
5. Clearly structured, repetitive planning designs that are locally inspired (downtown Cairo) and combine history and modernity.
6. Creating a unified digital infrastructure in addition to a renewable energy infrastructure
7. Applying strategies for reducing pollution, promoting green spaces, waste recycling; use of water conservation technologies and local construction materials; safeguarding the environment and harnessing the benefits of climatic elements (solar radiation)
8. Leading architects, the public and private sectors participated in project design and execution
9. Creation of a central zone (the Oasis) that houses all public services, recreational and social activities; distribution and safeguarding of green spaces
10. Use of telecommunications and information technology and creation of data bases that are accessible from housing units and interconnection of buildings
11. Use of environmentally compatible data converters and smart systems for security and administration, and central control units to operate services, public utilities and traffic systems
12. Clear, simple design that enables users to form a visual conception of the project; avoiding huge balconies and large spaces
13. Integrated high quality communications between the neighborhood, the residential zone and the city
14. Daily services provided to all categories of inhabitants, services located in close proximity
15. The design takes the human factor into account; encouragement of ownership and provision of payment facilities

16. Emphasis on surveillance, security and protection, in addition to compliance with safety and security standards during construction and operation works

### **Key Weaknesses of the Project**

1. Noncompliance with the walking distance to primary schools
2. Environmentally friendly architectural structures (domes and cellars) were not used and green systems were not installed in buildings
3. Housing spaces are not flexible, don't adapt to multiple uses, and no attention paid to possible future extensions
4. No community participation in decision-making
5. No attention given to tree planting details or variation of plant species
6. Smart systems were not installed either for smart outer casings or for automated housing units to allow for remote control and responding to changes in the surroundings (electronic controls)
7. A specific function was not allocated to each residential compound, not all levels of modern planning criteria were applied, interconnection of residential neighborhoods and connections to other neighborhoods not complete
8. Environmentally friendly materials were not used; buildings do not conform to green building certification conditions
9. Buildings are not equipped with smart systems that enable self-repair
10. Individuals and groups were not given the opportunity to alter or modify architectural spaces or buildings in accordance to their wishes or personal viewpoints.

### **RESULTS**

1. The analytical study of the project identifies both the strong points that led to successful smart and sustainable planning of residential compounds (so that they can be applied to future projects) and key weaknesses
2. The study shows that the residential compound in the new administrative capital was planned and designed in accordance with the criteria for smart sustainable residential compound development and in keeping with the future vision for urbanism in Egypt that is based on the application of sustainability and smart technology in urban conglomerates.
3. The design of the new administrative capital complies with the international principles and criteria for sustainability and it stands out in the fields of energy, environmental design and waste recycling. The city's strong points include its sustainable location, efficient water and energy exploitation, its climate, resources and materials, the quality of its internal environment, green spaces, renewable energy sources (solar panels or biogas produced from wastewater and solid waste).
4. The prevalent trend in the new administrative capital is towards applying e-government systems and smart technologies to public utilities, installing electronic traffic control systems, inclusion of more than one means of transportation, making use of solar energy and re-using treated wastewater.

5. The proposed vision for housing in Egypt depends on the application of a smart sustainable housing model that realizes Egypt's vision of the future.
6. The proposed vision for housing development in Egypt is based on three axes. The first axis is achieving housing sustainability in the new urban communities, the second axis is economical housing (housing that yields the highest material and utilitarian returns) and the third axis is to provide an appropriate climate for investment (smart technology products and e-systems).
7. Application rate for sustainability criteria in residential compounds was 'Very Good' (architectural criterion: 76%, environmental criterion: 67%, economic criterion: 76%, social criterion: 79%). Application rate for the smart criterion was 'Good' (56%), which raised the overall sustainability and smart technology application rate to 73% (Very Good). The principal factors that contributed to these results were the use of the latest smart technologies and systems to apply sustainability criteria.
8. The success of residential compounds and the degree to which they achieve planned objectives are related to the rate of application of sustainability criteria and the degree to which smart technologies are used in planning and design.
9. Provision and variation of sustainable housing is the key component of a smart development program that promotes different housing styles while realizing environmental, social and economic objectives. This necessitates the application of a number of principles: mixed / multiple use of space – compact buildings – provision of a range of housing opportunities – creation of pedestrian-friendly neighborhoods – promoting attractive, well equipped housing zones and creating a neighborhood identity – conservation of open spaces, agricultural land and environmentally friendly zones – reinforcing existing communities – providing alternative means of transportation – predicting developmental alternatives – encouraging the community to participate in decision making regarding developmental decisions
10. The principal modern principles for creating a residential neighborhood are the use of compact structures, mixed/multiple use of spaces, creating numerous traffic systems and adaptation to climatic and cultural conditions.
11. Modern housing neighborhood planning aims to create an integrated housing environment that fulfills the needs of its inhabitants in the light of recent developments and that promotes the concept of sustainability (economically, socially and environmentally).
12. The future vision of the new administrative capital is based on the realization of environmental dimensions that represent a future vision of the city and are based on the principle of sustainability.
13. The development of urban communities depends on taking full advantage of the information revolution, using advanced technologies and smart systems and linking them to the local identity of new communities, on the flexibility of plans and on phasing population settlement in parallel with infrastructural installations, thus creating a smart, sustainable green city that attracts capital and investments.

14. The building of a smart, sustainable city is in fact a continuing journey of comprehensive improvement; no single final solution results in residential communities that are smarter, more sustainable and more resistant to natural catastrophes.
15. Housing sustainability encompasses the concepts of housing community, social relationships, adaptation to the natural environment, creation of shaded small open spaces and the creation of residential cities that act as urban nuclei that attract and reinforce the urban identity.

### **Recommendations for Future Research Studies**

1. A strategy needs to be drawn up for modifying urban and architectural plans to encompass the smart technology dimension
2. There is a need for training the local workforce in the use of smart systems and technologies during operation and construction
3. The land surrounding new residential urban communities must be reallocated for use in case of future expansion of these communities
4. New urban communities must be equipped with services using smart technologies that serve other cities as well; likewise, the services in a residential compound should extend to the rest of the city
5. Monitoring of executive organs and production of preliminary reports on extensions, reinforcing communication with inhabitants and redrafting laws in keeping with modern and sustainable community development
6. Functionally flexible design solutions, creating public spaces to be maintained by community associations, private and semi-private spaces for each residential zone or group of housing units, to be managed by the inhabitants
7. Encouraging community involvement and a sense of belonging, and distribution of private and public responsibilities
8. Provision of a module network for the site and division into phases (extending public utilities, services, construction, maintenance and follow-up)
9. Creating an infrastructure that will support present and future needs, ensuring an organized and unified urban and architectural future expansion of the housing community based on a detailed study of future needs
10. The importance of prioritizing housing units that conserve and generate energy; superior quality buildings and extensions that safeguard the safety and security of inhabitants and can withstand external conditions, adaptation to climatic conditions through the use of architectural forms that express the local identity
11. Make use of strong points and avoid weaknesses in housing projects, work on improving these projects
12. Provision of financial support and cooperation between the public and private sectors to realize sustainability through the use of smart systems, encouraging the use of sustainable smart technologies and systems by awarding privileges when they are applied

13. Upgrading and rehabilitating existing urban communities and equipping them with smart systems and digital infrastructures
14. Provide the tools for realizing urban and architectural sustainability through the use of smart systems and technologies, assess the extent to which projects apply smart and sustainable housing criteria and the extent to which urban plans are adapted to the environment
15. Upgrade and develop architecture curricula to include smart technology developments, how to best make use of them and how to incorporate them into the urban and architectural design of different projects as an essential component.

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