



## THE FUNCTIONAL PRINCIPLES FOR THE OPEN SPACE DEVELOPMENT IN THE INDUSTRIAL ZONE (CASE STUDY EL-OBOUR INDUSTRIAL CITY)

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### ABSTRACT

This study explores the principles of planning for open spaces in Egyptian industrial cities; these spaces create the identity that gives them special patterns, forms, features, and characteristics. The current situation in those industrial cities is a critical and accumulated dilemma, as there is no more sense or special design for our industrial cities' spaces. All the attention is being paid to the buildings themselves, with little concern for their spaces. So, this research attempts to look forward to specific principles for open spaces planning in the industrial city that will meet the needs of users and city dwellers. The study analyzed a master plan of international experience and observed the cases to identify the most important principles and criteria used for planning and designing open spaces. The focus on industrial cities and the practical implications of the study are also important, as they highlight the necessity to develop open space design, planning, and management in order to set of planning principles that include consideration of the function, Social, environmental, and Aesthetic aspects.

**KEYWORDS:** Open Spaces, Industrial city, Industrial urbanism, Open spaces planning

### الاسس الوظيفية لتطوير الفراغات المفتوحة بالمنطقة الصناعية (دراسة حالة مدينة العبور الصناعية)

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### المخلص

تهدف الدراسة للوصول الى مبادئ تخطيط الفراغات المفتوحة في مدنا الصناعية ، هذه المساحات التي تخلق هوية المدينة وتمنحها أنماطاً وشكلاً وميزات خاصة. وتعتبر الأوضاع الحالية في مدنا الصناعية معضلة متراكمة وبات تخطيط المدينة الصناعية نابع من الاحتياجات الاقتصادية وإهال الجوانب العمرانية الأخرى. وتحولت المساحات المفتوحة إلى أراضٍ شاغرة أو مناطق محملة. وبالمدن الصناعية يتم إيلاء كل الاهتمام للمباني نفسها مع التقليل من الاهتمام بالفراغات العمرانية المفتوحة. ومن خلال الدراسة سوف نتطرق الى تحليل المخطط الصناعي في عدد من التجارب العالمية وتقييمها وذلك للتعرف على اهم الاسس والمعايير المستخدمة لتخطيط وتصميم الفراغات المفتوحة. يعد التركيز على المدن الصناعية والآثار العملية للدراسة مهماً أيضاً ، حيث إنه يسلم الضوء على ضرورة تطوير تصميم الفراغات المفتوحة والتخطيط والإدارة من أجل تلبية احتياجات المستخدم بشكل أفضل. وتؤكد الدراسة إمكانات التميز في التخطيط بناء على مجموعة مشتركة من المبادئ التي تشمل النظر في الجوانب الوظيفية والاجتماعية والبيئية والجمالية.

**الكلمات المفتاحية :** الفراغات المفتوحة، المدينة الصناعية، العمران الصناعي، تخطيط الفراغات المفتوحة.

## 1. INTRODUCTION

City planning has been characterized by industrial development since the Industrial Revolution. Towns and metropolitan areas have developed around factories and growing industries. Cities and industries have expanded together. So, the Industrial Revolution was considered to have had the greatest impact on urban planning, causing a significant change from the vernacular city to the planned city. As the industry is seen as one of the fundamental economic activities in cities and serves the economic development of communities.

As a result of this development, the planning of industrial cities led to maximize the productivity without considering the negative effects that design would have on the users from an environmental, social, and aesthetic aspect. Therefore, there is a reduction in open areas due to the rapid rise of cities. In this context, open spaces in Egyptian cities, in general, and industrial cities, in particular, have become neglected or ineffective spaces. As a result, industrial cities urgently require defined regulations, standards, and principles for open spaces.

Inadvertently, a lot of people mistakenly think that "open spaces" refer to "green lands" in our developing nations. All aspects of urban form, including open spaces, affect the urban tissue. Therefore, open space is the primary shaper of the urban form. The types, levels, forms, and scales of urban spaces as components of urban form vary [1]. Due to historical differences and the need for specific fields of study, many countries or researchers have varied definitions of open space. This study focuses on supporting and improving the industrial city through the effective use of open spaces. So, the study wants to suggest several approaches, including functional, environmental, social, and aesthetic. Those perspectives provide benefits to cities and their residents by advancing sustainability and improving quality of life.

When planning any urban open space, many facets have to be considered. First of all, the function of the space has to be determined, which has a primary impact on its type, shape, size, and design [2]. While the functions of open spaces are manifold, they may be classified into the provision of recreation, different services to the community, and the preservation of natural values [3]. In urban planning, various types of urban open spaces (streets, parks, gardens, playgrounds, edges, squares, plazas, pedestrian zones, buffer zones, and agricultural lands) can have a range of purposes and be used for several activities: recreation, play, physical activity, education, providing wildlife habitats, landscaping, agriculture, and community development [4]. The design of open space may have a historical background linked to central locations but has, over time, extended to other parts of the city [5].

Urban open space can be categorized in different ways depending on factors like size, form, intended function, location, etc. Types of open spaces that serve different uses

in the industrial city [6]. In this context, the study can classify urban open areas according to Table 1.

**Table 1. Open spaces classifications.**

Open spaces classifications			
According to form and function	1. Open spaces for accessibility and connectivity	2. Open spaces for gathering	3. Open spaces for recreation
a) Purpose	the ability to get from our residences to places of employment, educational institutions, and other amenities on foot, on bicycle, by automobile, motorcycle, or by public transportation	Provide social interaction, and a focal point or activity centers of cities.	Promote physical activity among people and raise health advantages because it offers a variety of recreational opportunities.
b) form	Roads, Street, pedestrian paths, and transportation network	Plazas and squares	Neighborhood playground, Gardens, open parks, and waterfronts

Since the Industrial Revolution, towns and metropolitan areas have developed around factories and growing industries. Cities and industries have expanded together. So, the industrial revolution considered the greatest impact on urban planning, causing a significant change from the vernacular city to the planned city. From a historical perspective, the industrial revolution spurred large-scale urbanization. From the 1750s on, three phases in the evolving spatial dynamic between city and industry were founded [7].

The industrial urbanization was not unified, but varied, and could be seen as an amalgamation of the three spatial categories of industrial areas: "integrated," "adjacent," and "autonomous". Each type has distinct effects on urban life and economic conditions differently, and some cities develop more than one type within their borders. The adoption of a selected type or another is frequently an indication of cultural, historical, economic, and political factors [8].

## 2. Methodology and context

The methodology consists of two main parts: first, a theoretical analysis of the term "open space" from several perspectives through a study of its definitions, elements, classification, and guiding principles. Studying the history and typology of industrial urbanism and studying the analysis of urban practices in industrial cities. On the other hand, empirical analysis is conducted through two methods: analysis of the uses of open space for international industrial areas by collecting data and noticing the results, and analysis of the impact of open spaces on the city of El Obour.

## 3. Empirical

This part includes the analysis of three international examples according to the prototype of the city, the income base, and the impact of open spaces on the city. The part includes the formulation of a set of findings for applying the main principles for open spaces planning in industrial cities.

### 3.1 The criteria of the international examples' selection

There are three main types of industrial urbanism as shown in **Error! Reference source not found.**. The cases included one type, which is adjacent industrial areas because of the characteristics of their urban fabric. This type mixes between community and industrial society, which meets the point of the research. The most important industrial regions are concentrated in (Germany, England, America and Japan) North America, Europe, and East Asia are the three continents with the largest manufacturing sectors worldwide, as shown **Fig. 1**. There are further manufacturing hubs located elsewhere [4].

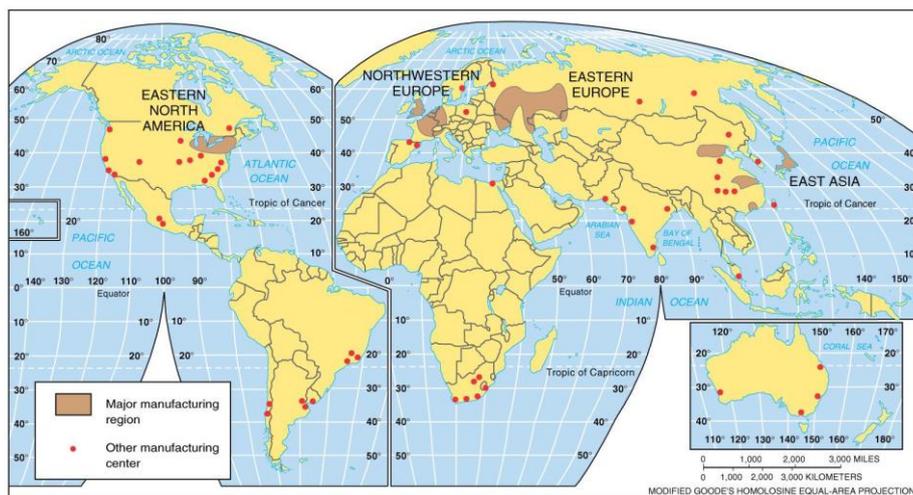


Fig. 1. The most important industrial regions [9].

**Fig. 2** shows that most of the developed countries are found in Europe, North America and a few countries in Asia. Also, the developing countries are the majority and most of the least developed countries are found in Africa and some in Asia [4].

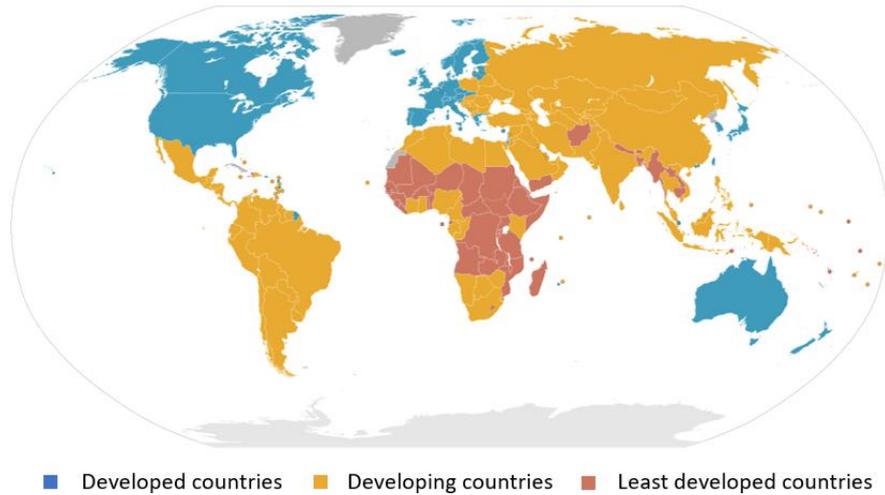


Fig. 2. Developed and developing countries map [10].

The selected cases have potential and keys of success for studying and collecting effective findings.

### 3.2 Analysis of open spaces in Yanbu Industrial City

The late King Khaled established the Royal Commission for Jubail and Yanbu by royal proclamation on September 21, 1975. About 350 kilometers north of Jeddah, on the Saudi Arabian Red Sea coast, is where Yanbu Industrial City is located. With a little more than three decades of history, Yanbu now has 14 large industrial facilities, including 52 support and light manufacturing businesses, 19 secondary facilities, two petrochemical complexes, a natural gas liquid fractionation plant, and two refineries as shown in **Fig. 3**. There are now more industrial facilities being built or in various phases of design and planning [11].

The industrial complex and the residential area are two discrete sections of the Plan that are split by a sizable green belt. Only industry and its associated activities are included in the industrial complex. Yanbu Industrial City is located 19 kilometers southeast of the historical settlement of Yanbu Al Bahr on a 24-kilometer-long seaside tract [11].

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Fig. 3. Urban fabric of Yanbu Industrial city [12].

Through a system utilizing modern highways, Yanbu Industrial City is connected to all other cities in the kingdom. The entrance to the kingdom from the north to the south is at Yanbu. The King Abdul Aziz Highway links Jeddah to the northern coastal regions. This roadway is connected to residential and commercial districts by secondary highways. The city's eastern bounds are connected to Yanbu Al-Bahr and Yanbu Al-Nakhl by the new eastern road [13]. Yanbu's community plan is distinguished by a convoluted circulation hierarchy. The Jeddah-Yanbu Highway, which serves as the primary path linking the community and industrial complex, the coastal road that runs alongside the water, the arterial roads that define the residential modules, the residential streets that pass through those modules, and cul-de-sacs make up the main street pattern [14].

Yanbu is a coastal city with many opportunities to create a pleasant atmosphere and an appropriate setting. The buffer zone is one of the key components of the legislation established by the Royal Commission of Yanbu City to control and adapt the city's environmental condition. The buffer zone offers enough green space so that places can reduce the impact of industrial emissions on air quality [15]. The design of Yanbu's open areas promotes social interaction, which creates a welcoming environment for gathering. These areas are used for social meetings and cultural events as well, enabling city dwellers to socialize, break up the monotony of their workdays, and have a place to relax. The green area, or buffer zone, in Yanbu is a functional space that serves the users, not just like a symbolic wall; it is an open space. The buffer zone isolates the community from an incompatible use of the industrial complex, protects the residential zone from possible negative effects, and provides a space for gathering and recreation [15].

### 3.3 Keihin Industrial Area

Keihin Industrial Area (KIA) is the most significant industrial area in Japan that has contributed to the nation's rapid economic development in the 20th century. From Tokyo

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Bay's northwest shore, KIA spreads inland. It comprises the Japanese capital city of Tokyo as well as a portion of the Kanagawa Ken prefecture. The Kawasaki and Yokohama harbor area, a sizable industrial belt along the northwestern shore of Tokyo Bay, is the center of the zone. The Keihin area has been at the center of Japan's postwar economic and industrial revitalization as shown in **Fig. 4**. The heavy industry in the Kawasaki-Yokohama harbor area, which consists of steel mills, oil refineries, petrochemical complexes, and shipyards, has been at the center of this growth. Large-scale land reclamation initiatives in the bay have made space for industrial growth. Plants for the production of items like autos, machinery, electrical equipment, textiles, and processed foods have been constructed further inland [16].

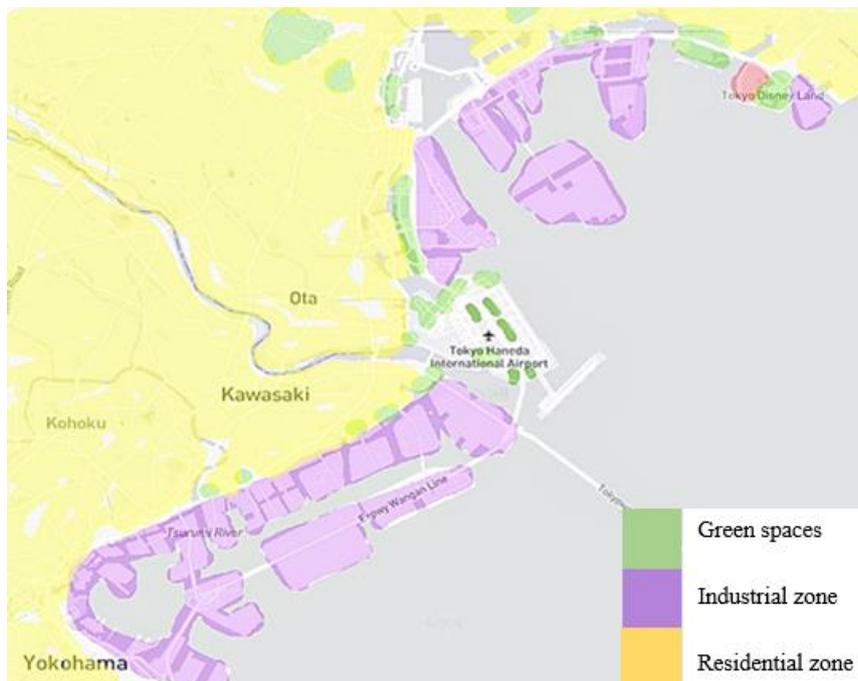


Fig. 4. Urban fabric of Keihin Industrial Area [17].

There isn't much public transportation in KIA. Some areas are connected to Japan Train Tsurumi and Hama Kawasaki stations by a passenger train built primarily for factory workers, however, the service is limited in comparison to typical passenger railway services in the Tokyo region [16]. The linkage to the Yokohama Ring Road, Route 357, the Tsurumi Coastal Line Arterial Road, and various connections to the inland urban region are examples of arterial roads for vehicles and trucks that have already been built and will be expanded in the future. These road expansions are necessary to relieve current traffic congestion and accommodate additional traffic in the future [18]. In KIA, there are several social activities for many uses. For example, there are canals of various lengths, with a total length of close to 70 km. Some seawalls serve as social gathering places in addition to their industrial uses. Additionally, there are green spaces, which creates opportunities for high-quality amenity developments. Historic industrial places, including shipyards, factories, and warehouses, are important assets for urban renewal.

Markets and open avenues are also taken into consideration for social activities in KIA for residents and workers. Japanese cities have always been characterized by innovative things, in this way, KIA was distinguished by the special use of lighting, so that industrial buildings became from just ordinary industrial buildings to landmarks of the city [18].

### 3.4 Höchst Industrial Area

Höchst Industrial Area in Frankfurt, Germany, is home to around 90 chemical and pharmaceutical companies that conduct research, development, and production in the city. It is already one of Europe's largest and most successful industrial estates and continues to attract new companies and millions of euros in investment from tenants every year. Total investment since 2000 amounts to roughly EUR 8.5 billion. The city offers a wide range of services to serve businesses at Höchst Industrial Area and other places, including consultation, site operation, and full-service site management. The experts at Höchst consistently satisfy the demands of different sectors. They offer raw materials, energy, and fluids, dispose of waste and wastewater by all regulations and permit requirements, maintain safety and security, and furnish and run facilities, laboratories, or undeveloped land for new construction [19].

Höchst is located in the heart of the dynamic Frankfurt Rhine-Main Metropolitan Region. The position in the center of Europe is now a highly competitive commercial location due to its geographic advantages and solid investor history [20]. Höchst is attached to Frankfurt Airport by ready-connected access to rail, road, and waterway networks [19]. The road network alone runs more than 70 kilometers, the internal rail network is approximately 55 kilometers, and the river port connects with the road and rail networks as shown in Fig. 5 [21].



Fig. 5. Urban fabric of Höchst [17].

Open spaces at Höchst enable a healthy lifestyle by encouraging users to become active. These areas make them valuable assets for enhancing the physical well-being of

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people who live and work in industrial cities. Open spaces in Hoechst support the development of the social infrastructure [19]. The city makes many events that need public spaces and uses the available facilities to make the place unique and achieve a better appreciation. Every year, approximately 80,000 individuals visit Höchst. Numerous clients from Germany and abroad, college students on field excursions, and residents [22]. The city tries to enhance social interactions by supporting local clubs and initiatives. Hoechst Industrial Area sponsors the Höchst Castle Festival and co-founded "Initiative Pro Höchst" for Frankfurt City. Additionally, Höchst extensive training and continuing education programme is accessible to its neighbors, in addition to industry experts [19]. The city cares about the visual aspect, and this appears in several forms the use of high-tech which became a landmark of the city [22]. At Höchst, the building conditions and factories are strength point to achieve visual interest for example painting factories and chimneys with colors, that give a natural sense.

The previous part attempts to study the urban environment of Keihin Industrial Area, Yanbu Industrial City, and Höchst Industrial Area in order to know the strengths on which city planning is based, which appear in the functional, environmental, social, and aesthetic aspects of the selected sites. the cases, several planning principles are summarized as shown in the following Table 2.

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**Table 2. Key Principles of open spaces planning in (Keihin, Yanbu, and Höchst).**

I. Purpose:	a. Open spaces for accessibility and connectivity	b. Open spaces for gathering	c. Open spaces for recreation
II. Form:	Paths (Roads, Street, pedestrian paths, and transportation network)	Urban Nodes (Squares & Plazas)	Recreation areas (Neighborhood playground, Gardens, open parks, and waterfronts)
1. Functional Principles	1. Integrated transportation network	1. Creates focal points	1. Enhance recreational experience
	2. Ensure accessibility and connectivity	2. Design place for gathering	2. Provide sports activities
	3. Include different street hierarchy and industrial street Facilities	3. Provide enclosure and places for collecting and meeting	3. Include Ecological function
	4. Linked with Harbor station, airport and railway	4. Provide places with various activities	4. Include variety of leisure activities
	5. Providing biking and pedestrian paths		5. Enhance the walkability
2. Environmental Principles	1. Ensure sustainable roads design and provide vegetation for air quality improvement	1. Contact with nature	1. Maintain the ecological values
	2. Provide green infrastructure and using of green roof and green facades	2. Provide green elements and increasing air quality	2. Provide green and water resource buffer zone
3. Socio-economic Principles	1. Encourage and enable social interaction	1. Encourage and enable social interaction	1. Enhance the attractiveness of the city
	2. Provide economical technical road infrastructure	2. Provide cultural facilities and leisure activities	2. Provide cultural facilities
	3. Provide commercial activities	3. Provide social events to strengthen the local community	3. Provide social events
	4. Provide Safety and security		4. Provide leisure activities
4. Visual aesthetics Principles	1. Ensure the branding and identity of the city	1. Use of Public Art	1. Enhance the visual interest by using water fronts
	2. Effective uses of colors and lighting elements	2. Enhance character and heritage values	2. Effective uses of Softscape and hardscape
	3. Provide Street and road facilities and amenities	3. Enhance the visual interest by using lighting and manufacturing style	3. Provide site facilities and amenities
	4. Treatment of Building facades architectural style		4. Smart uses of lighting and creating unique landmarks

#### 4. Case study (El-Obour city)

This part explains how the findings can be applied. It is founded on the observations of open spaces, reviews of maps, and surveys of El Obour city in term of assessing and evaluating the hypothesis of the research. So, this section suggests how the findings can be used to develop the open spaces in El Obour to meet the needs of users and improve the efficiency of open spaces.

There are three main types of industrial urbanism: autonomous, adjacent, and integrated. The case study has to include a type that mixes between community and industrial society in order to meet the point of the research. The adjacent industrial area is the common prototype of the industrial cities for the second generation of industrial new cities because of the characteristics of its urban fabric, which the main purpose of these cities is comprehensive urban development.

The selected city is El-Obour City, which has been selected for the following reasons:

- a) The geographical location of the city is in the Greater Cairo region, and it is linked by major regional roads.
- b) The city has appropriate and suitable infrastructure and utilities, with the ability for development. Another advantage is that the city is near the New Administrative Capital, which has high utilities and Amenities.
- c) The city is part of Egypt's Vision 2030 plan to achieve sustainability.
- d) The city's ability to develop and improve, and this appears in the open spaces of the city, which are analyzed in the next part.

El-Obour City, a part of the 1982-founded El-Qalyubia Governorate, is one of the second generation of brand-new cities that have sprung up in the greater Cairo area. It is a part of the El-Qalyubia Governorate, established in 1982. Its ability to simultaneously absorb population growth in the Cairo Great Region and increase the ratio of economic development in the region made it significant [23]. El-Obour City is a recently developed residential community situated in the El-Qalyubia Governorate. The governorate spans around 54.3 km<sup>2</sup>, approximately 35 km northeast of the Cairo Governorate, and is situated within the Heliopolis basin on the eastern side of the Nile Delta as shown in **Fig. 6**.

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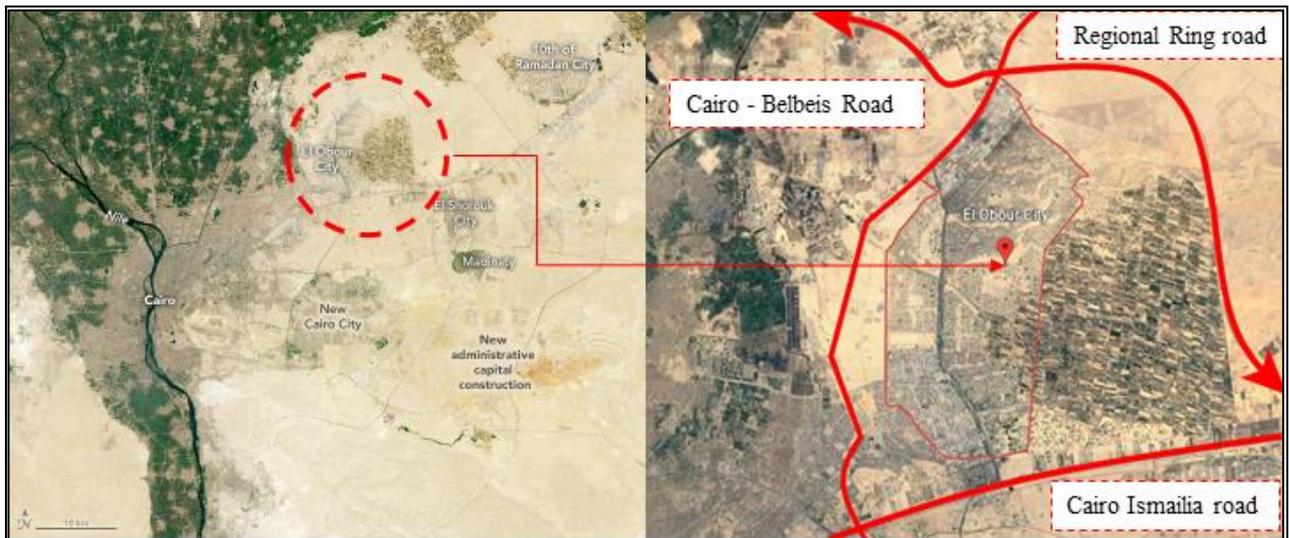


Fig. 6. El-Obour city location [17].

El-Obour is located at a depth of 7 kilometers and to the right of the Cairo-Bilbeis Desert Road, at a distance of 9 to 15 kilometers. The urban cluster itself is 12,500 acres in size, while its total area is 16,000 acres. In addition, the authorities provide resorts, investment companies, and pilot housing projects including the Future Society Housing Project, the Mubarak Housing Project, free housing projects, and family housing projects as shown in Fig. 7 [23].

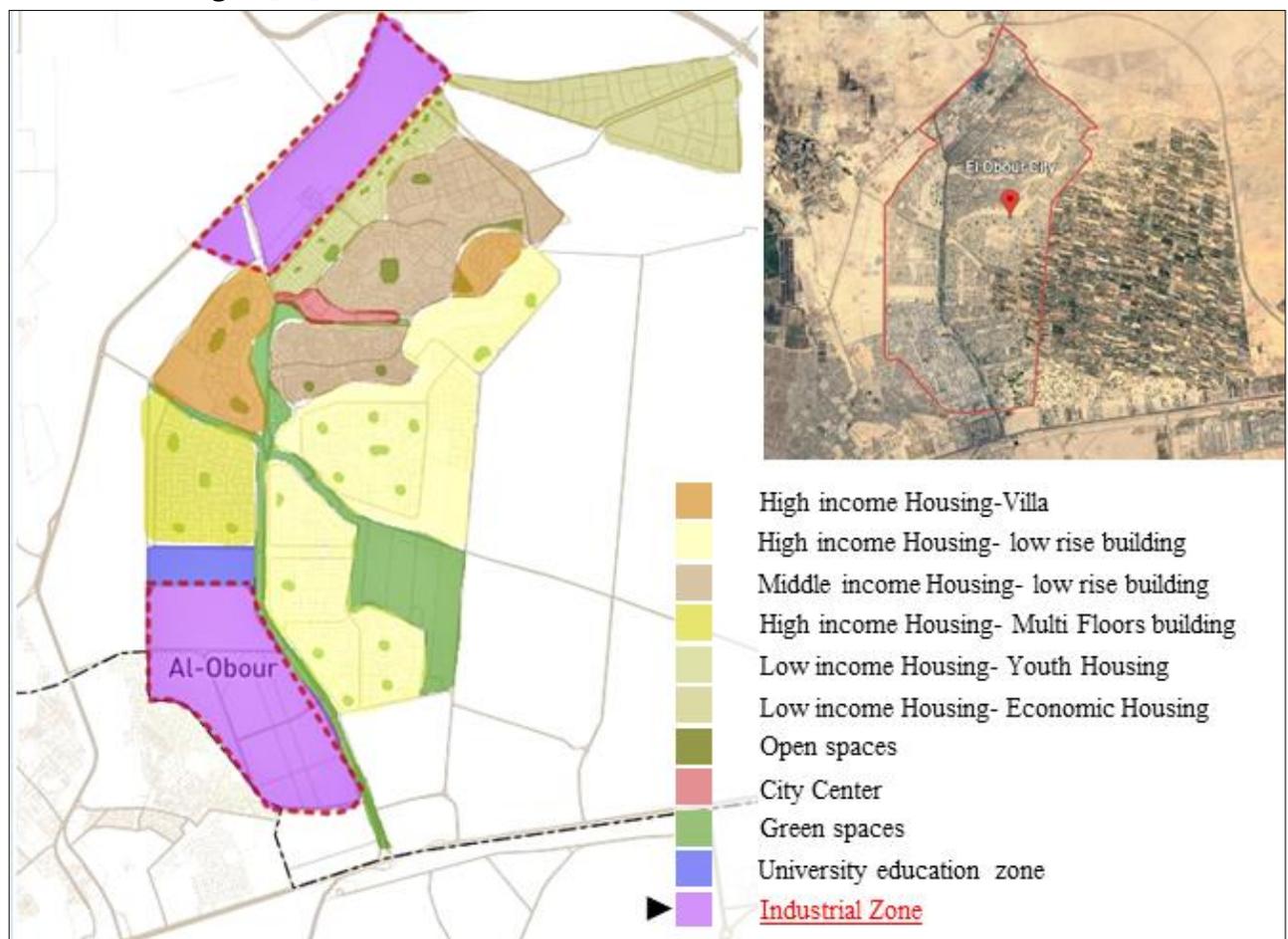


Fig. 7. Urban Fabric Of El Obour City [17].

#### ***4.1 Functional Analysis of Open Spaces in El-Obour city***

The El-Obour City's transportation network is primarily reliant on roads. Two regional routes, Cairo - Belbeis Road and Cairo - Ismailia Road, intersect the city. Additionally, it has two main entrances that are located on opposite sides of two arterial roads: Ahmed Badawy Road to the east and Gehaz Madina El-Obour Road to the west. Those roads the main items of the city network. [24]. There are four different types of public open spaces in the city: neighborhood, district, local, and regional. An additional aspect that could be advantageous is the abundance of green spaces that envelop the city's boundaries. While some of the lands are public areas and some are private properties, they can both be utilized for the city's expansion. In contrast to the industrial zones, which lack open places for socializing and recreation, the nearby open spaces offer a place for unstructured play and physical activity, relaxation, and urban social interaction.

#### ***4.2 Environmental Analysis of Open Spaces in El-Obour city***

As mentioned before, the city is distinguished by its green appearance, as this appears in the city context, as well as the surrounding areas. However, a clear problem appears, which is the industrial activity in the northern industrial zone directing the winds. This case effects on the residential area, which has another weak point represented in the shrinkage of the buffer zone and green. That condition may occur harmful effects on the ecosystem of the city [25]. On the other hand, the southern industrial zone is located in a suitable orientation with the wind direction. And the buffer zone in the main axes of the city separates the industrial activities from the residential area and provides environmental comfort to the area [24]. The open space strongly depends on the functions of the buildings that surround it. In El-Obour city, the design and orientation of open spaces in the residential area enclosed to the building to ensure safety and be more accessible to city dwellers. But in the industrial zone, it is open for getting more air movement [26].

#### ***4.3 Social Analysis of Open Spaces in El-Obour city***

In El-Obour City, as previously mentioned, has adequate infrastructure. There is the availability of various social infrastructure facilities such as health care, education, and recreation facilities. These services require effective planning for open spaces according to the function of the space [24]. The city has a good variety of open spaces, which helps in the diversity of social activities and allows all users and residents to work out social practices and activities [26]. One of those positive points is the effective use of buffer zone by making sports and recreational activities such as a sports area (gymnasium) and commercial activities like open markets as well as providing sports areas in neighboring gardens, which enhance the mental and social health of the city. On the other hand, the negative points appear in both the lack of gathering places in the industrial area and how

that affected social activities. And there is also insufficient lighting design, which reduces the sense of safety in public spaces at night.

#### 4.4 Aesthetics and Visual Analysis of Open Spaces in El-Obour city

The facades of the industrial cities lack aesthetics, as the grey color covers most of the industrial city. The different facades illustrate clearly that the industrial and residential areas contrast with one another, which has an impact on the aesthetics of the city from a visual point of view [26]. A common issue in new cities is that there is no clear identity for the city. The city's image may have historical value or a natural feature that gives it identity. The city may get an identity through its available capabilities, but in El-Obour, no unique identity or image characterizes the city [23].

#### 4.5 The case study Findings and Recommendations

The conclusion of observation appears that there are some principles that are partially verified, and others unverified as shown in **Table 3**.

**Table 3. Case study findings**

Element	1. Verified Principles	2. Partially Verified Principles	3. Unverified Principles
1. Open spaces for accessibility and connectivity	<ol style="list-style-type: none"> <li>1. Include different hierarchy</li> <li>2. Enhance the walkability</li> <li>3. Integrated transportation network</li> <li>3. Ensure accessibility and connectivity</li> <li>4. Provide various Facilities</li> <li>5. Encourage and enable social interaction</li> </ol>	<ol style="list-style-type: none"> <li>1. Create sustainable design to maintain the ecological values</li> <li>2. Provide comfortable pedestrian environment</li> <li>3. Provide vegetation for air quality improvement</li> <li>4. Provide Safety and security</li> </ol>	<ol style="list-style-type: none"> <li>1. Design integrated green infrastructure</li> <li>2. Provide cultural facilities and leisure activities</li> <li>3. Enhance the visual interest by uses of colors, lighting, and public Art</li> <li>4. Ensure the city identity and image</li> <li>5. Provide various Facilities</li> </ol>
2. Open spaces for gathering	<ol style="list-style-type: none"> <li>1. Create urban node or focal point</li> <li>2. Encourage and enable social interaction</li> <li>3. Provide commercial activities</li> <li>4. Provide leisure activities</li> </ol>	<ol style="list-style-type: none"> <li>1. Provide comfortable pedestrian environment</li> <li>2. Create sustainable design to maintain the ecological values</li> <li>3. Provide Safety and security</li> <li>4. Enhance the visual interest by uses of colors, lighting, and public Art</li> <li>5. Provide various Facilities</li> </ol>	<ol style="list-style-type: none"> <li>1. Design integrated green infrastructure</li> <li>2. Ensure the city identity and image</li> <li>3. Site image and city identity</li> </ol>
3. Open spaces for recreation	<ol style="list-style-type: none"> <li>1. Enhance recreational experience</li> <li>2. Encourage and enable social interaction</li> <li>3. Provide leisure activities</li> <li>4. Provide vegetation for air quality improvement</li> <li>5. Provide comfortable pedestrian environment</li> </ol>	<ol style="list-style-type: none"> <li>1. Provide comfortable pedestrian environment</li> <li>2. Create sustainable design to maintain the ecological values</li> <li>3. Provide Safety and security</li> <li>4. Enhance the visual interest by uses of colors, lighting, and public Art</li> </ol>	<ol style="list-style-type: none"> <li>1. Provide commercial Facilities</li> <li>2. Design integrated green infrastructure</li> <li>3. Ensure the city identity and image</li> <li>4. Enhance the visual interest by uses of colors, lighting, and public Art</li> </ol>

##### 4.5.1 Recommended Action Plan:

- e) To achieve sustainable development, the city should work through a strategic plan, that seeks to maintain the Egypt 2030 vision to achieve sustainability.

- f) Establish integrated green infrastructure to improve environmental quality and economic purposes.
- g) Develop and improve industrial buildings facades with coloring and lightings elements to enhance the new industrial city's identity.
- h) Provide open spaces with amenities that are attractive, high-quality, and durable and suitable for the intended use.
- i) Using of effective landscape like: vertical landscape, green wall and coloring the facades in the industrial zone to enhance visual interest.
- j) Increase the planting and buffering area in the low-income residential zone.
- k) Using creative public art to relate the identity of the industrial cities, which present the modern and high-tech image of the industry to create a unique character for the city.
- l) Increase the commercial facilities by providing occasional or regular open markets occasional or regular.

## SUMMARY AND CONCLUSIONS

The study analyzed a master plan of international experience and observed the cases to identify the most important principles and criteria used for planning and designing open spaces. These general principles aim to improve the overall efficiency of the industrial city through several urban aspects (functional, environmental, social and visual aesthetic). Open spaces should be functional and meaningful. Open spaces that take the environment into account by reducing waste, using low-carbon energy, reducing climate extremes, using locally produced materials, constructing green infrastructure, and establishing habitat for flora and fauna. Well-designed open space utilities provide a good feeling among users and add to the aesthetic value of the space. Public art can add aesthetic value and visual interest in the locations where it is used. Open spaces should contribute to the development of attractive and dynamic mixed-use areas. One of the key factors of the open space is how materials and finishes are applied, especially where it is used to define the levels of segregation and integration.

## CONFLICT OF INTEREST

The authors have no financial interest to declare in relation to the content of this article.

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