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Policies of Sustainable Economic Zones under the Fourth Industrial Revolution (4IR): A Case Study on Suez Canal Area Using Fuzzy Geographic Information System (Fuzzy GIS)

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Industrial zones are considered one of the most important sectors of economic development in any country. All countries seek to develop these zones and transform them into the fourth and fifth industrial revolution zones. This paper relies on an extrapolation approach and comparative analysis of the industrial and economic zones that include the currently enforced policies dealing with these zones all over the world. Accordingly, this study consists of three main stages. The first stage concerns reviewing the concepts and definitions of industrial and economic zones, defining policies for dealing with them, and then concluding the bases and criteria of those policies. The second stage focuses on defining the criteria of the fourth industrial revolution industrial zones, then determining the criteria for differentiating between the current economic zones according to their suitability to absorb the fourth-generation industries, and finally determining the criteria for the localization of these industries spatially, relying on Fuzzy GIS methods to identify the best sites for localizing high-quality industries. The third stage is about conducting a field application to the Suez Canal area in Egypt to determine the best high-tech industrial site within

the selected area in Egypt. The site identified as the most suitable for the settlement of high-tech industries is the area located in the northwest and southeast of the special economic zone (SEZ), northwest of the Suez Canal, with an area of 22 km^2, a weight of 0.357724, and a score of 20.

Keywords: economic zone policies, eco-industrial park (EIP), Fuzzy GIS methods, and the Suez Canal.

Introduction

With the advancement of science and technology, as well as economic integration and market standards, competition has grown, and economic zones have recently received great attention. Certainly, economic zones play a crucial role in economic development; as they have been effective in attracting industrial capacity and foreign direct investment (FDI) worldwide. The current economic zone seeks to diversify and expand its export base, create new job opportunities, and attract international industries and investments (Gray, 1994; Brown, 2006).

Economic zones are defined according to the Unified Building Law of Egypt, 2008, as "the specified areas of land which are located inside or outside the boundary of the governorates, with the coordinates of their outer boundary shown on cadastral maps, and are allocated to industrial projects and associated services by the provisions of laws and decisions regulating industry and investment within the scope of the strategic scheme."

The definition of economic zones varies globally; the United Nations Industrial Development Organization defined an economic zone as an export processing zone (EPZ) which is "a relatively small, geographically separated area within a country, the purpose of which is to attract export-oriented industries, by offering them especially favorable investment and trade conditions as compared with the remainder of the host country. In particular, the EPZs provide for the importation of goods to be used in the production of exports on a bonded duty-free basis" (UNIDO, 1980).

The high-tech industrial development zone (IDZ) is a crucial step in enhancing the innovation capacity of economic zones and providing a boost for new economic development (Li and Wang, 2019). In China, the high-tech industry witnessed an annual increase of only 23.15% of the total yearly output during the past ten years, and the fixed-assets growth was 18.19%. As a result, high-tech industry has had a tremendous impact on China's economic development (Ding, 2019). Varied IDZ high-tech regions have different growth strategies and different criteria as a result of the economic variances between various Chinese regions. The growth of China's high-tech industry has been hampered by this imbalanced development (Lin et al., 2020). Regarding Latin America and the Caribbean, the quantity of high-tech industrial goods produced in many of these nations may present a chance for the sector to grow, whether in terms of the number of high-tech industries or the quality of the industries used in the industrial area (United Nations, 2020).

The United Nations Conference on Trade and Development defined EPZs as "industrial estates that form enclaves within a national customs territory and are usually situated near an international port and/or airport. The entire production of such zones is normally exported. Imports of raw materials, intermediate products, equipment, and machinery required for export products are not subject to customs duty" (UNCTAD, 1985).

According to the International Labor Organization's International Labor Office, the United Nations Center for Transnational Corporations, and the United Nations Country Team, an EPZ was defined "as a delineated industrial estate which constitutes a free trade enclave in the customs and trade regime of a country, and where foreign manufacturing firms producing mainly for export benefit from a certain number of fiscal and financial incentives" (ILO, UNCTC, UNCT, 1988). World Export Processing Zones Association defined the EPZs as "all government authorized areas such as free ports, free trade zones, customs-free zones, industrial free zones or foreign trade or any other type of zones, as the Council may from time to time decide to include other zones" (WEPZA, 1985). The World Bank defined an EPZ as "an industrial estate, usually

a fenced-in area of 10 to 300 hectares that specializes in manufacturing for export. It offers firms free trade conditions and a liberal regulatory environment" (World Bank, 1992).

The EPZ aims to accelerate economic development by developing and diversifying industries, employment, production, and export. The success or failure of any economic/industrial zone depends on policy, development, incentive system, location, and management. Therefore, distinctive development policies and incentives must be put in place to create a competitive advantage (International Development Ireland, 2020).

Economic zones are usually established to achieve one of the following objectives:

- create a business-friendly regulatory and commercial climate;
- promote regional development;
- attract investors to establish businesses in the zones.

Job opportunities are created and developed to attract FDI; because the zone targets specific sectors, it means that the zone can operate under rules that are different from those governing the rest of the country. Usually, the "success" of a particular area depends to a large extent on whether it meets the goals set when it was created (generally for a 10- to 15-year period) (Janjua et al., 2017).

A wide range of development policies for industrial zones evolves and changes, influenced by global events such as the 4IR; e.g., SEZs, free zones, free-trade zones, foreign-trade zones, industrial development zones, industrial zones, industrial parks, tourist zones, eco-industrial parks, green industrial parks, low-carbon zones, and green economic zones, etc. (Ambroziak, 2016; Ziedina and Pelse, 2017).

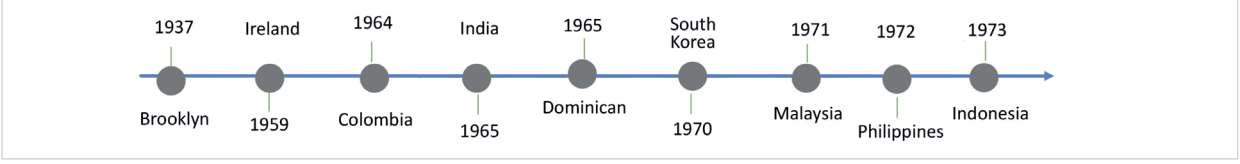
The world has witnessed three industrial revolutions, and we are currently experiencing the fourth and fifth revolutions, with the results to be seen in the future. The first was in the 18th century and was marked by the invention of steam engines. The second coincided with the expansion of the use of electricity and the principle of division of labor established by the founder of economics, "Adam Smith"; such a principle paved the way for mass production. The third arose in the middle of the last century and was characterized by the development of the concept of information technology and the emergence of the computer (Schwab, 2017). The concept of the 4IR describes a set of technological changes in manufacturing and industry and defines policy priorities: to maintain global competitiveness. Many writers see this transformation as a revolution against the old industry systems (Fassio and Nathan, 2020).

Many changes have occurred in industrial development as a result of the industrial revolution, leading to higher living standards in most countries in Europe, the Americas, and East Asia. The development is depicted in the diagram as shown in *Fig. 1* (ERIA Study, 2016), where development policies only started to appear clearly in the Korean national development agenda in the late 1980s. As a result of this, the Korean economy has developed at an average rate of 8%, and industrial zones with advanced industrial technologies have been established to encourage industry and growth, attract international investment, and boost exports (Kwang, 2011).

There are currently 2301 regions in 119 developing and immigrant countries, with China accounting for roughly 19% of all regions. China's transition to a market economy will be aided by these SEZs. At the same time, out of 135 countries/regions in the world, there are around 3500 regions that contribute to generating 68 million new job opportunities, and direct trade brought more than $500 billion to the economy (Wang, 2013).

The shifting of industrial policies in China during the last five decades has demonstrated the significance

Fig. 1. *Historical development of industrial zones (Source: according to Kwang Sik Kim, 2011)*



of China's New Industrial Policy exercise for emerging countries (Jigang, 2020). From the regime transition period (1978–1991) to the initial establishment of the market economy system (1992–2001), then to the period when from China's accession to the World Trade Organization (2001–2012), to the Eighteenth National Congress of the Communist Party of China (2012–2019).

In Vietnam, strategies are being investigated for improving industrial policy through the dynamic gains of FDI and international financial markets, as well as making rewards for foreign enterprises conditional on their performance, boosting organic integration between FDI and domestic sectors (Tri and Anh, 2020).

As a result, the United Nations, the Organization for Economic Cooperation and Development, and many other international organizations have issued many recommendations relating to new and existing industrial parks in various international contexts, with a particular focus on developing and transitioning economies. Such recommendations can be applied to many types of industrial parks, at various phases of development (2019, UNDO).

Research Aim

The research aims to identify the appropriate site mechanisms for the settlement of fourth-generation industries and to assist managers in making the best decisions through pre-prepared "sub-goals", using Fuzzy GIS techniques and tools. The following are the sub-goals: develop and identify the selection criteria for economic zones to accommodate the fourth-generation industries, classify and normalize economic zones within the framework of the 4IR, as well as select the most suitable sites for the settlement of the fourth-generation industries considering the circumstances in Egypt.

Methods

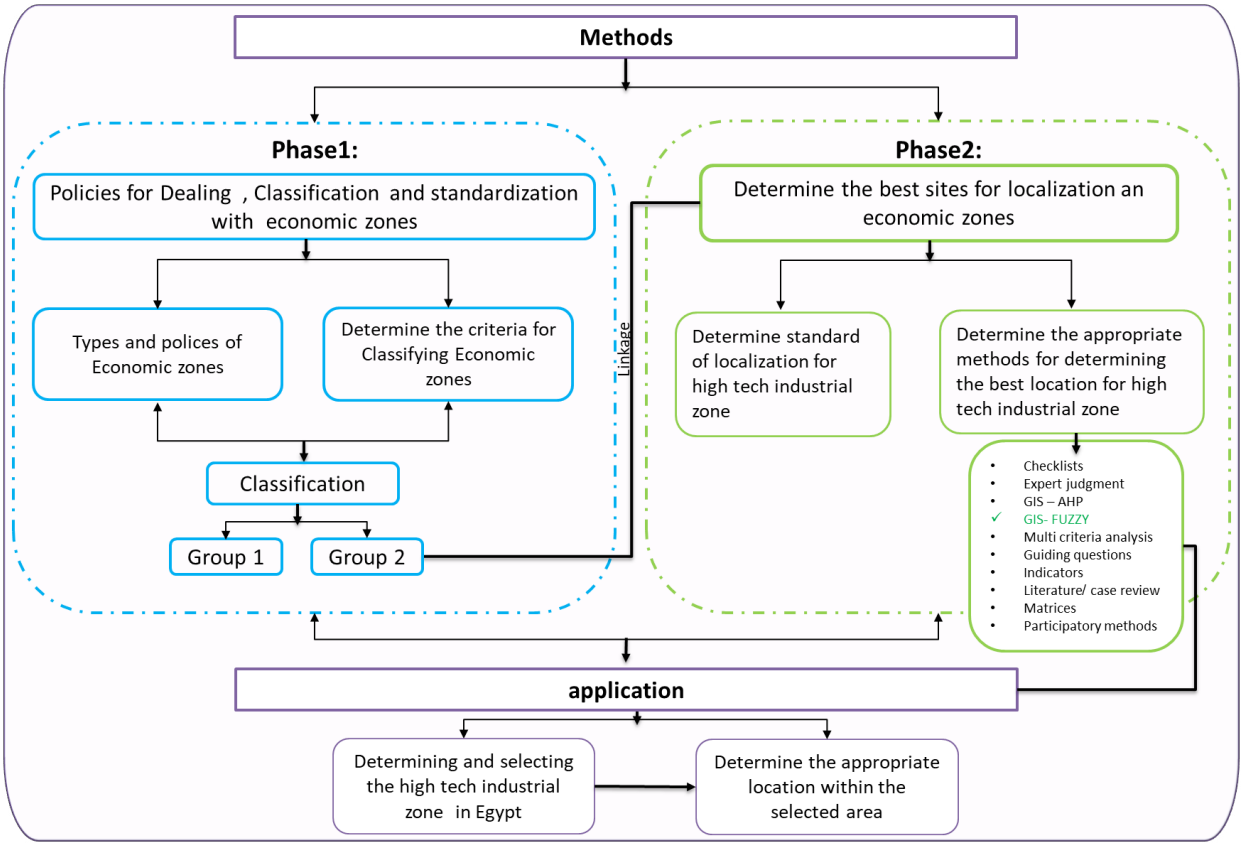
As shown in *Fig. 2*, the overall methodology used is to determine what types of economic zones exist and what criteria should be applied to classify them, through processes in successive and systematic steps that are detailed in the first stage of the research. Based on the classification reached, several factors are considered, the most significant of which is the industrial level. Consequently, the factors are split into two groups. Furthermore, the standards and criteria of the second group are found to be appropriate for the localization of high-tech businesses. The next phase is to define the criteria for resettling the high-tech industrial zone and the suitable techniques for selecting the optimum location for such a zone. The third phase is the application stage, which is to find and select the best high-tech industrial zone in Egypt, and find the proper location inside the selected region using the Fuzzy GIS approach. Spatial decision-making frequently uses this set of techniques, thus achieving the desired outcome and selecting the best option for the Egyptian situation.

Policies of Economic Zones under the Fourth Industrial Revolution (4IR)

The concept and technology have evolved as a result of successive developments in the industrial sector. In light of the 4IR and other developments, we have found that many types of economic zones have similar properties but different purposes and systems. Literature review and analysis have revealed two distinct groups, each with slightly different scopes but overlapping and similar aspects. Classification and comparison have been used to determine the principles and standards for each category, as in *Fig. 3* based on the classification below:

1 Zones for specific economic activities;
2 Fields conducive to marketing high-tech research results;
3 Zones for trade and export;
4 Fields of cooperation with specific countries or regions;
5 Industry level;
6 Efficiency, innovation, and sustainability in the industrial sector;
7 Investment zones designed to attract certain types of investment;
8 Sustainable development goals and principles;
9 Criteria and economic zone standards.

Fig. 2. *The framework of the methodology (Source: authors)*



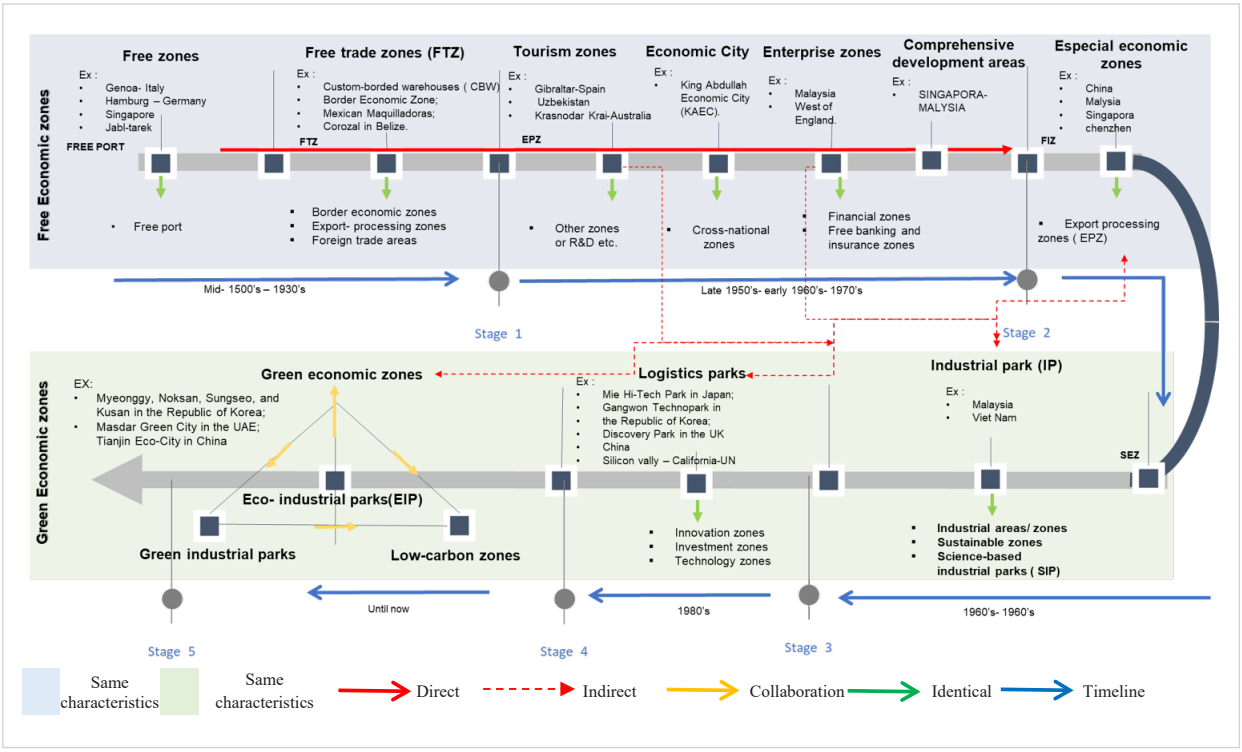
The level and location of industries in any generation have served as bases for comparison, analysis, and differentiation between the two groups; as the outcome of development is the role of technology and industrial ideology seeking to achieve sustainability and long-term sustainable growth in manufacturing.

Hence, the literature on economic zone concepts and approaches has been studied to determine the group to which these zones belong according to the similarity of objectives, policies, and types of industries. Two groups of economic zone characteristics and approaches have been identified in light of previous readings on this topic, as shown in *Fig. 2.* The first group is concerned with zones that aim to attract investment for specific economic purposes and activities, as well as traditional industrial activities, while the second group is concerned with zones that aim to conduct sustainable industrial processes, achieve high-tech industries through "zero" emissions, provide easy access and effective mobility, enhance the quality of life, create a sustainable environment, link high-quality education to innovation, promote the technology-based innovative industry, demonstrate a healthy lifestyle and utilize green areas, renewable energy, green buildings, smart manufacturing, data infrastructure, green and smart transportation, smart water management and smart waste management.

Each of the following policies consists of a series of standards, each of which follows a set of indicators. The first group is summarized in 7 policies for industrial zone development, along with 6 main standards and principles. The second group is summarized in 5 policies for industrial zone development, along with 6 main standards and principles.

The policy formulation suggestions for the green economic zone are shown in *Fig. 3.* (World Bank, 2016).

Fig. 3. *Setting policies for green economic zones (GEZ) (Source: Author)*



These policies are a long-term vision and a framework for long-term planning, addressing the target industry's specific requirements; emphasis should be on integrated infrastructure, focusing on environmental management, facilities, and social infrastructure in general, making the best use of the availability of land, flexibility in designing and maintaining the built environment, industrial symbiosis, preservation of the necessary natural elements, use of renewable energy sources and energy efficiency, planning and choosing the optimal site, environmental initiatives and clean production, resource-saving and low-carbon, solid waste management, decentralized sewage, and wastewater solutions, and sustainable transportation and mobility.

Spatial Analysis of Suitability for Fourth-Generation Industries

The goal of this analysis is to find the optimum places (Dawoud, 2013). The formation of fourth-generation industries is based on many variables (Tantillo, 2007), such as topography, soil, water resources, flood catchments, elevation, roads, the distance of cities, farmland, insolation, hills, shadow and light, vegetation, sea-level rise, standard humidity difference, air environment standards, etc. From a scientific and practical standpoint, the most significant task is to determine the proper criteria and circumstances for the site. Later on, when performing site selection analysis by the GIS, users must set various criteria so that the best or ideal sites can be rated based on these criteria. The Fuzzy GIS method is going to be used for analysis.

Fuzzy logic emerged in the context of the theory of fuzzy sets, introduced by Zadeh (1965). Such logic proposes that linguistic variables will better reflect a complex system of traditional representations of differential equations (Dixon, 2005). Furthermore, the potential of the fuzzy set theory in GIS emerged with the advent of computer-based GIS. For instance, in his essay on the principles of logic in a GIS, (Robinove, 1986) highlights the potential value of fuzzy set

theory. The relevance of fuzzy sets to GIS was recognized by a relatively small group of researchers many years ago (Robinson, et al. 2003). In fuzzy GIS, pixels are assigned an amount from 0 to 1, which helps the user to determine the likelihood that a site is suitable or unsuitable. This step assigns values with 0 being not likely or unsuitable and 1 being most likely or suitable, which indicates the suitability of the pixel location concerning factors and indexes for the intended purpose (high-tech zone /area site selection in this context) (Kamran, 2008). Fuzzy logic can investigate situations that are both true and false at the same time, as follows:

1 Define the problem and the criteria for selecting a site;
2 Collect levels of criteria;
3 Assign ambiguous membership values;
4 Apply a fuzzy overlay;
5 Verify and implement the results.

Quantitative indicators that are considered standard are decided by integrating factor maps with some fuzzy indicators, such as the fuzzy AND, fuzzy OR, fuzzy algebraic product, fuzzy algebraic addition, and fuzzy gamma coefficient as shown in *Table 1* (Koc-San et al., 2013).

Table 1. *Fuzzy membership values (Source: authors, according to Koc-Sa et al., 2013)*

Fuzzy Intersection (AND)	(1) μAND = MIN (μA, μB, μC ...,)
	Equation (1) defines the fuzzy membership values of pixels at a particular place on different factor maps. The values are represented by A, B, and C in this equation.
Fuzzy Operator (OR)	(2) μOR = MAX (μA, μB, μC ...,)
	Equation (2) defines an equation that is similar to Equation (1)
Fuzzy Algebraic Product Operator (Product)	(3) μproduct = $\mu^{\mu_i} = 1^{\mu i}$
	Equation (3) defines the value of membership on the (i) factor map which is represented by I in this equation, the numbers are skewed to (0); therefore, the combination of elements will weaken each other.
Fuzzy Algebraic Addition Operator (Sum)	(4) Sum = 1-($\mu^{\mu_i} = 1^{(1-\mu i)}$)
	Equation (4) shows μi as the value of membership on the factor map of (i) as well, the membership values get large and begin to approach equation (1). As a result, combining the elements will have an increasing effect, affecting the output map with all of the membership values from the input maps.
Fuzzy Gamma Coefficient	(5) μγ = (Eq. 4) γ × (Eq. 3) γ-1
	Equation (5) is the result of γ as a number from 0 to 1; in most cases, one fuzzy operator cannot be used to combine all layers of data due to a correct and deliberate choice of 0 and 1.
Defuzzification	(6) $b^* = \frac{\int_\gamma y \times \mu_B(y)dy}{\int_\gamma \mu_B(y)dy}$
	Equation (6) is the process of obtaining a single number from the output of the aggregated fuzzy set.

Results

Economic zone standards

It is evident from the overall policies of economic zones that they have a set of standards, and each standard has a set of indicators (Leonid et al., 2014). The researchers believe that such standards and indicators can be integrated and utilized to evaluate the efficiency of the industrial zone, consisting of 11 key standards with more than 50 out of a total of 753 as shown in *Table 2*.

Policies of Sustainable Economic Zones from 4IR to 5IR

By comparing the different types of industrial areas, it turns out that industrial zone development policies can be categorized into two groups, each of which includes a variety of objectives, regulations and policies; they are different for each country (International Development Ireland (IDI), 2020), and each policy will be explained as follows:

(A) First Group: In this group, the sustainable development approach is not followed (UNIDO, 2015),

Table 2. *Economic zone standards (Source: author according to (Feil, et al. 2019)*

Economic Zones	Standard										Total Frequency	Total of Indicators	Percentage of Compilation
Free zones	Regulatory Standards (OECD, 2018)	Legislative Standards (Sergiy, 2014)	Location Standards (Garcia, 2015)	Infrastructure Standards (Sun, Hrušovský, Zhang, Lang, 2018)	Financial Standards (OECD, 2010)	Financing Standards (OECD, 2006)	Economic Standards (UNIDO, 2020)	Occupational Health and Safety Standards	Environmental Standards (Schifman, Herrmann, Shuster and Ossola, 2017)	Social Standards (UNCTAD, 2019)	Urban and Political Standards (Science for Environment Policy, 2018)	697	753	92.6%
Free trade zones													
Free airport zones													
Tourist zones													
Enterprise zones "Projects"													
Free banking and insurance zones													
Economic zities													
Special economic zones													
Industrial park (IP)													
Logistics complexes													
Eco-industrial parks (EIPs)													
Low carbon zones "Eco-cities"													
Green industrial complexes													

A high degree of homogeneity for all criteria and sustainability indicators for the examined industrial areas is indicated by this result, which was obtained in various countries and industries with various activities.

and traditional industries are only used for economic components. The policies are in chronological order; as shown in *Fig. 3* and *Table 3.*

(B) Second Group: This group follows a sustainable development approach, while keeping abreast of the latest approaches in sustainability, and creates closed loops of raw materials intending to balance between inputs and outputs by reducing the number of industrial materials buried or lost in intermediate processes through reuse (GIZ, 2015), and utilizing high-tech industries and technology. The policies are in chronological order; as shown in *Fig. 3* and *Table 3.*

The green industrial zones, according to the researchers, are a critical component of the growth process and are the quickest and most efficient way to achieve full economic development. They are also seen as a key tool for encouraging, supporting, creating, renewing, and developing industries by providing the right site for targeted industries of all types and sizes, as long as they meet the criteria of the second group that achieves sustainability and comprises the characteristics and requirements of high-tech industries as shown in *Table 3*.

The second group strives to achieve response techniques in terms of technology, and turn the innovation strategy for the fourth-generation industries into design, implementation, discovery, and access to the fifth-generation industries, following the development approaches for sustainable industrial zones; aside from attaining comprehensive changes in future industries, society, and employment, which facilitates cooperation and internal industrial modeling of bodies, as well as global external industrial modeling of governments to each other. In addition to Group 2, being greater than 20 was "Fully Very High" and was assigned a score of 20; with a total of 42% as shown in *Table 4*.

To achieve the 4IR and the 5IR, a set of main objectives is achieved by following a set of approaches, which are three main approaches and include around 26 main principles and standards, in addition to policies to achieve sustainable development and green areas, particularly, in the second group, under the umbrella of national strategies, policies, and programs, taking into account the requirements of changing technology and information networks, as well as climatic and global changes. As shown in *Fig. 3*, based on the comprehensive data of the high-tech industrial zone, all classification criteria and regional economic changes are examined from the perspectives of the economic environment, the economic structure, the capital investment, and the regional scale of high technology, considering all other environmental and social aspects in addition to the industrial level of the economic environment. It is obvious from the results that there are many skills related to the high-tech industrial site, but there are differences in all other regions. For this reason, it is crucial to analyze the concepts of the specific economic zones from the 4IR to the 5IR with the aim of improving social and environmental changes and economies in high-tech areas through industry. The use of technology can increase the effectiveness of data processing and offer useful recommendations for the creation of high-tech industrial parks.

Criteria for determining suitability analysis for fourth-generation industries include proximity to roads due to the need to transport products and goods, proximity to the city where the source of employment is located, proximity to clean energy stations, proximity to ports, proximity to airports, gradients and slopes that affect the industrial area, proximity to reserves, proximity to aquatic life, agricultural land bending, radiation intensity, vegetation cover, normalized difference moisture index (NDMI), topography, etc. These are different from one site to another, there are many methods and analytical tools, e.g., MCA, GIS, Indicators, Checklist, Matrices, Participatory, but the focus will be on GIS Fuzzy methods.

According to studies, decision-makers and managers use 80% of the data that is related to spatial concerns (Worall, 1991), which is an analysis method that is not used to study the locations of high-tech industries in Egypt. Spatial decision-making frequently uses this set of techniques using relative weights and ratings for the criteria. On the other hand, the objective geographic data set of criteria will be using GIS. Also, factor and constraint layer maps will be created using tools for spatial analysis. To create a map of convenience, a decision rule will use Fuzzy GIS methods.

Table 3. *Policies of sustainable economic zones from the 4IR to 5IR (Source: authors)*

Developed by Countries/ Policies		Policies	Generation of Industry Revolution (GIR)	Financial Economic Activates	Objectives	Size/ Hectares
China – Genoa – Italy Hamburg - Germany Singapore / Shenzhen	Free zones/ Free trade zones/Free airport zones	Free zones	1	Exports: 60% Direct Investment: 46% Local Production: 22% Jobs: 30 million or more	Support trade.	≤ 10 to 100
		Free trade zones	1, 2			
	Enterprise zones 'Projets'/ Tourist zones/Free banking and insurance zones/ Economic cities	Free airport zones	1, 2	An increase in the level of GDP by 12% The long-term (cumulative) impact of the region will lead to an increase of about 20% in the level of GDP An analytical study for 270 provinces over 23 years	Use raw materials, goods, and industrial supplies, limited to traditional industries of high labor intensity, as investment mechanisms, knowledge-intensive industries	≤ 1000
		Tourist zones	1, 2			≤ 100
		Enterprise zones "Projects"	2			≥ 50
		Free banking and insurance zones	2			≤ 100 to 300
	Special economic zones / Industrial park (IP)/ Eco-industrial parks (EIPs)	Economic cities	2	An increase in the level of FDI by an average rate of 21.7% per capita The wages of workers increased by 8%, and the cost of living increased by 5% An analytical study for 321 cities at the provincial level between 1978 and 2008	Integrate development, stimulate the economy, export, manufacture, streamline procedures.	No-Minimum
		Special economic zones	2, 3			≥ 1000
		Industrial park (IP)	2, 3			
Malaysia / Singapore	Industrial park (IP) / Special economic zones /Green industrial complexes	Logistics complexes	3	The share of ecoregions in national merchandise exports increased from 22% in 1995 to 76% in 2003. The share of environmental areas in national FDI increased from 30% in 2000 to more than 85% in 2012	Develop enterprises, improve the effectiveness of public service and trade.	No-Minimum
		Eco-industrial parks (EIPs)	3, 4			
Vietnam/Korea/ Gyeonggi	Logistics complexes	Low carbon zones "Eco-cities" /Logistics complexes	3, 4	An annual GDP growth rate of 10.8% from 2006 to 2010, An average per capita income of US$1,662 (significantly higher than usual), and export value of US$602 billion (89% of the country's total average of US$1,085)	Revise land-use priorities, revise transportation priorities, restore damaged urban environments, promote recycling and green and high-tech industry.	No-Minimum
Dominican Republic / Vietnam / Korea / Gyeonggi China	Eco-industrial parks (EIPs) / Low carbon zones "Eco-cities"	Green industrial complexes	3, 4	Employment in free industrial zones increased from 500 in 1970 to nearly 200,000 in 2007		No-Minimum

Activities	Markets	Industries Contained	Approach / Policy	Methods	Sources
Warehouses trade-related	Municipal and Re-Export	Most industries contained in these policies are: textiles, clothing, leather, footwear, other light products, food processing, electrical and electronic products, transportation equipment, data entry/data processing, chemical and petroleum products, coal, rubber, plastics, sporting goods, etc., which all vary from country to country.	Economic corridors	CDF analysis	(Omi and Kenji, 2019), (Ghaempour and Latefi, 2016), and Farole (2011)
Processing and industrial production	Mostly export, manufacturing, or assembly process		Sustainable economic zones policy	CDF analysis / Checklists / GIS	(UNCTAD, 2020), (OECD, 2018), (Zhang and Ilhéu, 2014), (Ohrimenko and Ergunova, 2019), and (Kondratov, 2014; Nikolskaya, Blinova, Lepeshkin, Kulgachev, and Shadskaja, 2020)
Manufacturing and multi-uses	Municipal, domestic, and multiple re-export		Sustainable economic zones policy	AHP analysis / GIS	(Khurram Khan and Babar Khan, 2020), (Zeng, Special Economic Zones: Lessons from the Global Experience, 2019), and (Riley, 2020)
Utility services and sub-elements	A set of interlocking services that serve each other such as utilities, telecommunications, and industrial waste	Most industries contained in these policies are industrial electrical and electronic products; machinery and equipment for specific industries; power generation; machine tools; medical consumables, health care, pharmaceuticals, microelectronics and metals; auto parts industries, shipbuilding, aerospace, etc., which all vary from one country to another.	Green economic zones policy	AHP analysis / Checklists / GIS flowcharts and networks	(LIMA, 2020), (UNIDO, 2019), measures (Organization, Group and Zusammenammenarbeit, 2017), and (Assembly, 2015)
Utility services and sub-elements, urban fabric, transportation, safety and security, and governance and technology.	promotes export orientation and integration M MOSTLY EXPORT		Industrial park	Critical decision factors	(Cote and Cohen-Rosenthal, 1998), (Holden, 2008), (Roseland, 1997), (UNCED,2020), (LIMA, 2020), and (FIAS,2008)
			Sustainable environmental industries	Indicators	(GGGI, 2019), (World Bank, 2019), and (LIMA, 2020),

Table 4. *Classification values of groups (Source: authors)*

Groups	Classification							
	Industry-level	Fields conducive to marketing high-tech research results	Zones for specific economic activities	Fields of cooperation with specific countries or regions	Sustainable development goals and principles	Investment zones designed to attract certain types of investment	Fields conducive to marketing high-tech research results	Efficiency, innovation, and sustainability in the industrial sector
Group 1								
Free zones	→ (11.11%)	← (0%)	↕ (17.4%)	↕ (14.3%)	→ (10%)	→ (14.3%)	→ (14.3%)	↓ (7.14%)
Free trade zones	→ (11.11%)	→ (16.7%)	↔ (13%)	↕ (14.3%)	→ (10%)	→ (14.3%)	→ (14.3%)	↓ (7.14%)
Free airport zones	→ (11.11%)	→ (16.7%)	↓ (8.8%)	↕ (14.3%)	→ (10%)	→ (14.3%)	→ (14.3%)	↓ (7.14%)
Tourist zones	↓ (22.22%)	→ (16.7%)	↔ (13%)	↕ (14.3%)	↔ (30%)	→ (14.3%)	→ (14.3%)	↓ (7.14%)
Enterprise zones "Projects"	↓ (22.22%)	→ (16.7%)	↕ (17.4%)	↕ (14.3%)	↓ (20%)	→ (14.3%)	→ (14.3%)	↔ (10.7%)
Free banking and insurance zones	→ (11.11%)	→ (16.7%)	↔ (13%)	↕ (14.3%)	→ (10%)	→ (14.3%)	→ (14.3%)	↔ (10.7%)
Economic cities	→ (11.11%)	→ (16.7%)	↕ (17.4%)	↕ (14.3%)	→ (10%)	→ (14.3%)	→ (14.3%)	↔ (10.7%)
Group 2								
Special economic zones	↔ (13%)	↔ (13.6%)	↕ (19.05%)	↕ (16.7%)	↕ (16.7%)	↓ (11.8%)	↕ (16.7%)	↔ (12.5%)
Industrial park (IP)	↕ (17.4%)	↕ (18.18%)	↕ (19.05%)	↕ (16.7%)	↕ (16.7%)	↔ (17.7%)	↕ (16.7%)	↔ (12.5%)
Logistics complexes	↕ (17.4%)	↔ (13.6%)	↕ (19.05%)	↕ (16.7%)	↕ (16.7%)	↔ (17.7%)	↕ (16.7%)	↔ (12.5%)
Eco-industrial parks (EIPs)	↕ (17.4%)	↕ (18.18%)	↔ (14.3%)	↕ (16.7%)	↕ (16.7%)	↔ (17.7%)	↕ (16.7%)	↕ (16.7%)
Low carbon zones "Eco-cities"	↕ (17.4%)	↕ (18.18%)	↔ (14.3%)	↕ (16.7%)	↕ (16.7%)	↔ (17.7%)	↕ (16.7%)	↕ (16.7%)
Green industrial complexes	↕ (17.4%)	↕ (18.18%)	↔ (14.3%)	↕ (16.7%)	↕ (16.7%)	↔ (17.7%)	↕ (16.7%)	↕ (16.7%)

(A) ↕ = 20 Fully Very High, ↔ = 15 High, ↓ = 10 Average, → = 5 Weak, ← = 0 Not.

More Favorable *Neutral* *Less Favorable*

Discussion

Case study of Egypt (Suez Canal Area)

Egyptian policies for industrial zones

Egypt has been introduced to the idea of economic zones in the second half of the 12th century, represented by the policy of "free zones" when Alexandria was a center of international trade. In 1902, upon an agreement between the Egyptian government and the Suez Canal Company, a free zone was established in the city of Port Said to serve the Company's objectives of expanding and maintaining the Port, with all imported goods exempted from customs (Ahmed, 2004). According to the General Authority for Investment and Free Zones (GAFI) 2020, there are 114 industrial zones in Egypt spread across 26 governorates.

The policies of industrial zones in Egypt developed into seven types, which are public and private free zones, investment zones, technology zones, special economic zones, qualified economic zones, and industrial zones (OECD, 2020; Investment Policy Reviews: Egypt 2020).

The comparative analysis of plans and strategies, such as the sustainable development strategy (SDS) – Egypt vision 2030, the industrial development strategy 2052, the investment attraction plans, the general strategy of the Suez Canal area, and the investment attraction plan of the General Authority for the Suez Canal Economic Zone 2016-2035, has shown the endeavor to encourage the fourth-generation industries and to include sustainability vision in most plans and strategies. It has also been revealed that technical industries account for 50% of local demand, and more than 65% of local needs are met by imports (Bahaa El-Din, 2020).

Furthermore, Egypt's regulations and legislation include a series of incentives relating to Investment Law No. 72 of 2017 (VanGrasstek, 2008). The free distribution of industrial zones in Upper Egypt is among the most essential incentives. The state also provides them with essential infrastructure amenities in addition to other incentives (General Authority for Investment and Free Zones, 2017).

Given the identification of the generation of industries for each governorate in Egypt, it is found that industries in Egypt range between the first and second generations, which are medium and low-tech industries that are highly dependent on the most common natural and energy resources. Despite directing plans and strategies toward the fourth generation (UNIDO and GIZ, 2015), some governorates are heading to the third generation and only a few are migrating to the fourth generation, as shown in *Tables 5* and *6* and *Fig. 4*.

It is determined that the Suez Canal Economic Zone fits within the second group, which achieves high standards of industries. Where is suited for the establishment of high-quality industries. Reasons for choosing the study area for the application are that it achieves the principles of sustainability and all of the standards, principles, and objectives of the industries of the fourth industrial revolution.

Table 5. *Policies of economic zones in Egypt (Source: authors)*

Policies	Group	Area/ Acre	Generation of Industry
Free zones (public and private)	Group 1	19 867	2nd generation
Qualified industrial zones (QIZ)	Group 2	4942	3rd generation
Investment zones	Group 1	1785	1st and 3rd generations
Technological zones	Group 2	16 500	3rd and 4th generations
Special economic zones (SEZ)	Group 2	113 915	1st, 2nd, and 3rd generations
Industrial zones	Group 1	4.5	2nd and 3rd generations

There are four industrial zones, 250 industrial facilities, and six ports in the Suez Canal area. The special economic zone located northwest of the Suez Canal is selected for its economic and logistic importance and for the peculiarity of the Suez Canal, which aims to develop and advance the national economy, increase national income, encourage national, Arab, and foreign capital and to attract the largest number of investments.

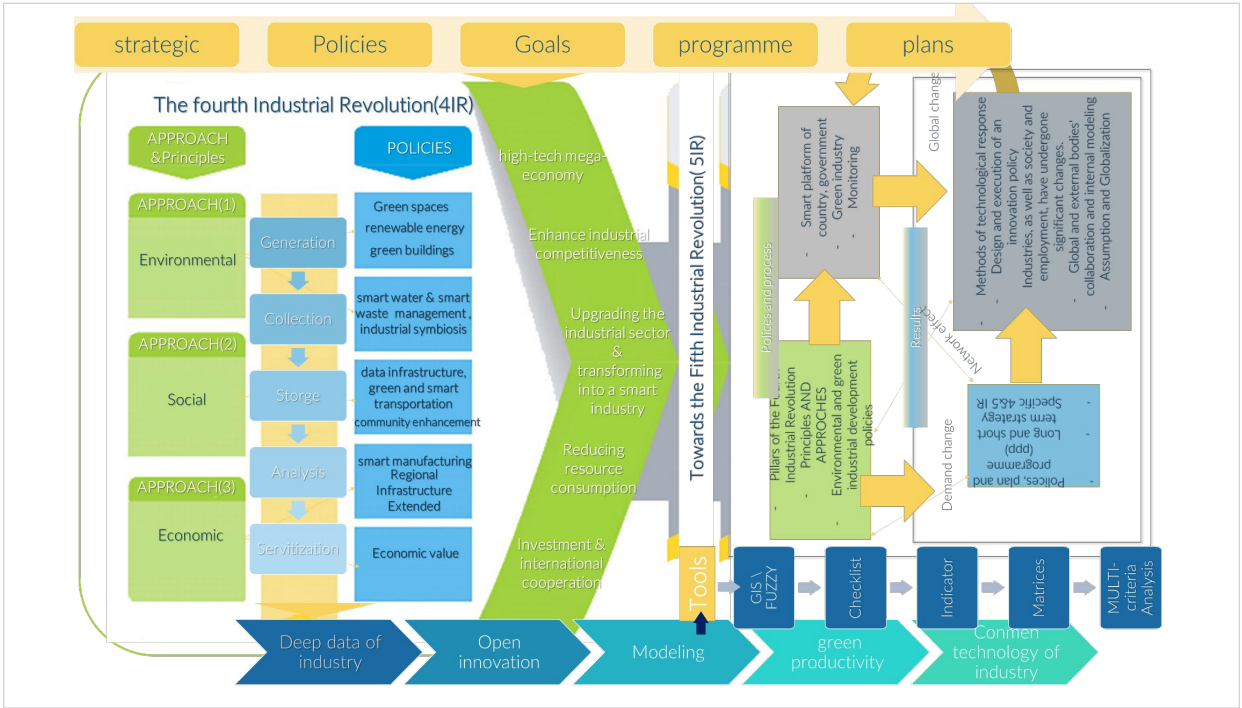
Table 6. *The development of industries due to the development of the generation of industries in Egyptian cities (Source: authors, according to Kamal, 2015)*

Egypt's Governorates	Development of Industry Generation	Types of Industries
Cairo	A pioneer in 3rd generation industries	Basic chemicals, electricity generation and distribution, and other manufacturing industries
Giza	A pioneer in 3rd generation industries	Basic chemicals, electricity generation and distribution, and other manufacturing industries
Qalyubia	Cumulative between 1st and 2nd generation industries and heading to 3rd generation industries	Spinning and weaving, clothing, leather, wood products, paper products, electricity generation and distribution, lighting, metals, and other transformative industries
Marsa Matrouh	A pioneer in 1st generation industries	Spinning and weaving, clothing, leather, wood products, and paper products
Alexandria	Cumulative between 1st and 2nd generation industries and heading to 3rd generation industries	Food, beverages, tobacco, metals, spinning and weaving, and clothing, basic chemicals, lighting, and other transformative industries
Beheira	Specialized in 1st and 2nd generation industries	Spinning and weaving, clothing, leather, wood, and metals
Port Said	Cumulative between 1st and 2nd generation industries and a pioneer in 3rd generation industries	Metals, spinning and weaving, clothing, leather, wood products, and paper products
Ismailia	Cumulative between 1st and 2nd generation industries and a pioneer in 3rd generation industries	Metals, spinning and weaving, clothing, leather, basic chemicals, electricity generation and distribution, lighting, and other transformative industries
Suez	Cumulative between 1st and 2nd generation industries and heading to 3rd generation industries	Coal, foodstuffs and drinks, building materials, ceramics, and refractories
Sharkia	No particular generation, but moving from a generation of industries to another	Chemicals, building materials, ceramics, refractories, metals, and spinning
South Sinai	Migrating to 4th generation industries	Engineering, electronic and electrical industries, and service and maintenance centers
North Sinai	A pioneer in 1st generation industries	Metal ores, coal, foodstuffs and drinks, building materials, and ceramics
Damietta	A pioneer in 2nd generation industries	Metals, textiles, clothing, wood products, and paper products
Dakahlia	No particular generation, but moving from one generation of industries to another and heading to 3rd generation industries	Electricity generation and distribution, lighting, and other transformative industries
Kafr El-Sheikh	Specialized in 1st generation industries	Foodstuffs and drinks, building materials, ceramics, refractories, clothing, leather, and wood products
Gharbia	A pioneer in 2nd generation industries	Metals, textiles, clothing, leather, wood products, and paper products
Monufia	No particular generation, but moving from a generation of industries to another	Clothing, manufacturing industries, weaving, and leather
Faiyum	Specialized in 1st generation industries	Metals, textiles, clothing, wood products, and paper products

Egypt's Governorates	Development of Industry Generation	Types of Industries
Beni Suef	No particular generation, but moving from a generation of industries to another	Clothing, manufacturing industries, and weaving
Minya	Specialized in 1st generation industries	Metal ores, coal, foodstuffs and drinks, building materials, and refractories
Asyut	Cumulative between 1st and 2nd generation industries and heading to 3rd generation industries	Foodstuffs and drinks, building materials, and ceramics
New Valley	A pioneer in 1st generation industries	Metal ores, coal, foodstuffs and drinks, and building materials
Sohag	Specialized in 1st generation industries	Metal ores, coal, foodstuffs and drinks, building materials, ceramics, and refractories
Qena	Cumulative between 1st and 2nd generation industries and heading to 3rd generation industries	Foodstuffs and drinks, building materials, and ceramics
Luxor	No particular generation, but moving from a generation of industries to another	Clothing, weaving, and foodstuffs and drinks
Aswan	1st generation of industries	Metals, coal, foodstuffs and drinks, building materials, ceramics, and refractories
Red Sea	Cumulative between 1st and 2nd generation industries and a pioneer in 3rd generation industries	Foodstuffs and drinks, building materials, ceramics, refractories, clothing, leather, wood products, and paper products

The Suitable Locations for High-Tech Industries in the Northwest of the Suez Canal Area by FUZZY-GIS

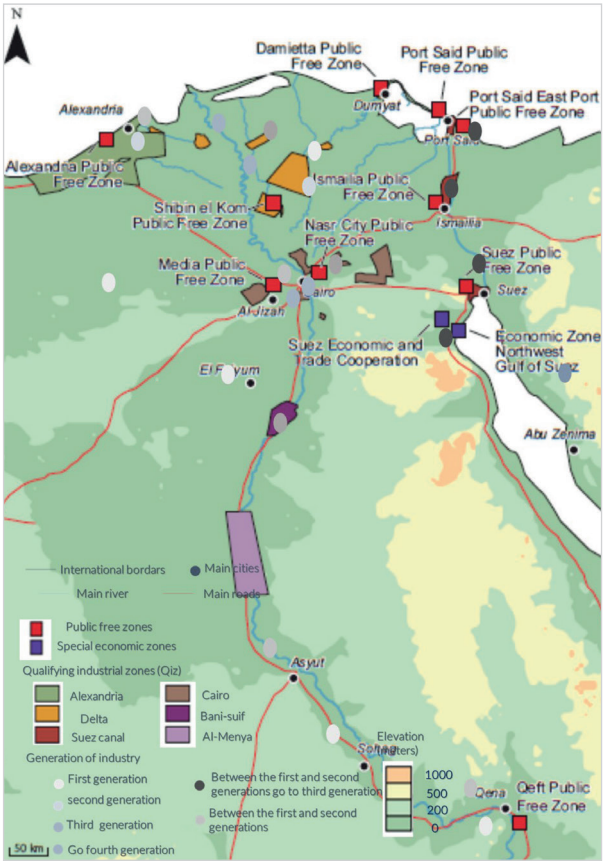
Fig. 4. *Concepts of economic zone defined by the 4IR and 5IR (Source: authors)*



There are numerous measurement tools available; however, the researchers feel that the best method for measuring and determining the greatest locations for fourth-generation industries is the Fuzzy GIS. In the Fuzzy GIS, pixels are assigned an amount from 0 to 1, which indicates the suitability of the pixel location concerning factors and indexes for the intended purpose (high-tech zone /area site selection in this context).

GIS methods are used based on several layers. In this study, layers of basic standards are generated as inputs for selecting potential locations for high-level industrial zones as shown in *Fig. 5.* These standards differ from one city to the next, and their relative importance varies depending on the city's location and nature. These factors are found to be the most essential after a comparison investigation, as shown in *Fig. 5.*

Fig. 5. *The classification of the industrial areas and the type of the industry generations in Egypt (Source: authors)*



Current analysis uses the classification and layer criteria for quantitative indicators and Fuzzy membership values by linear groups and the unification of each factor using the fuzzy function through the pairwise comparison method of the fuzzy rule process and fuzzy inference to membership function as shown in *Fig. 7.* By using the techniques of logical and weighted linear addition, then de-fuzzification, a decision-making algorithm selects the best crisp value from a fuzzy set to achieve locations for fuzzy rule and fuzzy inference to membership, as shown in *Table 7.* Equation (6) defines de-fuzzification in *Table 1.*

The Suez Canal Region comprises six governorates: Suez, Ismailia, Port Said, Sharkia, North Sinai, and South Sinai Governorate, and is one of Egypt's seven economic regions. For the sake of the current study, the area northwest of the Suez Canal is investigated, as it is one of Egypt's most important national projects, and attracts relatively high international direct investment. *Fig. 6* shows its location in the northwest of the city of Suez at (″25.36′ 58°29N) and (″34.57′31°32′E).

All requirements and standards are layered. The standards used in this study are as shown in Table 4; 14 out of the 26 standards in the GIS environment are appropriate for the case of Egypt: topography, soil, water resources, flood catchments, elevation, roads, distance of cities, farmland, insolation, hills, shadow and light, vegetation, sea-level rise, standard humidity difference. Each map has the highest value of 1 and the lowest value of 0 as shown in *Fig. 8*, leading to the composite map of all the standard layers in *Fig. 9* showing the most appropriate location for high-tech industries.

Given the selected region, the relative importance of standards, and whether the site is suitable for the settlement of high-quality industries, it is concluded that there are 4 regions suitable for the settlement of high-tech companies in the industrial areas. The industrial location is always the first choice for high-tech industries, along with the characteristics and quality of the industry and infrastructure initiatives in general.

The northwest of the Suez Canal is identified as the most suitable, with an area of 22 km^2, a weight of 0.357724, and a score of 20. The Southeast of the Suez Canal is identified as suitable, with an area of 17.5 km^2, a weight of 0.284553, and a score of 15.

Fig. 6. *Concept framework of the methodology of Fuzzy-Gis study (Source: authors)*

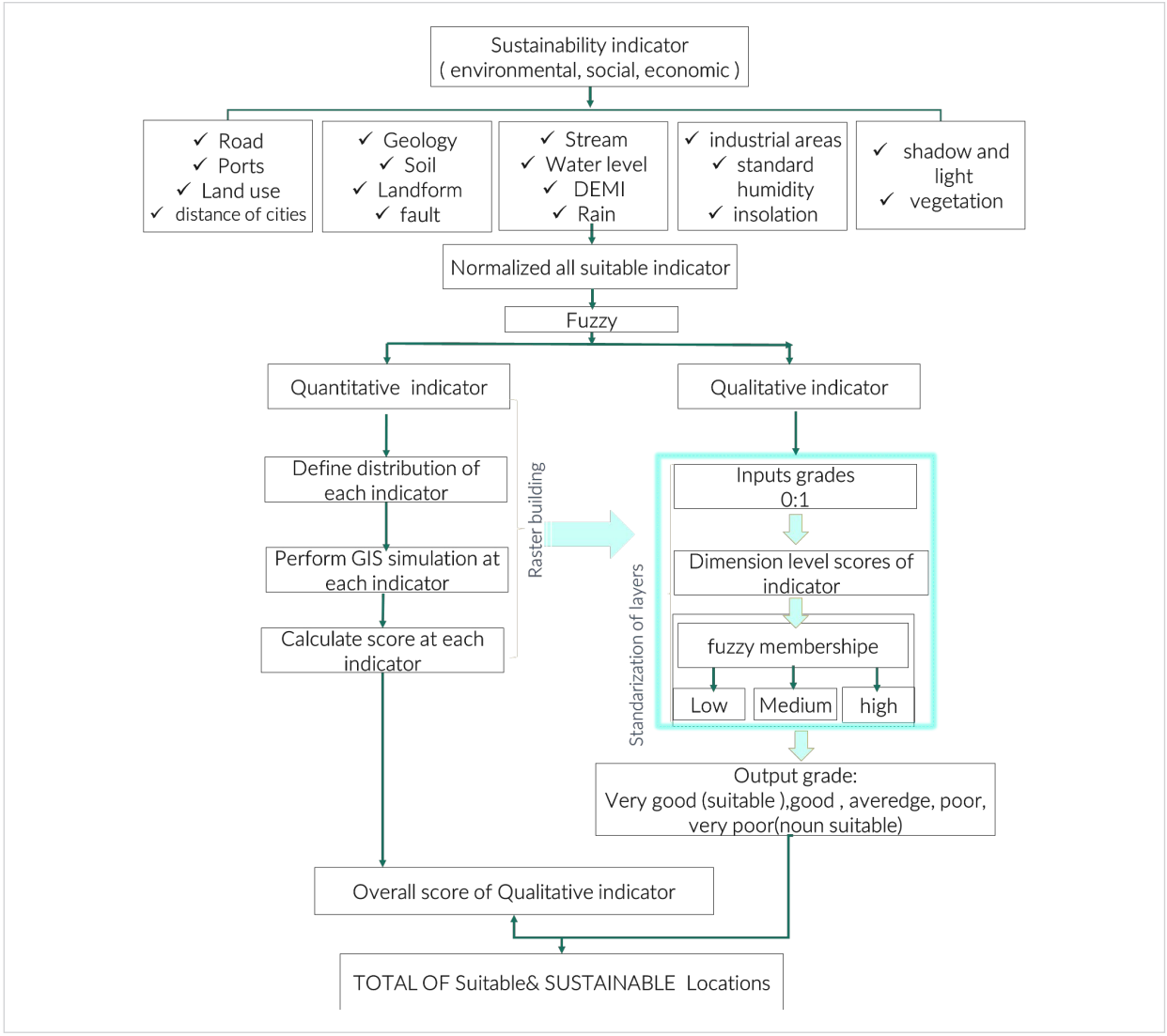


Table 7. *Classification and layer criteria for quantitative indicators (Source: authors)*

Layer	Membership	Weight	Layer	Membership	Weight
(A) Solar radiation	Linear	0/750	(b) Water resources	Linear	0/051
(C) Soil	Linear	0/040	(d) Roads	Linear	0/144
(E) NDVI	Linear	0/1	(f) Elevation	Linear	0/871
(G) Elevation/Contour	Linear	0/110	(h) Suez City Area (urban)	Linear	0/241
(I) Slope	Non-Linear	0/75.90	(j) Topography	Linear	0/30
(K) Hills	Linear	0/254	(l) shadow and light	Linear	0/254
(M) NDMI	Linear	0/0299	(n) NDWI	Linear	0/326

Fig. 7. *Classification of the study area (Source: authors)*

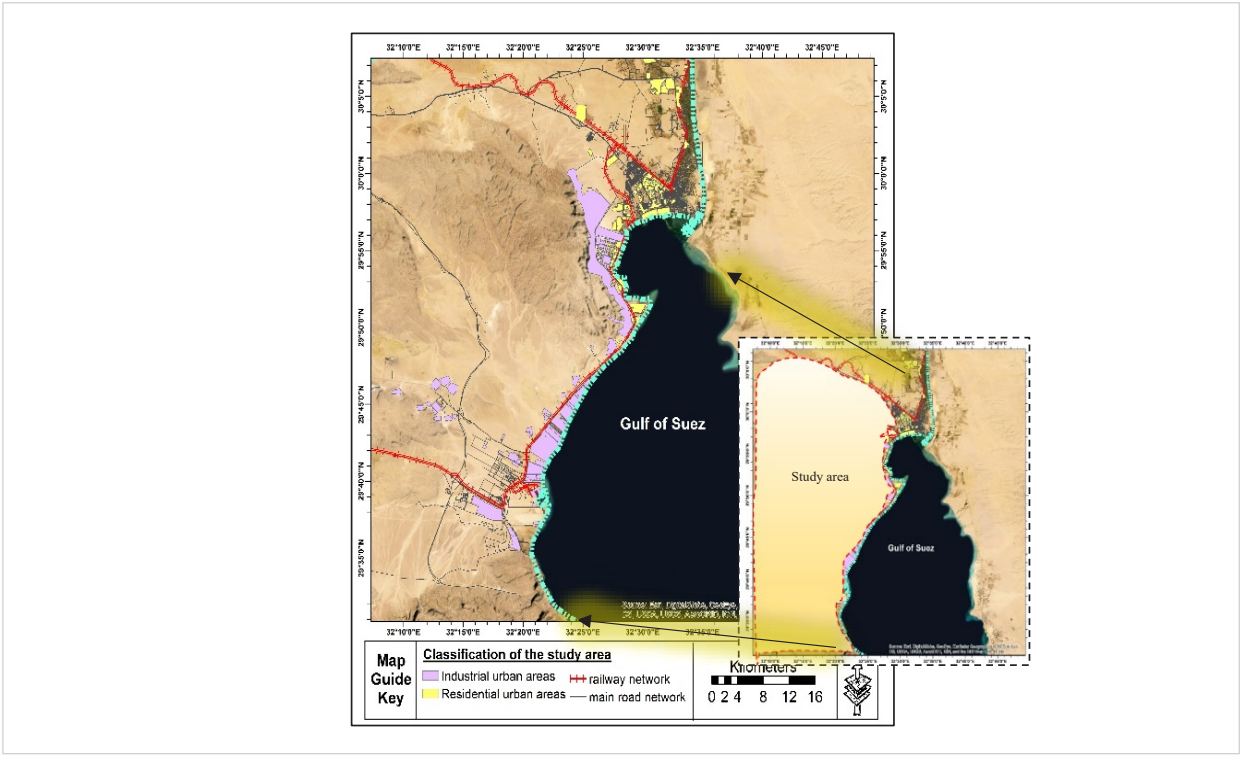
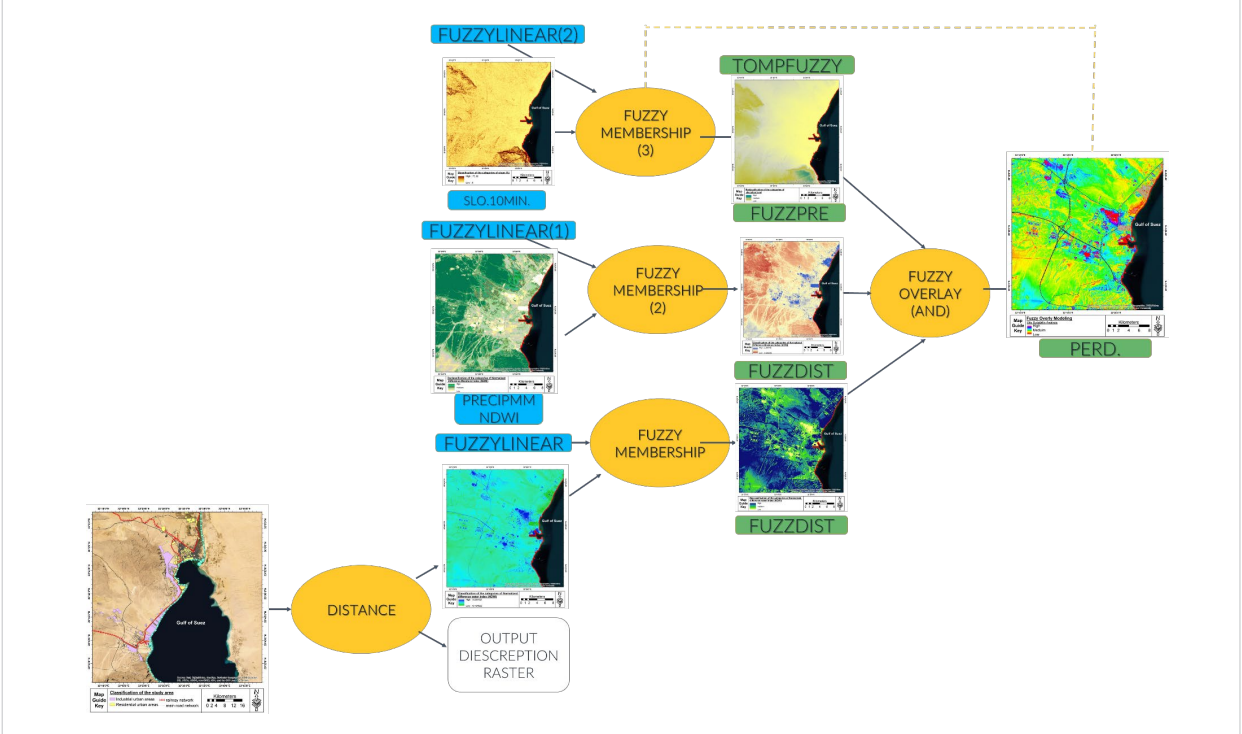


Fig. 8. *Concept framework of suitable locations for fuzzy rule and fuzzy inference to membership function (Source: authors)*



The Southwest of the Suez Canal is identified as moderately suitable with an area of 13 km^2, a weight of 0.211382, and a score of 10. The East of the Suez Canal is identified as less suitable, with an area of 9 km^2, a weight of 0.146341, and a score of 5.

Therefore, the most suitable locations for the high-tech industry, as shown in *Fig. 9*, are the northwest and then southeast in the special economic zone northwest of the Suez Canal, as shown in *Fig. 9* and *Table 8*.

Fig. 9. *Maps showing the spatial distribution of the 14 input standards in the GIS environment in the area of study (Source: Author)*

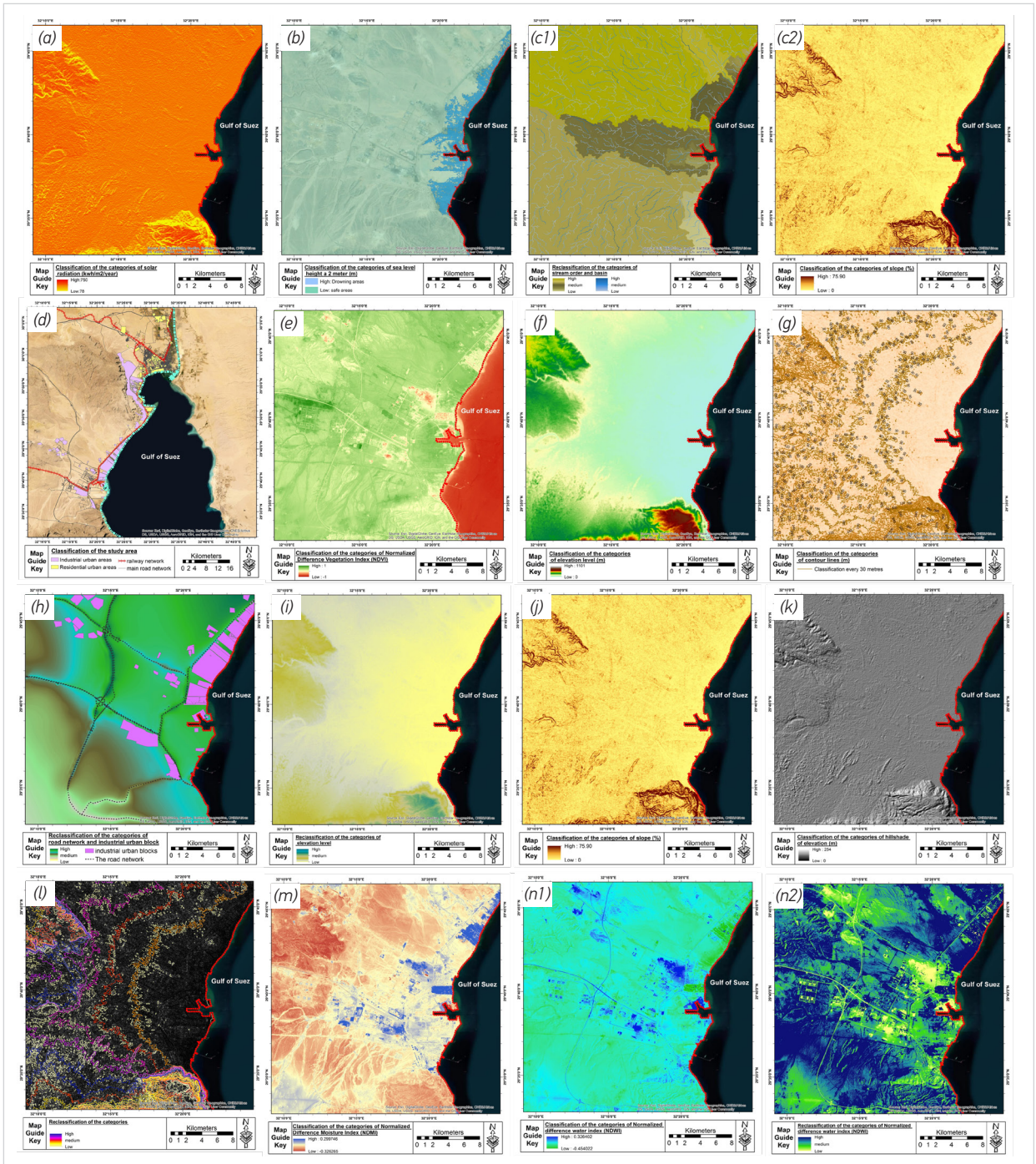
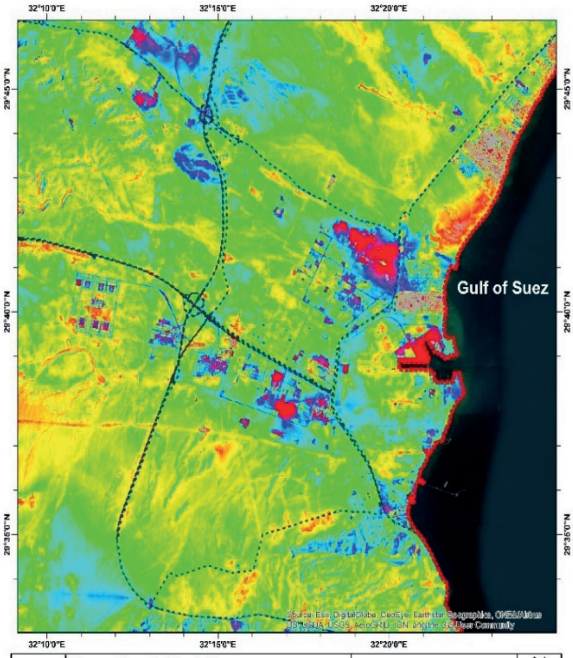


Table 8. *The result of the overlay fuzzy map of high-tech industries in the SEZ Northwest of the Suez Canal*

Result	Area/km²	Weight	Score	
Northwest	22	0.357724	20	Most suitable
Southeast	17.5	0.284553	15	Suitable
Southwest	13	0.211382	10	Moderately suitable
East	9	0.146341	5	Less suitable

Fig. 10. *Overlay fuzzy map of the locations of high-tech industries in the SEZ of the Suez Canal (Source: authors)*



Conclusion

This paper briefly addresses the policies dealing with economic zones in light of the 4IR. A set of criteria are proposed that define and classify industrial and economic zones according to the possibility of switching to the fourth-generation industries. The researchers conclude that the industrial areas can be classified into two groups, as follows: the first group which does not follow the sustainable development approach and traditional industries are only used for economic components, and the second group which follows a sustainable development approach, while keeping abreast of the latest approaches in sustainability, and creates closed loops of raw materials intending to balance between inputs and outputs by reducing the number of industrial materials buried or lost in intermediate processes through reusing and utilizing high-tech industries and technology. In addition to that, another set of criteria are proposed that can be used to determine the best geographical locations for the settlement of fourth-generation industries.

To find the ideal locations for establishing high-tech industrial regions, the research offers an environmental simulation through the Fuzzy GIS, which is deployed in the special economic zone northwest of the Suez Canal. Information systems using fuzzy's environmental approaches are crucial in order to discover high-tech industrial zones within complicated economic and industrial zone projects, considering the environment and urban, economic, and social factors that cannot be directly assessed by other ways.

By applying the results of the research to the Egyptian case, it became clear that the industrial zones in Egypt are still between the first and second generations. The criteria reached by the researchers are used to determine the best sites for the localization of fourth-generation industries through a comparison between the industrial and economic zones in Egypt, selecting the Suez Canal area as the best area that can convert to the fourth-generation industries, as well as the best geographical location for the settlement of high-tech industries. The research achieves its objective of finding ideal sites for the establishment of high-tech industries and fourth-generation projects. In the Suez Canal area, 14 of the 26 criteria are appropriate to the Egyptian case and GIS techniques. These criteria identify the economic zone northwest of the Suez Canal as an ideal environment for high-tech projects, located in the northwest and southeast. The northwest of the Suez Canal is identified as the most suitable, with an area of 22 km², a weight of 0.357724, and a score of 20.

Because of the expected long-term economic, environmental, and social benefits, the government should encourage the private sector to use such useful methods (Fuzzy GIS). On the other hand, the government should contribute to and support the technology industry and promotion of green policies, which is the future solution for most of the environmental problems in Egypt, especially in the Sinai region. However, these technologies must be used properly. Finally, the research recommends developing an integrated industrial strategy that takes into account the environment, communications, multiple energy sources, and transportation, to ensure that the pillars and elements of the Fourth Industrial Revolution are faced with global changes such as the COVID-19 pandemic (Corona Virus). Also, the research emphasizes the value of GIS Fuzzy methods, which are frequently used in making spatial decisions for high-quality industrial sites.

References

Association for the Development of Clusters and Technology Parks of Russia. (2019). Russian Special Economic Zones: Business Navigator 2018. Ministry of Economic Development of the Russian Federation. Retrieved from Association for the Development of Clusters and Technology Parks of Russia: https://www.economy.gov.ru/material/file/a0b90d14ca9320a4588538cf284d19b0/Business_Navigator_2018_ENG.pdf

Ambroziak, A. A. (2016). Income Tax Exemption as a Regional State Aid in Special Economic Zones and Its Impact upon Development of Polish Districts. Oeconomia Copernicana, 7 (2), 245-267. https://doi.org/10.12775/OeC.2016.015

Assembly, T. G. (2015). Transforming our world: the 2030 Agenda for Sustainable Development. UNITED NATION. Retrieved from United Nations: https://www.un.org/ga/search/view_doc.asp?symbol=A/RES/70/1andLang=E

Ali, A. (2014). The Impact of Foreign direct investment (FDI) on economic growth in Algeria. Czech University of Life Sciences Prague Faculty of Economics and Management. Retrieved from https://www.pef.czu.cz/dl/45931

Abedini, J. (2008). The Greater Arab Free Trade Area (GAFTA): an Estimation of Its Trade Effects. Journal of Economic Integration, 23(4), 848-872. https://doi.org/10.11130/jei.2008.23.4.848

Ahmed, B. (2004). The constituents and obstacles of Arab integration with a focus on free trade zones. The regional conference on Arab migration in a globalized world. Switzerland: International Organization for Migration (IOM).

Bahaa ElDin, Z. (2020). Do not let today's crisis sink tomorrow's economy. Capee Arabia. (S. ElKhawanky, Interviewer) Retrieved from https://cipe-arabia.org/wp-content/uploads/2020/04/ETEF_Interviews__Ziad_Bahaa_Eldin_March29_2020.pdf

Buckley, G., and Rynhart, G. (2011). The Sultanate of Oman the enabling environment for sustainable enterprises: An «EESE» Assessment. Geneva: International Labour Office. Retrieved from http://ilo.org/wcmsp5/groups/public/---ed_emp/---emp_ent/---ifp_seed/documents/publication/wcms_167007.pdf

Basenko, A. M., and Grigoryan, E. M. (2009). Special economic zones in Russia: your partner for growth.Russiaz. Retrieved from https://www.jp-ru.org/5forum/data/alabuga1.pdf

Ben Ali, B., and Ahmed, M. (2006). The role of free zones as an incentive to attract foreign direct investment, the study of the free zone Bellara International Forum on the effects and implications of the partnership agreement on the economy on the role of free zones as an incentive economy. Algerian: Farhat Abbas University.

Brown, R. (2006). A Practical Guide to Rural, Cluster-Based Economic Development Strategies. The University of North Carolina at Chapel Hill, City, and Regional Planning. CAROLINA: University of North Carolina at Chapel Hill. Retrieved from https://doi.org/10.17615/z223-xj39

Cheesman, A. (2012). Special economic zones and development: Geography and Linkages in the Indian EOU Scheme. The Bartlett Development Planning Unit (145), 1-42. Retrieved from https://www.ucl.ac.uk/bartlett/development/sites/bartlett/files/migrated-files/WP145_0.pdf

Crittle, J., and Akinci, G. (2008). Special Economic Zones: Performance, Lessons Learned, and Implications for Zone Development. Washington: World Bank Group. Retrieved from http://documents1.worldbank.org/curated/en/343901468330977533/pdf/458690WP0Box331s0April200801PUBLIC1.pdf

Cote, R. P., and Cohen-Rosenthal, E. (1998). Designing eco-industrial parks: a synthesis of some experiences. Journal of Cleaner Production, 6, pp. 181-188. Retrieved from http://www.umich.edu/~indecol/EIP-cote.pdf. https://doi.org/10.1016/S0959-6526(98)00029-8

Ding S. (2019). A novel discrete grey multivariable model and its application in forecasting the output value of China's high-tech industries. Computers and Industrial Engineering, pp. 127: 749-760. https://doi.org/10.1016/j.cie.2018.11.016

Division of information affairs. (2014,). the GCC: process and achievements. Division of information affairs. Riyadh: Cooperation Council for the Arab States of Gulf secretariat general. Retrieved from https://www.gcc-sg.org/enus/CognitiveSources/DigitalLibrary/Lists/DigitalLibrary/The%20GCC%20Process%20and%20achievement/7161447306380.pdf

Dawoud, M., (2013), The development of integrated water resource information management system in arid regions, Arab journal of geosciences, 6, pp 1601-1612. https://doi.org/10.1007/s12517-011-0449-6

Dutt, A. (2008). International Handbook of Development Economics (Vol. 2). (J. Ros, Ed.) US: Edward Elgar Publishing. Retrieved from https://EconPapers.repec.org/RePEc:elg:eebook:3813 https://doi.org/10.4337/9781848442818

European Commission. (2010). Trade and private sector policy and development support programs are financed by EU external assistance. Luxembourg: Office for Official Publications of the European Union. Retrieved from https://www.enterprise-development.org/wp-content/uploads/EC_Trade_And_Private_Sector_Policy-and-Development-1.pdf

Fassio, C., and Nathan, M. (2020, April). Exploring Industry 4.0 production in Sweden. Industry 4.0 and Regional Transformations, pp. 133-151. https://doi.org/10.4324/9780429057984-8

Feil, A. A., Schreiber, D., Haetinger, C., Strasburg, V. J., and Barkert, C. L. (2019). Sustainability Indicators for Industrial Organizations: Systematic Review of Literature. Sustainability, 11(3). doi:10.3390/su11030854. https://doi.org/10.3390/su11030854

General Authority for Investment and Free Zones. (2017). The investment law No 72 of 2017. General Authority for Investment and Free Zones. Cairo, Egypt: General Authority for Investment and Free Zones. Retrieved from https://www.investinegypt.gov.eg/flip/library/LawsAndRegulations/PDFs/Law72_and_Exec_reg_en.pdf

Ghaempour, M. A., and Latifi, G. (2016). Impact of Free Trade Zones on Welfare and Social Development of Urban and Rural Areas (Case Study: Salafchegan Free Trade Zone). Social Development and Welfare Planning, 8(27), pp. 197-232. Retrieved from https://qjsd.atu.ac.ir/article_5943.html?lang=en

Gothmann, K., Jain, P., Nikov, K., and Vest, H. (2015). Guidelines for Sustainable Industrial Areas (SIA) (Vol. 1). Eschborn: Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ).

Gothmann, K., Jain, P., Nikov, K., Vest, H., and Working Group on Sustainable Industrial Areas (SIA. (2015). Guidelines for Sustainable Industrial Areas (SIA). Eschborn: Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH.

Graham, E. M. (2004). Do export processing zones attract FDI and its benefits? International Economics and Economic Policy, 1(1), pp. 87-103. https://doi.org/10.1007/s10368-003-0003-4

Gray, A. (1994). Industry Clustering for Economic Development.

Holden, M. (2008). Social learning in planning: Seattle's sustainable development codebooks. Progress in Planning, 69(1), pp. 1-40. Retrieved from: https://doi.org/10.1016/j.progress.2007.12.001

International development Irland. (2020). Technical assistance to the Gambia investment promotion and free zones agency (GIPFZA). Retrieved from International development Irland: https://www.idi.ie/

Japan International Cooperation Agency. (2018). Data Collection Survey on Trade and Logistics in Jordan, Palestine, and Region. Japan International Cooperation Agency. Retrieved from https://openjicareport.jica.go.jp/pdf/12320149.pdf

Janjua, S., Khan, A., and Asif, N. (2017). Sustainable Urban Development and SEZs Consideration for China Pakistan Economic Corridor. Centre of Excellence for CPEC. Retrieved from https://cpec-centre.pk/wp-content/uploads/2018/03/Working-paper-no-14-1.pdf

Khan, A., Bibi, S., Lorenzo, A., Lyu, J., and Babar, Z. U. (2020). Tourism and Development in Developing Economies: A Policy Implication Perspective. Sustainability, 12(4), 1-19. https://doi.org/10.3390/su12041618

Khurram Khan, M., and Babar Khan, M. (2020). Research, Innovation, and Entrepreneurship in Saudi Arabia: Vision 2030. Taylor and Francis Group. Retrieved from https://books.google.com.sa/books?id=di4OtAEACAAJ. https://doi.org/10.4324/978135104002

Kechichian, E., and Jeong, M. H. (2016). Mainstreaming Eco-Industrial Parks. Washington: World Bank. Retrieved from https://openknowledge.worldbank.org/handle/10986/24921. https://doi.org/10.1596/24921

Kondratov, D. (2014). The government's role in the export of capital from Russia. Herald of the Russian Academy of Sciences, 84(5), 385-393. https://doi.org/10.1134/S1019331614050025

Koc-San, D., San, B. T., Bakis, V., Helvaci, M., Eker, Z. (2013), Multi-Criteria Decision Analysis integrated with GIS and remote sensing for astronomical observatory site selection in Antalya province, Turkey. Advances in Space Research, 52(1), 3951.https://doi.org/10.1016/j.asr.2013.03.001

Kamran, K. V. (2008). Comparison of Boolean, overlay index and fuzzy logic methods for hazardous material disposal center site selection. Geogr Space, 28, 9-24.

LIMA, P. (2020). towards Circular Economy for Industry, developed with the assistance of UNIDO, under the Programme for Action on Green Economy (PAGE) Framework. Industrial Parks for Inclusive and Sustainable Industrial Development. Peru: UNIDO. Retrieved from https://www.unido.org/international-conference-industrial-parks-inclusive-and-sustainable-industrial-development

Lin S., Lin R., Sun J., Wang F., Wu W. (2020). Dynamically evaluating technological innovation efficiency of high-tech industry

in China: Provincial, regional and industrial perspective[J]. Socio-Economic Planning Sciences.: 100939-100946. https://doi.org/10.1016/j.seps.2020.100939

Li Y., Wang X. (2019). Innovation in suburban development zones: Evidence from Nanjing, China. Growth and Change. 50(1): pp. 114-129. https://doi.org/10.1111/grow.12270

Laura A. Schifman, Dustin L. Herrmann, William Shuster, And A. Ossola,(2017). Situating Green Infrastructure in Context: A Framework for Adaptive Socio-Hydrology in Cities. https://doi.org/10.1002/2017WR020926

L.E. Garcia, (2015(. Guidelines and Procedures on Environmental and SocialSafeguards for CAF/GEF projects Manual. Version1. https://www.caf.com/media/6742/d0-7_s_e_safeguards_manual_to_caf-gef_projects_may_2015_28.pdf

Litvinova, T., Bakitko, E., Popova, L., Ioda, E., Suleimanova, L., and Chirkina, M. (2015). Perspectives of Growth of Economic Security by Clustering of Small Innovation Enterprises. European Research Studies Journal, XVIII(3), 167-176. https://doi.org/10.35808/ersj/463

Leonid, M., Oleksandr, K., and Sergiy, P. (2014). The impact of foreign direct investment on economic growth: Case of post-communist transition economies. Problems and Perspectives in Management, 12(1), 17-24

Lesjak, I. (2012). The role of parks in attracting resources. Europe and Central Asia Regional Conference on Industrial Parks as a tool to foster local industrial development (pp. 42-60). BAKU, AZERBAIJAN: UNIDO and the Government of Slovenia. Retrieved from https://www.unido.org/sites/default/files/2012-10/Europe%20and%20Central%20Asia%20Regional%20Conference%20on%20Industrial%20Parks%20as%20a%20tool%20to%20foster%20local%20industrial%20development_0.pdf

Lim, S.-H., and Lim, K.-T. (2006). Special Economic Zones as Survival Strategy of North Korea. North Korean Review, 2(2), 47-61. Retrieved from http://www.jstor.org/stable/43910248. https://doi.org/10.3172/NKR.2.2.47

Lowe, E. (2001). Eco-industrial Park Handbook for Asian Developing Countries Report to Asian Development Bank. Asian Development Bank. Retrieved from https://www.researchgate.net/profile/Ernest_Lowe/publication/334204752_Eco-industrial_Park_Handbook_for_Asian_Developing_Countries_Report_to_Asian_Development_Bank/links/5d1cc4d6458515c11c0f0c23/Eco-industrial-Park-Handbook-for-Asian-Developing-Countries-

MENA-OECD Investment Program, and Iraqi Institute for Economic Reform. (2009). Infrastructure Development and Financing Through Economic Development Zones. opportunities for infrastructure financing in Iraq. Paris, France: MENA-OECD Investment Program and Iraqi Institute for Economic Reform. Retrieved from https://www.oecd.org/mena/47563506.pdf

Meng, G. (2003). The Theory and Practice of Free Economic Zones: A Case Study of Tianjin/People's Republic of China. Peter Lang Publishing. Retrieved from https://core.ac.uk/download/pdf/32578724.pdf

Maex, R. (1983). Employment and multinationals in Asian export processing zones. Geneva: International Labour Office. Retrieved from International Labour Organisation: https://www.ilo.org/wcmsp5/groups/public/---ed_emp/---emp_ent/---multi/documents/publication/wcms_126563.pdf

Massey, D. (1982). Enterprise zones: a political issue. International Journal of Urban and Regional Research, 6(3), pp. 429-434. https://doi.org/10.1111/j.1468-2427.1982.tb00391.x

Nikolskaya, E. Y., Blinova, E. A., Lepeshkin, V. A., Kulgachev, I. P., and Shadskaja, I. G. (2020). Strategy for the Promotion of a Tourism Product in the International Market. International Journal of Advanced Research in Engineering and Technology (IJARET), 11(2), 238-245. Retrieved from https://ssrn.com/abstract=3553330. https://doi.org/10.14505//jemt.11.2(42).20

OECD. (2020). OECD Investment Policy Reviews: Egypt 2020. OECD. https://doi.org/10.1787/9f9c589a-en

OECD. (2020). OECD Tourism Trends and Policies 2020. OECD. https://doi.org/10.1787/6b47b985-en

Ohrimenko, E. I., and Ergunova, O. T. (2020). Tourism Industry: Development and Importance of Foreign Economic Relations of Russia. Proceedings of the First International Volga Region Conference on Economics, Humanities, and Sports (FICEHS 2019) (pp. 152-155). Atlantis Press. https://doi.org/10.2991/aebmr.k.200114.035

OECD,)2018(, Enhancing Competitiveness in Central Asia, https://doi.org/10.1787/20765762

OECD. (2018). Investment policy and promotion in southeast Europe. OECD. https://doi.org/10.1787/9789264298576-6-en

Organization, U. N., Group, W. B., and Zusammenammenarbeit, D. G. (2017). An International Framework for Eco-Industrial Parks. Washington: World Bank. Retrieved from http://hdl.handle.net/10986/29110

OECD, (2006). Policy Framework for Investment. https://www.oecd.org/daf/inv/investment-policy/36671400.pdf

Popkova, E. G. (2020). Public Administration and Regional Management in Russia. (K. V. Vodenko, Ed.) Springer International Publishing. Retrieved from https://www.springer.com/gp/book/9783030384968. https://doi.org/10.1007/978-3-030-38497-5

Partnership for Action on Green Economy (PAGE). (2017). Green Industrial Policy and Trade: A Tool-Box. United Nations Environment Program. Retrieved from https://wedocs.unep.org/bitstream/handle/20.500.11822/22915/Green_Industrial_Policy_Trade_ToolBox.pdf?sequence=1andisAllowed=y

Riley, G. (2020). Regional Policy - Enterprise Zones. Retrieved from tutor2u: https://www.tutor2u.net/economics/reference/regional-policy-in-the-uk-enterprise-zones

Robinson, V. B., Petry, F. E., and Cobb, M. A. (2003). Special Issue on Incorporating Fuzzy Sets in Geographic Information Systems. Wiley Online Library, 7(1), 1-1. https://doi.org/10.1111/1467-9671.00126

Roseland, M. (1997). Dimension of the eco-city. Cities, 14(4), 197-202. https://doi.org/10.1016/S0264-2751(97)00003-6

Robinove, C. J. (1986). Principles of logic and the use of digital geographic information systems. Department of the Interior, US Geological Survey. https://doi.org/10.3133/cir977

Science for Environment Policy.)2018(Indicators for Sustainable Cities. In-Depth Report 12. Produced for the European Commission DG Environment by the Science Communication Unit, UWE, Bristol. Available online: http://ec.europa.eu/science-environment-policy (accessed on 14 January Komal

Sun, Y.; Hrušovský, M.; Zhang, C.; Lang, M. (2018). A Time-Dependent Fuzzy Programming Approach for the Green Multimodal Routing Problem with Rail Service Capacity Uncertainty and Road Traffic Congestion. Complexity. https://doi.org/10.1155/2018/8645793

Tzioutziou, A., and Xenidis, Y. (2021). A Study on the Integration of Resilience and Smart City Concepts in Urban Systems. Infrastructures, 6(2), 6 - 24. https://doi.org/10.3390/infrastructures6020024

The EU-Egypt Association Agreement Programme. (2020). Institutional strengthening of the General Authority for Investment and Free Zones (GAFI) in Egypt. Egypt. Retrieved from http://www.esteri.it/mae/gemellaggi/meda/egitto/med_egi_eg05a-afi04_gafi_twi_pf.pdf

Tri, V. T., and Anh, N. D. (2020). Experiences of Vietnam in FDI Promotion: Some Lessons for Myanmar. (10), 131-172.

Thomas, F., and Akinci, G. (2011). Special Economic Zones: Progress, Emerging Challenges, and Future Directions (Vol. 1). world bank GROUP. Retrieved from https://documents.worldbank.org/en/publication/documentsreports/documentdetail/752011468203980987/special-economic-zones-progress-emerging-challenges-and-future-directions

Tantillo, Maria Daniela (2007), «GIS Application in Archaeological Site of Solunto,» Journal of Planning Tourism, vol.2

United Nations, (2020). Foreign Direct Investment in Latin America and the Caribbean, 2020LC/PUB.2020/15-P ISBN: 978-92-1-122055-1

UNCTAD,)2019(. The Digital Economy Report 2019.https://unctad.org/system/files/official-document/der2019_en.pdf

United Nations Industrial Development Organization. (2019). INTERNATIONAL GUIDELINES FOR INDUSTRIAL PARKS. Vienna: United Nations Industrial Development Organization (UNIDO). Retrieved from https://www.africaeconomiczones.com/wp-content/uploads/2019/12/International-Guidelines-for-Industrial-Parks-1.pdf

V.A, B., A.M, B., G.N, K., and M.A, S. (2018). Functioning of Tourist Recreational Special Economic Zones as Institutional Tools to Include Tourist Clusters in the World Economy. European Research Studies Journal, XXI (2), 230-237. Retrieved from https://www.ersj.eu/journal/1232

VanGrasstek, C. (2008). The Challenges of Trade Policymaking: Analysis, Communication, and Representation. SSRN Electronic Journal, 1-47. https://doi.org/10.2139/ssrn.1278022

West of England Combined Authority. (2020). Enterprise Zones. Retrieved from West of England COMBINED AUTHORITY: https://www.westofengland-ca.gov.uk/business/enterprise-zones/

Wang, X. (2013). The Role of Economic Development Zones in National Development Strategies, the Case of China. California: Pardee RAND Graduate School. Retrieved from https://www.rand.org/content/dam/rand/pubs/rgs_dissertations/RGSD300/RGSD320/RAND_RGSD320.pdf

Yao, D., and Whalley, J. (2015). China (Shanghai) Pilot Free Trade Zone: Background, Developments and Preliminary Assessment of Initial Impacts. National Bureau of Economic Research, 4-17. https://doi.org/10.3386/w20924

Zeng, D. Z. (2019). Special Economic Zones: Lessons from the Global Experience. PEDL Synthesis Paper Series, 1(1), 1-28. Retrieved from https://pedl.cepr.org/sites/default/files/PEDL_Synthesis_Paper_Piece_No_1_0.pdf

Ziedina, D., and Pelse, M. (2017). Main characteristics of economic zone types: Latvia's experience. Economic science for rural development, (pp. 212-218). Jelgava. Retrieved from https://llufb.llu.lv/conference/economic_science_rural/2017/Latvia_ESRD_44_2017-212-218.pdf

Zahraa Kmal, (2015(. The role of the economic development stage in shaping the industrial development path to achieve sustainable development. Cairo University.

Zeng, D. Z. (2015). Global Experiences with Special Economic Zones: Focus on China and Africa. Washington: World BPDF Retrieved from http://hdl.handle.net/10986/21854. https://doi.org/10.1596/1813-9450-7240

Zhang, H., and Ilhéu, F. (2014). The Role of Special Economic Zones in African Countries. Development and the Chinese FDI. CESA - Centre for African and Development Studies. Retrieved from https://ideas.repec.org/p/cav/cavwpp/wp129.html