Assessing Land Use Efficiency to Enhance Urban Dynamics through City Development Strategy

Case Study of Damietta City - Egypt

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Abstract

The acceleration of land consumption which associated with rapid urbanization especially in the medium cities of Delta region – Egypt and their consequences of many environmental impacts, require sensitive care in preparation the CDS for these specific cities. The aim of research is setting indicators to assess the efficiency of land uses that can be used as guidance tools for enhancing land management & development strategies, in order to succeed in closing the cycle of land consumption and optimize its metabolic flow. The adopt approach choose SDG11 as a base for formulating LUE Indicators which link the targeted actions in city development scheme with the urban components of the city's structure to offer a holistic framework that can enhance Strategic Urban Planning & City Development Strategies to achieve inclusive, safe, resilient and sustainable cities. The results of assessment LUE in Damietta CDS 2027 showed that the efficiency degree of land use in new added zones is larger than in the existing built up area and that indicate to the focus of CDS on enforcement new development strategy more than redevelopment strategy (which leads to lose the value of the developed land and increase in the consumption of new land). So the strategic urban planning must shift to be more proactive and responsive process to avoid inefficient land flow and enhance the appropriate strategies for “reduce, reuse, and recycle” land.

Keywords

Land consumption, Indicators of Land Use Efficiency, SDG11, Patterns of Urban Dynamics, City Development Strategy, and Damietta CDS 2027.

1. Introduction “The Context of Research Problem”

1.1. Global Urbanization Trend and Increases of Land Demand

A fundamental driver of future land use is population growth. It is expected that by 2050 about 9 billion people will inhabit the earth (UNDESA, 2014). Related to that, urbanization will be the defining trend over the next decades especially in Asia and sub-Saharan Africa, between 2010 and 2050 the urban population share will grow to more than 2/3 of the world's population (UNDESA, 2014). The expansion of urban areas and land required for infrastructure is expected to match with population growth. An additional 100 Mha of land is estimated to be required for residential, industrial and infrastructure until 2050, more than 90% of it in developing countries (FAO, 2011).

In the next 30 years, the doubling of urban population in developing countries will be triple the extent of built-up areas (Fragkias et al., 2013). Up to 2030, global urban land cover is expected to increase by over 200% (compared to 2000), while global urban population growth will be about 70% within the same timeframe. The most relevant dynamics is expected for Africa where urban land cover is projected to increase by 700%, while the African urban population will increase by 160 % in the same period (Fragkias et al., 2013). (Resource-Efficient Land Use, 2015) p.23

1.2. Land Consumption in Egypt and Delta Region

The annual rate of population growth is 2,04% concentrated on only 6.7% from the total area of Egypt especially on Delta Region, and that is causes annual rate of losing agriculture land approximately 13,000 fadan between 1984 to 2007 (Ministry of agriculture 2010). The Delta Region population increased during the period from 1996 to 2016 by an amount (46%), and the total agriculture land decreased until the per capita share of agricultural land was 0,11% fadan/person (Urban Development Strategic Scheme for Delta Region 2017).

As a result of rapid urban population on delta region that accompanied by losing agricultural lands and decreasing in its quality and productivity, the major urban centers in the region especially the capitals of the main governorates, suffer from a lot of problems such as: high densities, over loads on utility networks, informal growth, merging of attachment rural settlements, high land prices, traffic congestion, and deteriorated in old city centers. Despite the national urban strategy establish new cities to attract the urban population outside the delta, urban development plans for major cities in the delta still support the addition of new zones to accommodate future population growth and provide the necessary services, which lead to more population concentration and increase rates of land consumption and follow of many negative environmental impacts.

This highlights the importance of searching for methods able to enhance the efficiency of the whole city urban structure and promote reducing the more consumption of land. Therefore, the research aims to: Formulate indicators for assessing "land use efficiency" can be used as a guidance tool for enhancing land management and development strategies. The city of Damietta, the capital of Damietta Governorate that located in the Delta region, was chosen as a case study to implement the proposed approach.

2. The Research Background

2.1. Land use Definitions and Drivers of Change

The UN-Environment explained three main definitions related to the term of "Land" as the following: "Land cover" which refers to the physical surface characteristics of land, "Land use" which describes the economic and social functions of land, or the purposes for which humans exploit land cover, "Land functions" include provision of goods and services related to land use but also include 'unintended services' such as provision of aesthetic beauty, cultural heritage and preservation of biodiversity. (Arnout, UNEP, 2016) p.22

According to Heistermann et al. (2006), a driver of land-use change is defined as "causing a change in the total area allocated to a specific land-use type or a change in spatial distribution of land-use types" (Arnout, UNEP, 2016). These driving factors interact and change over time to create spatial dynamics internal city boundary, the main factors that causing these dynamics are; Natural environment, Demographic factors, Transportation systems, Consumer preferences, Land ownership, and Policy, regulation and management. (WBI, SULUP, Module 01, 2012)

2.2. Urban Dynamics and City Development Strategy

There are two main forces that are responsible for reshaping city urban structure during future growth; Centrifugal forces which drive a city's built form outwards, at a faster rate than would be expected from population growth; and Centripetal forces which are associated with the densification of core city, compact urban form and relatively slow horizontal physical expansion, relative to population growth. The Densification process is associated with several urban dynamics, including: Infilling, Redevelopment, Industrial relocation, and Self-organizing & informal densification. While Extensification process refers to the physical development of areas beyond the contiguous existing built-up city in different spatial patterns, including: Contiguous unchanneled peripheral development, Corridor development, and Satellite cities and new towns. (WBI, SULUP, Module 01, 2012)

A city development strategy is defined as an action-oriented process, developed and sustained through participation, to promote equitable growth in cities and their surrounding regions to improve the quality of life for all citizens. A CDS helps cities integrate a strategic development approach and a long-term perspective into their urban planning. With a CDS, cities move beyond planning around the short-term political or donor-funding cycle to consider where they should be in 20 or 30 years, and the steps that need to be taken to achieve those goals. The idea behind CDS is that well-positioned, well-timed public, private and civil society strategic interventions can change a city's development path and improve its performance. (<https://www.citiesalliance.org>)

NUA draw the path for CDS to "land development" in points "51; 69; 98" through; promote integrated urban and territorial planning that based on "preserving and promoting the ecological and social function of land", to achieve equitable; efficient; and sustainable land use, through infill or planned urban extension strategies. Also it committed to enhance compactness, polycentrism, appropriate density, connectivity, mixed use of space and built-up areas, and reduce mobility challenges and service delivery costs per capita, in order to prevent urban sprawl, unnecessary land-use change, and the loss of productive land. (NUA, 2017)

2.3. Efficiency of Land Use "Definition and Strategies"

The resource efficiency defined as "a way to deliver more with less", it increases aggregate economic value through more productive use of resources over their life cycle" (UN, 2017, p.38). In land use planning the term "Efficient Land Use" is related to the term of "Smart Growth" and "Intelligent Urbanism", it is including the practices from demand management strategies (decreasing the demand before increasing the supply) for land development practices that minimize negative environmental impact and foster vibrant communities. (Efficient Land Use Strategy, 2016) p.19

The Roadmap to a resource efficient Europe requires better integration of direct and indirect land use and its environmental impacts in decision-making at all levels (EC, 2011a). The Roadmap calls for a multi-sectoral limitation in land take and soil sealing, asking in particular for the following: reducing land take for buildings (e.g. urban sprawl); reserving fertile land for agriculture; minimising the impact of the transport infrastructure on land fragmentation; optimising land use to reconcile it with other uses; optimising the energy infrastructure; remediating contaminated sites. (What is a resource-efficient city?, 2015)

There are little cases of CDS that include the term of "Efficient Land Use" in formatting city development plan and setting strategies to enhance the different patterns of urban dynamics that target efficiency of land consumption; two of succeeded experiences are: "Lethbridge city plan" and "Complete Communities in Delaware" project, the main strategies in both case studies are:

- The major strategies of Efficient Use Land in Lethbridge city plan, are: Reduce the rate at which land is converted from an undeveloped state into permanent built environment, Utilize the minimum amount of land necessary for new development and build at higher density than current practice, Increase the proportion of new development that takes place within already developed or disturbed lands either through infill, redevelopment and/or shared use, relative to new development that takes place on previously undeveloped lands. And Build awareness and understanding of the efficient land use principles and the application of land-use planning tools. (Efficient Land Use Strategy, 2016, p.11)
- The main tools for achieving efficient land use in planning for “Complete Communities in Delaware” project, are: Traditional Land Use Planning Tools, Form-Based Codes, Master Planning, Infill and Redevelopment Strategies (Residential Infill Development, Commercial Infill Development, Brownfield Infill Development, and Mixed-Use Infill Development), and Mixed-Use Development Strategies (Vertical Mixed-Use Development, Horizontal Mixed-Use Development, and Mixed-Use Walkable Areas). (<https://www.completecommunitiesde.org>)

3. Research Approach

By reviewing the draft report for measuring “land consumption”, and the updated one that titled “land use efficiency” (un-habitat, 2018), which discuss SDG11; 11.3.1 indicator that focus on measuring (ratio of land consumption rate to population growth rate), the main finding is:

Although the adopted method refer to the dynamic and functional change of city boundary, and identify the pattern of urban growth that represent types of development strategy (infill, extension, leapfrog development and inclusion) (UN-habitat, 2018 p.8), but this method of calculation lack of:

- The method was based on calculating the area of new added zones to the external boundary of the city structure, and didn’t take into account the internal dynamics changes that occurring in the existing built up area through different development strategies, that can provide many alternatives for re-development strategies and enhance “reduce, reuse, and recycle” of land consumption & development. Which demands the importance of searching for a method enables to consider all the stages of the whole life cycle of land development.
- Also this method of calculation focus only on the amount of land consumption, and that reflect the change in land area neglecting some important variables likes the changes in; density of land, types of land uses (land function); land value, return of land, etc. also the time taken to make this changes and the participant actors. So, the proposed benchmark (10-150 person/hectare) that setting for assessing land use efficiency doesn’t reflect all sides of efficient use of land. (UN-habitat, 2018 p.15)

3.1. Proposed Indicators for Assessing Land Use Efficiency

With Goal 11, the global community acknowledged well-planned urban development as a key driver for sustainable development (UN, sdg11 2018). Chosen all objectives of SDG11 as a basis for formulating Land Use Efficiency Indicators offer a holistic framework to guide Strategic Urban Planning & City Development Strategies to achieve inclusive, safe, resilient and sustainable cities. Depending on the analysis of SDG11 that clarify the linkages between the targeted actions in City Development Scheme with the city’s urban structure composition, the proposed indicators for measuring “LUE-I”, are: Table 1

Indicators relative to urban-rural linkages on the scale of the direct city region

- Connectivity: Support links between urban, peri-urban and rural areas with the city.

Indicators relative to main urban sectors

- Affordability: Provide /ensure access to housing and basic services sectors.
- Availability: Provide open public spaces within city boundary.
- Variety /Diversity: Provide variety in all urban sectors (housing, services, and infrastructure).
- Accessibility: Provide access to/ expand in public transportation system.

Indicators relative to specific zones internal urban city structure

- Formality: Upgrade deteriorated urban zones (slums area).
- Minimization/Compactness: Reduce land consumption, and Enhance compact urban form.
- Optimization: “Optimum Capacity”: Increase utilizing of existing built up area.
- Maximization: “Highest Revenue”: Maximize the revenue from new land consumption, and utilizing of existing building intercity boundary.
- Conservation: Preserve the high value zones (culture and natural heritage locations).
- Protection: Reduce the environmental impacts from risk zones.

Indicators relative to urban development processes

- Locality: Enhance utilizing of local material in construction process.
- Participatory: encourage participation in planning and management process.

Sdg11	LUE-Indicators	CDS Actions	Elements of City Structure	
11.A	Connectivity	Support	Links between city and rural/urban units	Direct City Region
11.1	Affordability	Ensure assess	Housing, and basic services	Basic Urban Sectors
11.7	Availability	Provide	Public open spaces	
11.2	Accessibility	Expand in	Public transportation system	
Add to 11.1	Diversity	Vary in	All urban sectors	
11.3	Minimization/ Compactness	Reduce Enhance	Area of new added zones/ Compact urban form	City Urban Structure
Add to 11.3	Optimization	Increase	Existing built up area	
Add to 11.3	Maximization	Scale up	The capacity building of whole city structure	
11.1	Formality	Upgrade	Deteriorated urban zones	
11.4	Conservation	Preserve	Valuable zones	Specific Urban Zones
11.5,11.6,11.B	Protection	Reduce	Environmental impacts from risk zones	
11.3	Participatory	Enhance	Planning & management processes	
11.C	Locality	Encourage	Construction process	

Table (1): Proposed indicators For assessing land use efficiency based analysis of SDG11, Made by the Authors

3.2. Limitation of Research Approach

Despite, the SDG 11 considered as the base for proposing indicators of land use efficiency, we add three indicators to the previous list as a complementary indicator for measuring the achievement of “main and sub” target goals, which are:

- Variety/diversity indicator, that enhance the indicators of affordability and availability which target providing the main urban sectors (housing, services, and open spaces) on city structure for all citizens, and for achieving that we proposed the variety or diversity indicator to ensure that all citizens classes have the ability to access for which matching with their suitable needs.
- Optimization and Maximization indicators, those enhance the indicator of Minimization/Compactness indicator which target reduce land consumption and enhance compact urban form. Adding optimization indicator ensure the best utilizing of “full capacity building” for existing and proposed built up area, and adding maximization indicator ensure achieving the highest revenue from utilizing of existing and proposed built up area, therefore the two indicators enhance reducing the land consumption for future urban growth.

For applying the check list that evaluates efficiency of land use to proposed actions in City Development Scheme, we exclude three indicators from evaluation; there are:

- Locality indicator which target enhance utilizing of local material in construction process because it is need specific quantative and qualitative data for building materials and analyzing details stages of construction process, and that are not available on the scale of the city.
- Participatory indicator which target encourage participation in planning and management process, because it was needed pervious evaluation to the stage of preparing the development scheme to can assess the range of participation and their influence for all target group.
- Variety indicator which target providing variety in all available urban sectors (housing, services, and infrastructure), and that is not found in GIS data base and development report for the city.

3.3. Benefits of Proposed Indicators from Holistic Perspective

- * From Urban Side; Land Use Efficiency will enhance all objectives of proposed indicators.
- * From Social Side; Land Use Efficiency will enhance: Affordability, availability and variety of social services, high Levels of Citizens skills (health and education), Social equity of resources distribution, large Numbers of beneficiaries, Community satisfaction, Sense of belonging to the place, Social interaction (social collaboration), Ensure social safety.
- * From Economic Side; Land Use Efficiency will enhance: Numbers and types of economic projects, Availability and variety of jobs opportunities, higher levels of income, Economic benefits, Activation market and encourage Investment, Integration in multi economic sectors, Diversity of available goods and services.
- * From Environmental Side; Land Use Efficiency will decrease: Resources consumption, Heat urban island, Negative impacts of climate change, Emissions and pollutions, Disasters risk. And enhance; Quality of life, Conservation natural resources, Healthy urban environment, Conserving natural equilibrium, Securing biodiversity.
- * From Institutional Side; Land Use Efficiency will enhance: Development revenue for local governance, Ability for providing citizens basics services, Trust between government and citizens, Achieving Political stability, Participation and Conservation on development projects from all stakeholders.

4. The Applied Case Study

4.1. Identify the City of Damietta – Egypt

Damietta is located in the far east of the Delta on the eastern side of the River Nile and inland from the Mediterranean Sea by 13 km. This location is between the strong natural boundary of Manzala Lake which extends south and east of the city, and agricultural lands to the south and the Nile River in the west. The city is connected to the regional road network through 4 main entrances: Damietta, Port Said, Damietta, Faraskour, Damietta, Mansoura, Damietta, Ezbet El Borg and Ra s El Bar. Figure 1

Figure (1): The location of Damietta City in Delta region, and the city urban structure 2006. R. GOPP 2011

The city region (Markaz Damietta) includes 10 local units, 16 independent villages, in addition to Ezbet El Borg and Ras El Bar. The population of Markaz Damietta was 453,008 in 2006. The total population is 203187 inhabitants, and the total area within the administrative border is 3172 acres in (2006). The future population is estimated to 393553 inhabitants in 2027. The economic activities in Damietta vary between agriculture, fishing, and industrial. Trade is one of the most important economic activities in the city. Also the city has much potential for local tourism.

4.2. Analyze Land Consumption & Patterns of Inefficient Land Use

The city consumed land through its stages of urban growth, as the following:

First Stage (until 1896): the city has grown in linear direction adjacent to the east side of the Nile River in a stripe form that resembles a T-shaped area. The built up area in this period was 30:35% from the current built up area in 2006 (952 fadan), and has about 32,000 inhabitants.

Second Stage (1896 - 1936): the city has grown in north direction adjacent to the east side of the Nile. The built up area was increased only 10% in this period over the current built up area in 1896 (1269 fadan), and has about 49,000 inhabitants.

Third Stage (1936 - 1946): the city has grown in all directions especially at north and south from the east side of the Nile in linear shape. The built up area was increased 10:15% from built up area in 2006 (1586 fadan), and the population has about 62,000 inhabitants.

Fourth Stage (1946 - 1966): This stage was characterized by scattered extensions separated from the city structure in all direction especially in north and south, with an increase of about 5:10% of the total built up area in 2006 (1745 fadan), and the population has about 72,000 inhabitants.

Fifth Stage (1966 - 1986): This stage was characterized by rapid growth in all directions, especially in north and south (1810 fadan), with population 89,069 inhabitants.

Sixth Stage (1986 - 2006): This stage was characterized by rapid growth in all directions to occupy agricultural plots inside built up area, in addition to growth in the western direction and emerged many villages with the city urban structure. Parallel to regional axes. (3172 fadan) the population was 203187 inhabitants.

The patterns of inefficient land use that associated with land consumption through city growth are:

- Losing agriculture land: - Decreases in agricultural land over the last 11 years with an annual average of 500 feddans. The decrease in the per capita share of agricultural land from 0.18 feddans /person in year 1976 to 0.12 feddans per capita in 2006.
- Unused land: - The ratio of vacant land plots, agricultural enclaves and fallow lands represented about 3.57 % of the total urban area of the city, equivalent to 113.6 feddans.
- Inoccupation housing units: - The percentage of vacant buildings within the urban built-up area internal city boundary and that are considered to be in good condition represented about 30% of the total number of housing units.
- Not Fully used building: - The buildings in good condition that can be extended vertical are about 56.1% from the city structure.
- Informal areas: - The total number of informal areas in the city 33 areas represents 31% of the total housing units in the city.
- Deteriorated Building: - The area of the heart of the old city of Damietta is considered to be one of the most deteriorated housing areas, where the original age of the buildings in this area has been completed before 1947 and the buildings in this area have un-durability structure.

- Inefficient used for valuable location: - Cemeteries with area of 44 acres representing 1.39% from the total land uses, and is located in the center of the urban built-up area of the city.

4.3. Identify the City Development Strategy for Damietta City 2027

The City Development Strategy for Damietta City 2027 based on strategic planning approach that enhance participation and resources efficiency, and target achieving sustainable development. The adopt methodology is: set vision and goals; formulate strategies; propose action plan; arrangement of activities and projects, Based on city profiling and SWOT analysis. The main target sectors: Basic sectors: (shelter and slums, basic services and infrastructure, and local economy), with Intersection issues of: (urban governance, social issues, and environmental issues)

Vision Formulating: The future vision of Damietta city is considered planning region of the city (Ras El Bar - Ezbet El Borg - Damietta Port - New Damietta City) as a development pole in the North Delta region, especially in the region from Port Said in the east to Alexandria in the west. Vision Statement for Damietta City in 2027 was: "Damietta as a development pole at the regional level"

4.4. Evaluate the Proposed Actions in CDS 2027 from "I-LUE" Perspective

- The CDS achieve connectivity through; adding the new zones for future urban growth in the direction of the urban and rural unties that compose the direct city region; merging some of attachment villages to institutional legal city boundary, and expanding into regional axes roads.
- The CDS achieve affordability through; providing new housing areas for multi levels of income and providing services centres especially (education, health, ...) at local and regional levels in new added zones, proposed new housing project after redevelopment the city centre on the long term, and providing new service centres in vacant land and framing zones in existing built up area (infilling and framing strategies).
- The CDS achieve availability through; redevelopment of some important vital squares internal the built up area of the city, and providing new open public spaces within new extension areas.

- The CDS achieve variety through; providing varies types and levels of housing projects, also in services centres, and infrastructure networks.
- The CDS achieve accessibility through; expanding in public transportation lines, and providing some new stations at regional roads in new added zones, Relocation the existing railroads lines, and establish a movable metal bridge to cross the Nile.
- The CDS achieve formality through; proposed upgrading of five attachments villages to the city boundary, and highlight framing zones to these informal areas as priority for planning, and setting the new regulation on new added zones.
- The CDS achieve minimization/compactness through; enhance other alternatives for accommodate future population growth by increase the capacity building of existing built up area: (infilling strategy) utilize the vacant land, (densification strategy) increase the number of floor at good new building, and (redevelopment strategy) upgrading the informal areas which included into existing built up area.
- The CDS achieve optimization through; increasing the capacity building of existing built up area by utilize the vacant land (infilling strategy) and raise the number of floor of good new building. Also enhance redevelopment the old building in a bad conditions (not durable, doesn't have a stable safe structure).
- The CDS achieve maximization through; enhance mixing use development on scale of the buildings site also on the scale of individual building, and allocation the land use that have high return in valuable locations.
- The CDS achieve conservation through; proposed high return investment on valuable locations (mixed use development), framing strategy that preserve the surrounding area of merged village, and propose only two historical building for renewal without taken the area surrounding into actions (neglecting the other historical buildings in the city).
- The CDS achieve protection from pollution side only focusing on waste management, and neglecting the risk disasters zones that located in the south edge adjust El-Manzala lake, through; allocation new spots for treatment and burial wastes outside the city boundary, and ensure road safety from accidents, also providing some environmental administrative units for monitoring, awareness, and training.
- The CDS achieve participatory through; encourage all stakeholders to participate in all stages of planning process (preparation, setting vision, determine priorities, and implementation).
- The CDS didn't achieve locality because; the scheme doesn't have any proposed actions for enhance utilizing of local material in construction process.

5. Measuring Indicators of Land Use Efficiency "LUE-I"

After identifying the indicators of assessing land use efficiency, we select ten for applying on Damietta City Development Scheme 2027 using spatial analysis program (GIS). We explain the base of measuring every indicator and ranking the values from 1 to 10 into specific categories according to its relative weight. Then we intersect the ten layers to get the final map that collect the measuring values of all affecting indicators on land use efficiency, and discuss the output results. Also we do statistical analysis using (Factor Components Analysis) to ensure the influence of the proposed indicators and return every indicator to its real weight of influence.

- Connectivity indicator measured depending on the location of new added zones for future urban growth in CDS 2027 to the approved Legal City Boundary LCB in 2006, and its spatial relations with urban, peri-urban, and rural units which compose the direct city region. The degree of connectivity ranked based on the socio-economic importance of connected urban units to the city which has the biggest flow of people, goods, etc. also the separation distance between each other.
- Affordability indicator measured depending on the proportion of housing area and the proportion of services area that affordable within the total area of every Shiakha (the administration division of legal city boundary 2027), in relation with the total number of population in each one. The degree of affordability ranked from the highest to the lowest value of per capita share of housing plus per capita share of services for every shiakha, according to the administration division for legal city boundary that proposed for 2027.
- Availability indicator measured depending on the proportion of public open spaces (which included the roads and other open spaces) that available within the total area of every shiakha (the administration division of legal city boundary 2027), in relation with the total number of population. The degree of availability ranked from the highest to the lowest value of per capita share of public open spaces, according to the administration division for legal city boundary 2027.
- Accessibility indicator measured depending on the separation distance between the land plots or building and the current or proposed local public transportation lines on city development scheme (CDS) 2027. That means the more accessible is the nearest distance to public transportation lines. The degree of accessibility ranked based on dividing the area around the proposed internal public transportation lines on city development scheme (CDS) 2027, to three main graded zones; (< 400m); (400m-800m); and (> 800m), because the standard walking distance to a public transit stop that are often conceived as maximum trip-lengths of 400 m (approximately 20 minutes' walking time) to the nearest bus stops.
- Formality indicator measured depending on the legal framework that is provided to draw the characteristics of future urban environment (for both new development and redevelopment zones), and set the building and planning regulations that can achievable at short or long term. The degree of formality ranked based on the date of the approved legal framework that was provided to organize the construction process (for both new development and redevelopment zones), in relative to these processes (new development or redevelopment) were done (before or after the setting these regulations).
- Minimization/Compactness indicator measured depending on two main factors: minimizing new land consumption (per capita share of land area), and enhance compact urban form. So, the degree of Minimization/Compactness ranked based on the average value between two indicators (minimizing land consumption, compact urban form),
 - Measuring and ranking Compactness Indicator based on evaluate how stages of urban growth compose compact urban form of city structure, (the separation distance from the end of LCB 2006 to each of new zones in the same added direction).
 - Measuring Minimization Indicator based on calculate the total area for every shiakha and the total number of population, then calculate the density (p/f), after that rank the values from the highest density one which represents the least land consumption to the least dense one which represents the highest land consumption.

- Optimization indicator measured depending on the abilities for future urban growth on relation to the stages of the whole life cycle of “Urban Development Process”, that graded to add new zones, increase the capacity building of existing built up area, and the multi approaches for upgrading and redevelopment processes. The degree of optimization ranked based on the size of adding to current city structure for future urban growth on relevance to the time spending.
- Maximization indicator measured depending on the land revenue that resulting from the choice of current and proposed types of land uses which was set in city development scheme (2027). Also on the adding value to city inhabitants that targets increasing numbers of beneficiaries, and make it as great, inclusive, and sustain as possible. Our method based on the socio-economic benefits that can enhance the public interest by providing the basic needs for the most citizens. So, the degree of maximization ranked based on the type of land use and its return or benefits from socio-economic point of view.
- Conservation indicator is measured depending on identifying the valuable locations on city urban structure and the proposed action that taken to preserve its natural or culture consideration, in relative to its return from investment. The degree of conservation ranked based on the importance for intervention that depending on the value of location as valuable zones (from natural, to culture, then high value locations) in relative to the existence of proposed appropriate action in CDS 2027 or not.
- Protection indicator measured depending on the scale of risk (size/type) and its impacts that exposed to disasters locations in urban city structure, in relative to the proposed action on CDS 2027 that have taken for protection. The degree of protection ranked based on graded the risk zones from highest to lowest and also on the action that proposed on CDS which taken for protection.

Figure (4): Assessing indicators of land use efficiency, using GIS program. Made by the Authors

6. Results and Discussion

6.1. Testing the Validity of Proposed LUE Indicators

By using “Exploratory Factor Analysis” that based on “The Principle Component Model” using “SPSS” program, to test the validity of proposed LUE indicators which measures the degree of influence for each indicator and examine the pattern of correlations between them, the results show these important points:

- The high accuracy rate of our tested sample (0.731).
- The confirming and reliability of influence of all proposed indicators on evaluation efficiency of land use on the CDS for Damietta City without needing for extracting variable.
- The value of indicators rank from (0.916) as the highest value for “Conservation” indicator, to (0.424) as the least value for “Protection” indicator.
- The high value group is including (Conservation, Formality, Minimization, and Accessibility) indicators, and then the medium value group is including (Maximization, Availability, Affordability, and Connectivity) indicators, and the low value group is including (Protection and Optimization) indicators.
- The sign of indicators mostly have a positive value effect (+) (eight indicators from ten), and only two indicators have a negative value effect (-) (Maximization and Protection indicators).

The program collect the ten proposed and tested indicators into three main components, every component are composed from numbers of indicators that are correlated with each other and have the same pattern of influence on measuring Efficiency of Land Use, and they are:

- Component (1) which has the most numbers and influence of variables, it composes from seven factors from total ten tested factors, these factors are: Conservation (+ 0.916), Formality (+ 0.870), Minimization/Compactness (+ 0.782), Accessibility (+ 0.734), Availability (+ 0.683), Affordability (+ 0.683), and Connectivity (+ 0.611).
- Component (2) composes of only one factor that is: Protection with value of (- 0.555).
- Component (3) composes of two factors that are: Maximization (- 0.687), and Optimization (+ 0.424).

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.731
Bartlett's Test of Sphericity	Approx. Chi-Square	80248.553
	df	45
	Sig.	.000

Component Matrix^a

	Component		
	1	2	3
conservation	.916		
formality	.870		
compactness_indicator_evaluation	.782	-.479	
accessability	.734	-.360	
availability	.683	.615	
affordability	.683	.629	
connectivity	.611	.317	
protection		-.555	.500
maximization		-.355	-.687
optimization		.423	.424

Extraction Method: Principal Component Analysis.

a. 3 components extracted.

Table (2): Results of Factor Analysis. Made by the Authors

6.2. Statistical and Spatial Results of Measuring LUE-I

After evaluate each indicator on proposed CDS for Damietta City 2027 using GIS program, and ensure the validity of these proposed indicators, we gather and intersect the ten affecting indicators that resulting from our evaluation to conclude the final map which represent the effectiveness ratios for all the affecting factors and localizing them from the most to the least values, we find and conclude these important points as the following:

6.2.1. Statistical Results: we find that:

- The program collect the land and building areas with the same degree of efficiency, into five categories as a natural distribution from the most to the least ratio (from 80% to 24%), as; group (1) which classify as the most efficient land use has a degree of (80:69), then group (2) which has (68:64), then group (3) which has (63:59), then group (4) which has (58:41), and finally group (5) the least efficient land use which has a degree of (40:24).
- The categories ranked as a proportion from the total built up area (that represent 66% from the total area in LCB 2027) as: group (1) which classify as the most efficient land use = 34.2%, then group (2) = 28.4%, then group (3) = 15.0%, then group (4) = 16.3%, and finally group (5) the least efficient land use = 6.1%.
- We conclude that the groups with highly range of efficiency which ranked (80:59) are represented 77.6% from the total area in LCB 2027, and (58:24) represented just 22.4%.

6.2.2. Spatial Results: we conclude that:

- The most efficient land use is mostly located in the new added zones, mainly in the east and north directions, and especially with the maximizing utilize of land which have the highest revenue and the most numbers of beneficiaries (the economic activities, the social services, and the mixing housing), and also with the highest accessible zone to public transportation network (0:400m), and that is sign to the high effect value of maximization and accessibility indicators.
- Then, the framing zones (from the new added zones) that are surrounding the slums areas (contained villages internal city boundary) and selected as a priority zones for legal prepared to protected them from informal self-organized construction processes, and mostly which classify as a high value location especially located adjusting to Nile river in the west direction, and that is sign to the high effect value of formality and conservation indicators.
- Then, the existing built up area internal LCB (2006) without including the merged villages (that classify as informal areas needing to upgrading), and especially which located in a high value location especially adjusting to Nile river, and which have the highest revenue and the most numbers of beneficiaries (economic activities, and social services), and also which classify as the most accessible zone to public transportation network. And that is sign to the high effect value of minimization/compactness, formality, and conservation indicators.
- Then, the villages which vary to contained within the existing built up area LCB (2006), and the attachment villages that are added to Legal City Boundary (2027), (those classify as informal areas needing to upgrading), and especially which located in high risk zones (the areas which exposed to drowning and also to "overhead power line") that is intersected with unprotected zones of (agriculture land, and area surrounding culture building) from existing built up area. And that is sign to the effect value of formality and protection indicators.

- Then, The informal urban extensions outside LCB (2027), which have the value of (40:24)% degree of land use efficiency, and that is represent the least degree of efficiency from the mostly all measured indicators.

Figure (5): The final map of assessing land use efficiency that result from intersection 10 layers. Made by the Authors

6.3. Discuss the Gaps in Development Strategies from “I-LUE” Perspective

- The CDS included (New development Strategy) that enhance; connectivity by support links between urban, peri-urban and rural areas with the city; affordability of housing and basic services sectors; availability of open public spaces; accessibility by expand in public transportation system; maximization of land revenue and conservation the high value zones in new added zones. But it didn't consider into account the risk zones and the merged villages that contained into new adding zones. And the city shape didn't achieve compactness centric shape especially from east direction.
- The CDS included (Re-development Strategy) that enhance; formality by propose upgrading of merged villages into existing built up are; minimization/compactness by reduce land consumption and enhance compact urban form; optimization by increase utilizing of existing built up area; and conservation the high value zones in existing built up area. But it didn't activate instruments for enhancement upgrading of merged villages that will require long term processes. Also neglecting some valuable locations within city boundary and didn't take into account the buffer zones that needed for protection especially which surrounding the historical buildings. In addition to the CDS take 5 year for preparation and proving from GOPP and that required modification in roads networks on implementation stage.
- The CDS included (Re-location Strategy) that enhance; maximization of land revenue; and conservation the high value zones in existing built up area. Which target relocation of old train station; the cemeteries area, traditional crafts in old city centre to new added zones Without considering the multi spatial linkages of this old work spaces, and didn't have any instruments to support implementation process.

- The CDS included (Infilling Strategy) that enhance; affordability of housing and basic services sectors; maximization of land revenue; minimization/compactness by reduce land consumption and enhance compact urban form. Put it faced a constrain of private ownership of land plots internal existing built up area that considered as strong obstacle for any governmental intervention. Also the citizens didn't provide the needed community services as they promise.
- The CDS included (Mixed use Strategy) that enhance; affordability of housing and basic services sectors; and maximization of land revenue; that increase the land value and the prices of housing and services units especially internal existing built up area, which causes high dense built up area; very crowded transportation modes, overload utilities networks.
- The CDS included (Framing Strategy) that enhance; formality by prevent the surrounding area of merged village from increasing in informal growth and set the planning and building regulations. But these regulations doesn't consider the small areas of land plots internal existing built up area, and put the same regulation in new added zones (building ratio 70% from total area) and that is causes informality and building houses without legal permission.
- The CDS included (Merging Strategy) that enhance; connectivity which aim to support links between urban, peri-urban and rural areas with the city. By added merged/adjusted villages into legal city boundary for 2027, without including them in the same local city council which causes many problems in management procedures. Also these rural areas can't transit to urbanized life style after long time. (not achieve inclusion)
- The CDS didn't include (Prevention Strategy) that must prevent any future informal growth on city hinterland, and there was appeared at expansion roads despite of the availability of un-developed land in the new added zones.

7. Conclusion and Recommendations

The acceleration of land consumption especially in the medium cities of Delta region – Egypt, for future growth which reflects the pattern of spatial urban centralization on delta, and their consequences of many environmental impacts, require sensitive care in preparation the CDS for these specific cities. The paper presents a holistic framework able to guide City Development Strategies to achieve all targets of SDG11, and propose Indicators for measuring Land Use Efficiency to enhance Urban Dynamics processes through whole stages of city urban growth.

The results of assessment Indicators of Land Use Efficiency in Damietta CDS 2027 prove that the degree of efficiency in new added zones is larger than in the existing built up area. The most efficient land use in new added zones mainly are those the highest accessible zone to public transportation network, which located in valuable zones, and have a maximum utilize of land with high revenue. That can guide the new development strategies to be mixed land use, with high density, and accessible to public transportation network. (Expect merged villages and risk zones)

The least efficient land use in existing built up area, mainly are the merged villages that classify as informal areas needing for upgrading. That can guide the redevelopment strategies to must adopted and speed up upgrading process for informal areas and conservation process for the valuable zones that increase the local return from development. (Expect the high value location)

The CDS can enhance Urban Dynamics based on Indicators of Land Use Efficiency by:

- Activate the redevelopment strategies more than the new development strategies, to be more efficient land use driven, that can be able to decrease the demand for new land consumption in future city growth. (The demand)
- Slow down the new development strategies to decrease the supply of new land consumption, and provide it gradually compatibility with population growth. (The supply)
- The new development strategies must be aimed to; enhance compact city urban form; reduce the new added zones, connected with urban/rural units of direct city region.
- The redevelopment strategies must aim to; enhance upgrading informal areas, conservation of valuable locations, activate instruments to ensure implementation.
- The new development and redevelopment strategies must maximize the benefits of utilizing the land on both existing built up area and new added zones by enhance; mixed development strategy; infilling strategy; relocation strategy.
- The new development and redevelopment strategies must take into account the emergency of providing protection strategy target the risk zones that exposed to (disasters, pollutions, and crimes).
- The CDS must include strategy to enhance Locality; by encourage using of local building materials on construction process.
- The CDS must include Prevention strategy that can stop up more informal future growth on pure urban land outside the legal city boundary of the city.
- The CDS must be reinforced by economic; social; financial; environmental instruments, and also by modifications of planning and building regulations.
- The CDS must provide tools for ensure responsibility of participants for implementation of proposed projects that were approved in CDS.

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