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MEASURING THE URBAN MATURITY OF MEDIUM-SIZED CITIES "A CASE STUDY OF SINBELLAWEEN CITY"

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ABSTRACT

Maturity is considered a natural process the city achived during its development and growth, and it is also necessary to achive goals efficiently and effectively. Maturity represents the ideal stage of development because of the optimal investment of environmental, urban, social, economic, political and technological savings with the required efficiency, and the sustainable use of resources to ensure the sustainability of maturity for the longest possible period. Maturity is considered comparative process, as cities and regions are uneven in maturity degree, the time frame for achieving it, and the possibility of its sustainability. Urban maturity represents an important sector in the maturity of the city, as urbanism is the melting pot in which the environmental, social, economic and technological characteristics appear. The study relied on a set of global, regional and local standards, such as standards of sustainability, flexibility, and quality of life, as well as standards for assessing the maturity of cities to arrive at a complex mathematical methodology that relies on a set of statistical methods such as (time series analysis - correlation analysis...) to arrive at a measure of urban maturity. For cities, which consists of 10 sectors and about 70 urban indicators. The city maturity assessment scale suffers from major shortcomings due to the diversity of the urban and functional characteristics of each region. Therefore, the scale depends on the flexibility of indicators for each region depending on the function, approved urban theories, and architectural and construction techniques. The study also had a set of theories such as (urban dynamics1 - urban cycles[2] -..) There is a role in understanding the impact of indicators on urban maturity, and the reasons for the variation in influencing factors, such as size and functional characteristics, on the urban maturity of the city. Medium cities represent a very important sector of urban Settlements, and their role is to link local and regional Settlements, in addition to their role in providing some sub-regional services and activities. Therefore, countries are keen to pay attention to the development of medium cities for their urban, social and economic role for smaller agglomerations within their urban scope. The study case the city of Sinbillawain as an applied model for measuring urban maturity, which specified the period between 2008 AD and 2022 AD in implementing the city's strategic plan[3], which indicates that it has reached the end of the development period and the beginning of the maturity stage, which indicates the importance of assessing the city's urban maturity. The study identified five Sample areas for each stage of the city's growth and development. The study found that there is a difference between urban maturity and spatial urban growth. Although the city's urban growth rate amounts to 97% of the approved area, the maturity rates of the city's areas range between 21.6% and 27.1%, which indicates that the urban growth of the city of Sinbillawen requires Activating urban maturity technique, also confirms the shortcomings of the mature development vision of the city plan, which affected the maturity of the urban sector.

KEYWORDS: Measures, city maturity, mature city, urban maturity, spatial growth, urban sustainability - urban resilience.

قياس النضج العمراني للمدن المتوسطة دراسة حالة مدينة السنبلاوين

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الملخص

يعتبر النضج عملية طبيعية تمر بها المدينة أثناء تطورها ونموها، كما انه ضروري لتظل قادرة على تلبية أهدافها بكفاءة وفعالية، حيث يمثل النضج مرحلة التطور المثالية نتيجة الاستغلال الأمثل للوفورات البيئية والعمرانية والاجتماعية والاقتصادية والسياسية والتكنولوجية بالكفاءة المطلوبة، والاستخدام المستدام للموارد لضمان استدامة النضج أطول فترة ممكنة، ويعتبر النضج عملية نسبية حيث تتفاوت المدن والمناطق في مظاهر النضج والمدي الزمنى لتحقيقه وامكانية استدامته، ويمثل النضج العمراني قطاعا مهما في نضج المدينة، فالعمران البوتقة التي تنصهر فيها وتظهر من خلالها الخصائص البيئية والاجتماعية والاقتصادية والتكنولوجية. اعتمدت الدراسة على مجموعة من المقاييس العالمية والإقليمية والمحلية مثل مقاييس الاستدامة والمرونة وجودة الحياة، وكذلك مقاييس تقييم نضج المدن للوصول الى منهجية رياضية مركبة تعتمد على مجموعة من الاساليب الإحصائية مثل (تحليل السلاسل الزمنية- تحليل الارتباط-..) للوصول الى مقياس للنضج العمراني للمدن، والذي يتكون من 10 قطاعات و 70 مؤشر عمراني. ويعاني مقياس تقييم نضج المدينة من قصور كبير لنظرا لتنوع الخصائص العمرانية والوظيفية لكل منطقة، لذا يعتمد المقياس على مرونة المؤشرات لكل منطقة تبعا للوظيفة والنظريات العمرانية المعتمدة والتقنيات المعمارية والإنشائية، كما كان للدراسة مجموعة من النظريات مثل (الديناميكا الحضرية1- الدورات الحضرية2-..) دورا في فهم تأثير المؤشرات على النضج العمراني، وأسباب تفاوت العوامل المؤثرة على النضج بين المدن. وتعبر المدن المتوسطة عن قطاع شديد الأهمية من التجمعات الحضرية، وتمثل دورها في الربط بين التجمعات المحلية والإقليمية، بالإضافة الى دورها في توفير بعض الخدمات والأنشطة شبه الإقليمية، لذا تحرص الدول على الاهتمام بتنمية المدن المتوسطة لدورها العمراني والاجتماعي والاقتصادي للتجمعات الأصغر في نطاقها الحضري، وقد اختارت الدراسة مدينة السنبلاوين كنموذج تطبيقي لقياس النضج العمراني، والتي حددت الفترة بين عامي 2008م: 2022م في تطبيق المخطط الإستراتيجي للمدينة3، ما يشير الى انها قد وصلت الى نهاية فترة التنمية وبداية مرحلة النضج، ما يشير أهمية تقييم النضج العمراني للمدينة، وقد حددت الدراسة خمس مناطق كعينة لكل مرحلة من مراحل نمو وتطور المدينة. وقد توصلت الدراسة الى وجود اختلاف بين النضج العمراني والنمو العمراني المكاني، فبالرغم أن نسبة النمو العمراني المدينة تبلغ 97% من مساحة الحيز المعتمد الا أن نسب نضج مناطق المدينة تتراوح بين 21.6%: 27.1%،ما يشير الى أن نمو عمران مدينة السنبلاوين يحتاج الى تفعيل أليات النضج العمراني، كما يؤكد على قصور الرؤية التنموية الناضجة لمخطط المدينة والذي أثر على نضج قطاع العمران.

الكلمات المفتاحية : المقاييس، نضج المدينة ، المدينة الناضجة ، النضج الحضري ، النمو المكاني ، الاستدامة الحضرية ، المرونة الحضرية.

1. INTRODUCTION

Mature cities are important urban destinations and represent a unique urban development model, as they have managed to achieve an advanced stage and relative stability through the ideal growth cycle and the balance of environmental and urban indicators. The maturity of a city is realized in relative forms with varying returns and different rates due to natural, political, social, economic, and cultural factors.

Measuring the maturity of a city is essential for providing mechanisms to guide development, maximize returns, and enhance sustainability based on the city's background and future. However, it is not without obstacles, as it is challenging to achieve maximum values for all factors and variables simultaneously. Additionally, establishing a consistent scale for all cities is difficult due to variations in natural and human resources, developmental inputs, and gaining a clear understanding of the interplay of governing factors for each city[4].

The research aims to build a flexible mathematical model for measuring urban maturity, taking into consideration the environmental, social, economic, functional, and urban characteristics of different city regions. This model is based on the concept of urban maturity, drawing from various urban theories such as spatial cycles, optimal size, and global maturity metrics like (Complete Communities[5] - Maturity Model[6]-.)[7]. It is applied to the city of Sinbellaween, located in the heart of the Delta region, which has reached the end of the specified development timeframe as outlined in the approved plan. The goal is to evaluate urban maturity, assess its ability to fulfill local and regional roles,

and make appropriate developmental decisions to activate and sustain maturity while avoiding stagnation[8].

2. Research Methodology and context

The research assumes that an urban evaluation scale can provide a methodology for assessing the urban maturity of a city, which varies in terms of inputs, goals, factors, interconnections, and their impact on the overall city system. It should be tailored to the local context, regional characteristics, and urban structures. The research aims to reinforce this concept through a set of research methodologies, including:

- The Descriptive Approach: To crystallize the key concepts related to urban maturity, urban maturity, and their metrics.
- The Analytical Approach: To develop a scale for assessing urban maturity in the areas of Sinbellaween city.
- The Applied Approach: To apply the urban maturity assessment scale to a representative sample of Sinbellaween city regions.
- The Conclusive Approach: To reach general and specific results and recommendations.

3. Main Definitions:

3-1 Mature Cities:

The concept of maturity encompasses a set of characteristics such as balance, stability, completeness, and preservation. Urban studies use some parallel terms to describe mature cities, such as integrated and stable cities. Mature cities can be defined by their ability to achieve balanced rates of population, spatial, economic, and technological growth for the purpose of sustaining their natural resources and achieving social and economic stability[9]. This requires a deep understanding of the interplay between a set of governing indicators of volumetric, spatial, and functional urban growth and the mechanisms of development and control[10]. It also involves the creation of integrated and interconnected urban structures that exhibit urban vitality, urban prosperity, and quality of life[11].

Several urban theories play a significant role in defining and shaping the concept of a mature city, such as the theory of spatial interaction (Wilson - 1970), regional and urban dynamics (Alonso - 1971), optimal size (Richardson - 1972), and spatial cycles (Burgess - 1982). These theories aim to explain the mutual influence between volumetric growth and the governing factors in the environment, urban, social, and economic dimensions of the city [12]. Additionally, Henderson (2005) has managed to explain some of the factors influencing the spatial growth patterns of cities, such as and economic characteristics of housing, land prices, population densities, and more[13].

The term "mature cities" is applied to certain urban agglomerations in North and Western Europe, such as Zurich and Copenhagen, as well as in Northeastern North America, including Toronto and Edmonton, and some major cities in the Far East, like Tokyo and Nagasaki[14]. These cities have been able to achieve ideal and balanced rates of social and economic growth through planned urban development, with the goal of achieving stability in population size, urban characteristics, and the quality of jobs.

The characteristics of mature cities are reflected in the planned population growth that considers environmental and social dimensions alongside urban quality. This is achieved through the distribution of land uses, the arrangement of density in various areas, the quality of housing, and urban tissue patterns that influence connectivity and transportation. Additionally, the stability of economic factors like labor, production, and income is an essential component.

The concept of urban maturity represents a specific stage in the life cycle of cities[15], and it differs from the concept of comprehensive or balanced development. Balanced development can occur during periods of growth and emergence, while urban maturity signifies achieving equilibrium while maximizing potential and opportunities. This necessitates understanding and analyzing the correlations between urban indicators and sectors, as well as building mathematical models that optimize returns while minimizing losses.

3-2 Urban Maturity:

Mature urbanism is defined as the ability to achieve urban objectives, meet the material and spiritual needs of the population, and align with the environmental, social, and economic characteristics of the surrounding environments[16]. This is achieved through land use planning capable of meeting the population's needs and balancing uses, spaces, and density[17]. Additionally, it involves providing advanced, comprehensive, and secure infrastructure, integrated and advanced services that adapt to changing social, economic, and technological conditions, as well as diverse and economical options for sustainable housing. Furthermore, there should be a clear urban identity at the regional and environmental level in the built environments and urban spaces[18].

Urban maturity is evident in a city through a set of considerations[19], such as providing a diverse, integrated, and interconnected urban environment for housing, services, and activities that rely on effective planning and organization of all indicators. It also involves the quality of infrastructure, including roads, streets, public facilities, and transportation systems. Additionally, sustainability of environmental and urban structures, support for heritage structures, and the presence of institutions and methodologies that provide continuous corrective measures to control indicators in the

best possible condition under current circumstances and challenges through sustainable planning and balanced development.

Measuring urban maturity plays a crucial role in identifying urban issues resulting from dysfunction in various city sectors and assessing their current and future impact. It provides a vision for future solutions based on tracking city indicators and their performance throughout the city's life cycle, influencing development guidance and achieving maximum returns and sustainability, because of effective urban development, size and density control, diversification of housing, and service functions. Therefore, the research aims to develop a mathematical methodology for evaluating urban maturity that considers the diverse dimensions of the concept of urban maturity and the different characteristics of city regions

4. Urban Maturity Assessment Scale:

Relying on methodologies and methods that express the characteristics and attributes of phenomena in the measurement context is essential. Therefore, the research adopted a performance evaluation approach for assessing urban maturity due to its provision of reliable, straightforward evaluations and specific results that guide decision-makers to strengths and weaknesses. However, one of the main drawbacks of this method is its neglect of the mutual effects between evaluation factors, resulting in overly simplified and superficial outcomes.

The research developed a complex mathematical methodology to design the urban maturity assessment scale using the performance evaluation approach. It relied on global, regional, and local urban metrics in selecting a set of urban indicators capable of evaluating urban maturity, such as sustainability and quality of life metrics. The study also considered the analysis of global urban maturity metrics like Br-SCMM or Complete Communities, which played a crucial role in identifying urban maturity-expressing indicators.

The study adhered to the requirements set by international, regional, and local authorities for regions, such as the Egyptian Urban Harmony Fund, to define specific criteria for each region. Additionally, the role of urban theories that explain the mutual influence of population growth, spatial expansion, urban development, and technology, such as spatial cycles analysis and urban and regional dynamics, was highlighted in classifying indicators into three categories based on their impact. These categories are (boundary equation, linear descending, or ascending equation, second or third-degree power function, etc.), as follows:

- constant value after rate: These provide a constant value beyond the desired average, resulting in a maximum indicator value of 100%. Examples include fully qualitative data, the mixed development ratio, the private open spaces ratio, etc.

- Unbounded & Linear Equations: These offer increasing values beyond the desired average, signifying an increase in maturity characteristics. For example, the ratio of multi-family residential buildings, parking spaces in residential and commercial areas, etc. These equations may also represent an increase in quality of life or humanity without a disruption in balance or integration criteria. An example is an individual's share of services.
- Quadratic Equation: These provide decreasing values beyond the desired average, indicating a deficiency in balance and integration criteria. Examples include land use ratios, the number of entrances, road density, property ownership, etc. **Fig (1)** illustrates the proposed methodology for the urban maturity scale.

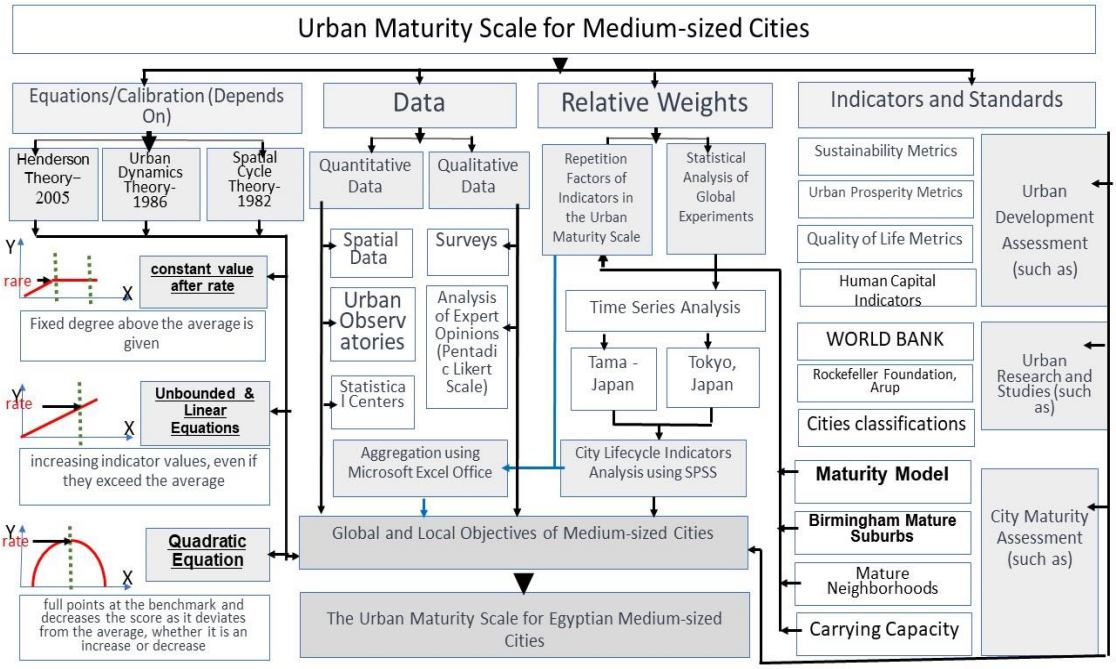


Fig (1): the proposed methodology for the urban maturity scale.

The research aims to use urban theories to explain the mutual effects of city indicators and urban indicators through measures and urban studies in creating mathematical expressions and equations for evaluating urban maturity. Additionally, it studies the medium-term objectives of cities globally and locally to develop the proposed scale.

The scale categorizes the set of indicators in it into two groups: "Indicators for Measuring Traditional Heritage Structures" and "Indicators for Measuring Modern Structures." This classification provides an effective way to measure areas based on their urban and functional characteristics and the period of their construction. The study relied on a set of criteria specific to heritage areas and with unique urban content globally and locally. **Table (1)** presents the proposed scale for urban maturity in medium-sized cities.

Table (1): The proposed scale for urban maturity in medium-sized cities.

sector	N	index	Weight	equation	rate	effect	total
Division of Neighborhoods and Regions	1	Connectivity Ratio of Regions	2	Length of Non-Isolated Perimeter / Total Area Perimeter	100%	constant value after rate	11 degree
	2	Division of Regions Based on Population Densities	1	Population Density Standard / Area Population Density	100%	Quadraticequation	
	3	Alignment of Boundaries with Road Network Planning	1	Percentage of Local Roads within the Area	100%	constant value after rate	
	4	Extent of Deviation in the Area of Regions	1	Spatial Analysis using GIS Software	100%	constant value after rate	
	5	Percentage of Public Ownership in the Region	2	Public Area / Total Area of the City Center	60%	Quadraticequation	
	6	Percentage of Planned Areas	2	Planned Area / Total Area of the City	100%	constant value after rate	
	7	Percentage of Official Areas	2	Official Areas / Total Area of the City	100%	constant value after rate	
Land Use Plan	8	Mixed Usage Ratio	2	Spatial Analysis using GIS Software	30%	Linear equation	9 degree
	9	Mixed Usage Distribution	1	Qualitative Variable	points 5	constant value after rate	
	10	Urban Usage Compatibility	2	Qualitative Variable	points 5	constant value after rate	
	11	Services Ratio	1	Spatial Analysis using GIS Software	20%	Quadraticequation	
	12	Roads and Urban Spaces Ratio	1	Spatial Analysis using GIS Software	25%	Quadraticequation	
	13	Open Space Ratio	2	Spatial Analysis using GIS Software	10%	Quadraticequation	
Housing Sector	14	Multi-family Building Ratio	2	Statistical Data	60%	Linear equation	14 degree
	15	Ratio of Good Housing Units	1	Spatial Analysis using GIS Software	100%	constant value after rate	
	16	Occupied Housing Units Ratio	2	Statistical Data	100%	constant value after rate	
	17	Private Ownership Ratio for Housing Units	1	Statistical Data	70%	Linear equation	
	18	Average Ownership of Housing Units	2	Number of Housing Units / Number of Households	120%	Quadraticequation	
	19	Average Area of Housing Unit	1	Spatial Analysis using GIS Software	,150	Quadraticequation	
	20	Average Rent for Housing Relative to Income	2	Statistical Data	20%	Quadraticequation	
	21	Ratio of Planned Housing Units	2	Housing Units in Planned Areas / Total Number of Housing Units	100%	constant value after rate	
	22	Ratio of Attached Housing Units	1	Statistical Data	100%	constant value after rate	
Public Services Sector	23	Individual Share of Basic Education Service	1	Area of Primary Education Zones / Number of Students in the Stage	3person/m2	Linear equation	13 degree
	24	Individual Share of Health Service	1	Area of Health Use / Population Number	0.5person/m2	Linear equation	
	25	Individual Share of Cultural Services	1	Area of Cultural Use / Population Number	0.5person/m2	Linear equation	
	26	Individual Share of Religious Services	1	Area of Religious Use / Population Number	0.5person/m2	Linear equation	
	27	Individual Share of Entertainment Services	1	Area of Recreational Use / Population Number	0.2person/m2	Linear equation	
	28	Individual Share of Administrative Services	1	Area of Administrative Use / Population Number	10person/m2	Linear equation	
	29	Individual Share of Security Services	1	Area of Security Use / Population Number	0.2person/m2	Linear equation	
	30	Number of Technical Schools	1	Qualitative Variable	points 5	Linear equation	
	31	Number of University and Research Facilities	2	Qualitative Variable	points 5	Linear equation	
	32	Ratio of Area Served by Educational Service within a 400m Range	1	Spatial Analysis using GIS Software	100%	constant value after rate	
	33	Ratio of Area Served by Health Service within an 800m Range	1	Spatial Analysis using GIS Software	100%	constant value after rate	
	34	Ratio of Area Served by Entertainment Service within an 800m Range	1	Spatial Analysis using GIS Software	100%	constant value after rate	
Transportation Infrastructure	35	Public Transportation Path Ratio	1	Statistical Data	800km/ milion	Quadraticequation	16 degree
	36	Road Density (km/km2)	1	Spatial Analysis using GIS Software	25km/100km2	constant value after rate	
	37	Sidewalk Ratio	2	Sidewalk Length / Road Network Length	100%	constant value after rate	
	38	Connectivity of Sidewalks and Pedestrian Paths	2	Qualitative Variable	5points	constant value after rate	
	39	Parking Spaces Index in Residential Areas	1	Number of Parking Spaces / Housing Unit	2park/unit	Linear equation	
	40	Parking Spaces Index in Commercial Areas	2	Number of Parking Spaces / Total Area of the Area	5park/100m2	Linear equation	
	41	Provision of Islands and Street Lighting	1	Numeric Variable	5points	constant value after rate	
	42	Average Street Widths	1	Spatial Analysis using GIS Software	10m	Linear equation	
	43	Street Configuration Analysis	2	Spatial Analysis using SPACE SYNTAX Software	5points	constant value after rate	
	44	Ratio of Good Roads	1	Spatial Analysis using GIS Software	100%	constant value after rate	
	45	Pavement Materials	2	Qualitative Variable	5points	constant value after rate	
Utilities Sector	46	Ratio of Energy-Sustainable Buildings	2	Number of Sustainable Buildings / Total Number of Buildings	100%	constant value after rate	4 degree
	47	Availability Degree of Facilities in the Area	2	Qualitative Variable	5points	constant value after rate	
Urban Activities	48	Ratio of Area Served by Weekly Activities within an 800m Range	3	Spatial Analysis using SPACE SYNTAX Software	100%	constant value after rate	3
Urban Regulations	49	Building Density	1	0	2.5	Quadraticequation	15 degree
	50	Average Plot Area	2	Spatial Analysis using GIS Software	400m2	Quadraticequation	
	51	Average Setbacks from Highways	1	Spatial Analysis using GIS Software	5m	Quadraticequation	
	52	Frontage-to-Depth Ratio	1	Spatial Analysis using GIS Software	60%	Quadraticequation	
	53	Average Side Setbacks	1	Spatial Analysis using GIS Software	2.5m	Quadraticequation	
	54	Average Rear Setbacks	1	Spatial Analysis using GIS Software	5m	Quadraticequation	
	55	Average Front Setbacks	1	Spatial Analysis using GIS Software	3m	Quadraticequation	
	56	Height-to-Street-Width Ratio	1	Average Heights / Average Widths	1.5	Quadraticequation	
	57	Average Distance between Intersections	2	Spatial Analysis using GIS Software	100m	Quadraticequation	
	58	Ratio of Commercial Uses on Ground Floors	1	Statistical Data	100%	constant value after rate	
	59	Ratio of Licensed Floors	1	Statistical Data	100%	constant value after rate	
	60	Ratio of Lots Served by a Single Road	2	Spatial Analysis using GIS Software	100%	constant value after rate	
Urban Design	61	Urban Spaces Ratio	2	Qualitative Variable	points 5	constant value after rate	8 degree
	62	Number of Urban Spaces Functions	1	Numeric Variable	points 5	constant value after rate	
	63	Quality of Urban Spaces Components	1	Qualitative Variable	points 5	constant value after rate	
	64	Urban Spaces Gradation	1	Qualitative Variable	points 5	constant value after rate	
	65	Private Spaces Ratio	2	Residential Gardens Area / Total Residential Use Area	40%	Quadraticequation	
	66	Character Harmony	1	Qualitative Variable	points 5	constant value after rate	
Development Systems and Programs	67	Strategic Plan Alignment with Detailed Plan	2	Qualitative Variable	points 5	constant value after rate	7 degree
	68	Percentage of Developed Buildings	1	Developed Buildings / Number of Deteriorated Buildings in the Previous Plan	100%	constant value after rate	
	69	Percentage of Mixed Development	2	Percentage of Mixed Developed Buildings / Number of Developed Buildings	100%	constant value after rate	
	70	Percentage of Strategic Plans Implementation	2	Number of Implemented Urban Projects in the Previous Plan	100%	constant value after rate	

5. City of Sinbellaween Description:

The city of Sinbellaween is considered a medium-sized city located in the heart of the Delta region of Egypt. It has a total population of 171,000 people. Administratively, it

is the capital of the Sinbellaween district, and it is further subdivided into about 18 local units and 60 villages. According to the classification of potential development capacities of Egyptian urban agglomerations, Sinbellaween is considered one of the secondary growth poles, with approximately 150 points out of a total of 1,200 points, ranking fourth among six categories in this classification.

Sinbellaween is strategically located at the convergence of several regional roads that connect the cities of Mansoura, Zagazig, and Greater Mahalla. The city is also situated along a network of semi-regional roads, with the most prominent being the regional ring road that passes to the west of the city. The city serves as a hub for various craft, commercial, industrial, maintenance, and transportation activities. Educational and healthcare services are also available in the city.

The city's objectives, as outlined in the general strategic plan, include becoming a nucleus for both heavy and light industries in the region, promoting regional integration with neighboring agglomerations, and serving as a center for productive employment, training, and marketing opportunities. The city's urban assets, such as available land and the regional road network, are key components in achieving these objectives. Additionally, the city aims to eliminate informal settlements, enhance housing standards, provide services, and support infrastructure.

5-1 Reasons for Choosing the City of Sannbelaween

The proposed urban area for the year 2022 in the city covers an area of approximately 1,354 acres, while the current urban mass for the city in 2023 covers about 1,316 acres. The total available land for development within the approved urban boundary is about 38 acres, which constitutes approximately 3% of the total land area. This indicates that most of the city has reached the end of its growth phase.

Therefore, Sannbelaween is one of the medium-sized cities that have reached the end of their planned development until 2022. Evaluating the current conditions and assessing the state of urban sectors, both mature and emerging, and those in decline, is an urgent need in order to provide recommendations for urban maturity.

5-2 The growth stages of the city of Sinbellaween

The city of Sanbelawein currently consists of more than 24 sub-districts. The city began to grow in 1950 and has developed into its current form over six stages, including:

The First Growth Stage: This stage started around 1950 and mainly encompasses the older districts situated along the railway line. These areas have their origins dating back to before 1970, and their residents are engaged in administrative and commercial activities. The area covers approximately 224 acres, accounting for 17.0% of the city's

total area , as shown in **Fig 2**.

The Second Growth Stage: Between 1970 and 1980, the city's urban area expanded in the southern and western directions. In this period, the older urban areas extended further, encompassing regions like Al-Burjasiya, Azbat Habeib, Souq El- Smak, and more. This stage added approximately 205 acres to the city's urban space, representing 15.6% of the total area , as shown in **Fig 3**.

The Third Growth Stage: During this stage, from 1980 to 1990, the urban area of Sinbellaween expanded in all four directions. An additional area of approximately 271 acres, roughly 20.6% of the total area, was added to the city. This expansion included parts of areas like Al-Zahraa, Al-Jamaal, Ardh Khalil, Al-Maahida behind Al-Shuna, Al-Maahida on the road to Meet Ghamr, Al-Bustan, and others, as shown in **Fig4**.

The Fourth Growth Stage: This stage includes the urban area of the city up until the year 2000. It covers parts of areas such as Al-Ma'dawi, Al-Maahida on the road to Meet Ghamr, and more, adding about 201 acres, which represents approximately 15.8% of the city's total area, as shown in **Fig 5**.

The Fifth Growth Stage: This stage witnessed urban growth until 2010. It extended over more than twenty years and witnessed the addition of new areas to the city. These areas are characterized by modern design and modern facilities, In the (Al-Burjasiya) area, where the use of nearly 30% of the neighborhood's land area has changed, the locations of the barns and the cotton gin have been transformed into a residential neighborhood (Al-Mahallag), as shown in **Fig 6**.

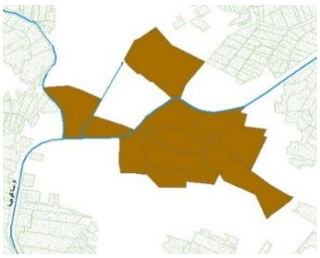


Fig (2) the first growth stage of Sinbellaween

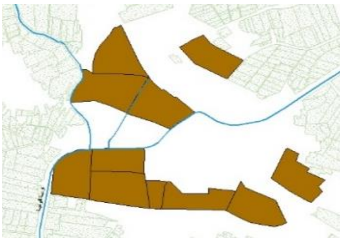


Fig (3) the Second growth stage of Sinbellaween

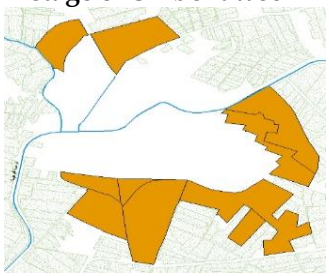


Fig (4) the Third growth stage of Sinbellaween

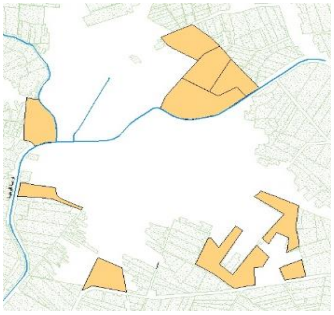


Fig (5) the Fourth growth stage of Sinbellaween

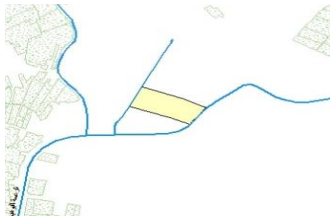


Fig (6) the Fifth growth stage of Sinbellaween

The Sixth Growth Stage: This is the urban mass that has grown for the city until 2022 in the northern outskirts towards Nub Taref and the regional circular road. The total area added in that period is approximately 254 acres, representing about 19% of the city. The area is characterized by a lack of urban data.

These growth stages showcase the urban and demographic expansion of Sinbellaween over the years. They reflect the significant increase in urban and population areas in the city and its impact on city planning and development.

5-3 Criteria for Selecting Study Regions

Given the increase in the number of districts in the city of Sanbellawin to more than 25 zones, the study has established criteria for selecting the study regions. for the urban maturity scale. These criteria include:

- The selected areas should encompass all five stages of the city's growth.
- The entire area selected should have originated in a single growth stage.
- The sixth growth stage is excluded from measuring urban maturity due to insufficient urban data. **Table (2)** illustrates the study zones for the urban maturity scale.

Table (2) the study areas for the urban maturity scale.

	First Growth	Second Growth	Third Growth	Fourth Growth	Fifth Growth
Time	1970	1980	1990	2000	2010
Regions Name	Azbat Habeib	Al-Nazha area	Al-Maahida behind Al-Shuna	Al-Ma'dawi	Al-Mahallag& Al-Borjasiya
Total area (Acres)	16.49	24.66	16.48	21.61	20.9
Density (Individuals/Acre)	56	59	44	44	143

The previous table shows that the zone of Arad Al-Mahalaj and Al-Borjasiya has the highest population density and represents the fifth growth stage. In contrast, the regions of Al-Mahtah Tariq Nub and Al-Mahtah Tariq Gharib have lower population density and represent the urban peripheries of Sanbellawin and the sixth and final growth stage. **Fig (7)** illustrates The Approved Urban Space and Urban Blocks for Sinbellaween City 2022.

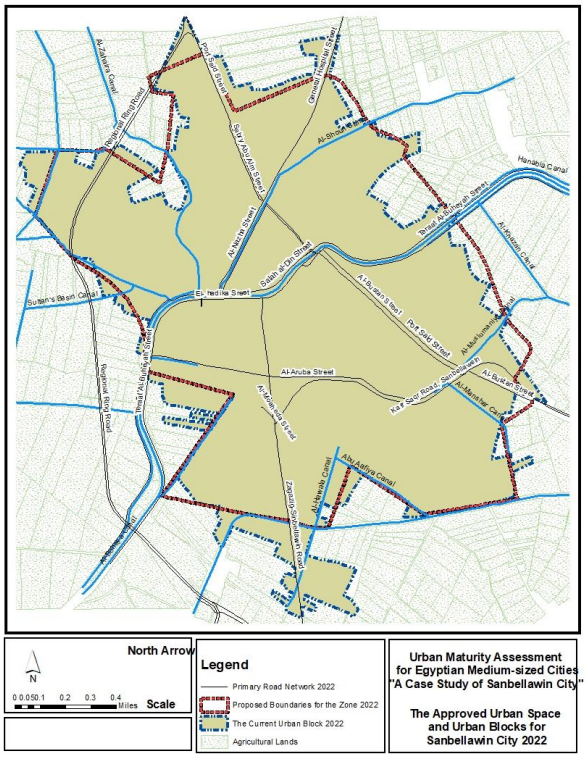


Fig (7) The Approved Urban Space and Urban Blocks for Sinbellaween City 2022

6. Urban Characteristics of Study Regions:

The study focuses on urban characteristics for assessing urban maturity, including the following:

6-1 Regions Division Characteristics:

The study considers the railway line (Zagazig - Mansoura) and the two canals (Al-Buhiya and Al-Shawn) as the main dividing boundaries between the areas of Sinbellaween. The percentage of isolated surroundings for the Arad Al-Mahalaj and Al-Borjasiya area is 68%, for Azbatah Habeib

is 61%, and for the Al-Nazha area is 39%. **Fig (8)** illustrates the dividing boundaries between the study areas in Sinbellawin. The urban characteristics of the study areas vary in terms of planned and unplanned areas, as shown in **Table (3).**

Table (3) The urban characteristics of the study areas					
	Azbat Habeib	Al-Nazha area	Al-Maahida behind Al-Shuna	Al-Ma'dawi	Al-Mahallag& Al-Borjasiya
Planned areas	0%	0%	0%	0%	0%
the percentage of official areas	100%	100%	100%	40%	100%
Unutilized Lands	0%	0%	16.4%	43.2%	0%

From the table above, it can be observed that the percentage of official areas in the Maadiyah area is about 40%, while open spaces account for 43.2%. In contrast, in the Mahtat Khalf Al-Shouna area, open spaces make up about 16% of the total area.

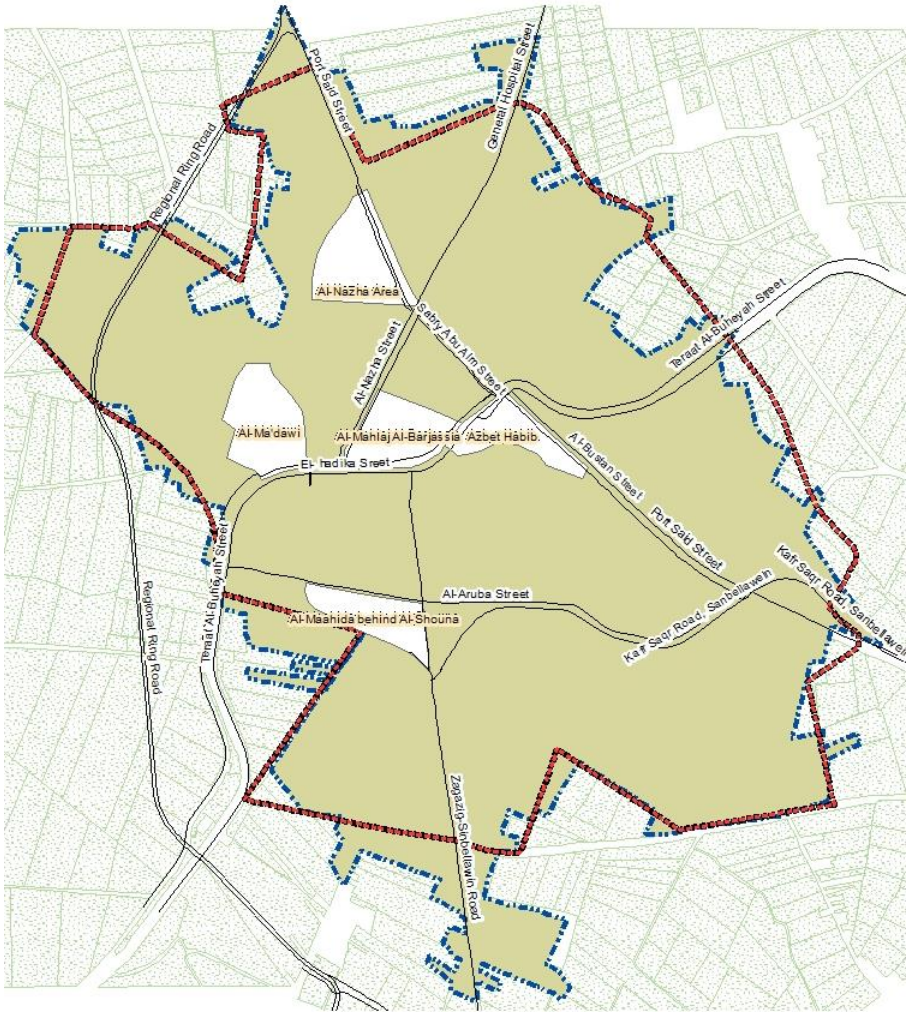


Fig (8) the dividing boundaries between the study areas in Sinbellawin

6-2 Land Use Plan Characteristics

Urban planning quality is a crucial factor in urban maturity, and a balanced distribution of residential, commercial, industrial, and other areas helps achieve urban maturity**. Fig (9) to (14)** show the land use plans and the percentage of land use in the study areas in Sanbellawin.

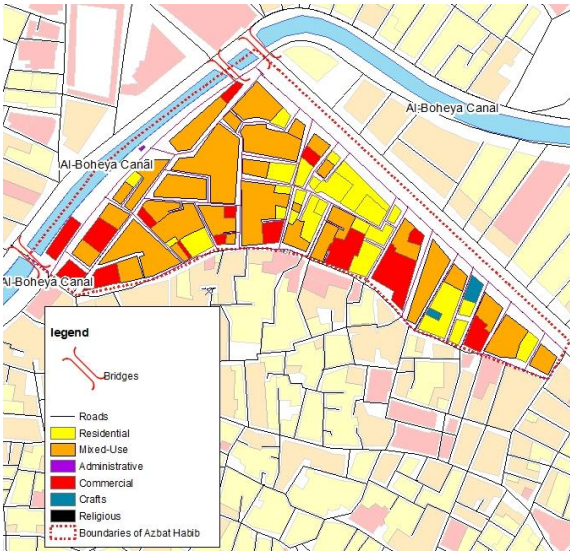


Fig (9) Azbat Habib land use plan

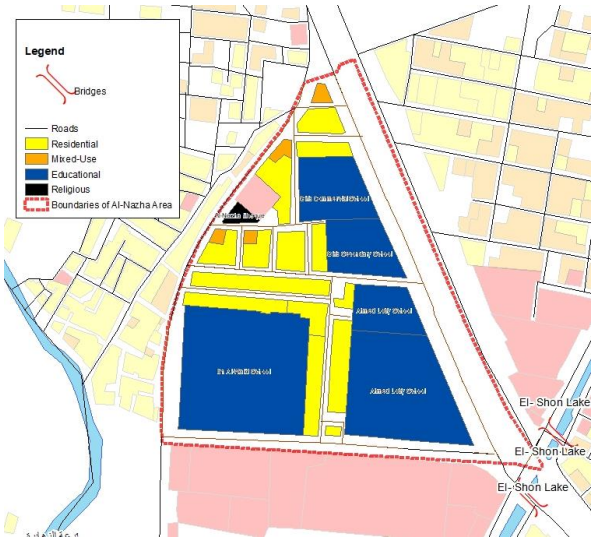


Fig (10) lAl-Nazha Area and use plan

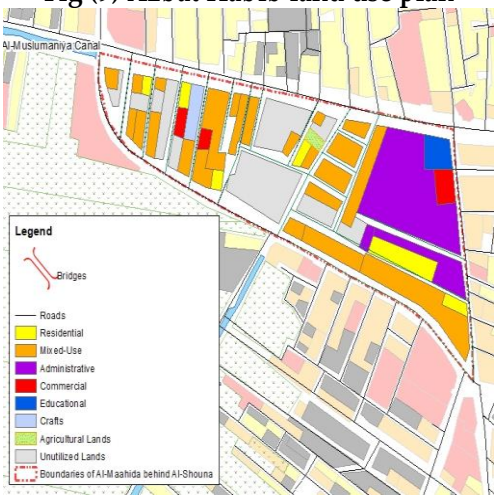


Fig (11) Al-Maahida behind Al-Shouna land use plan

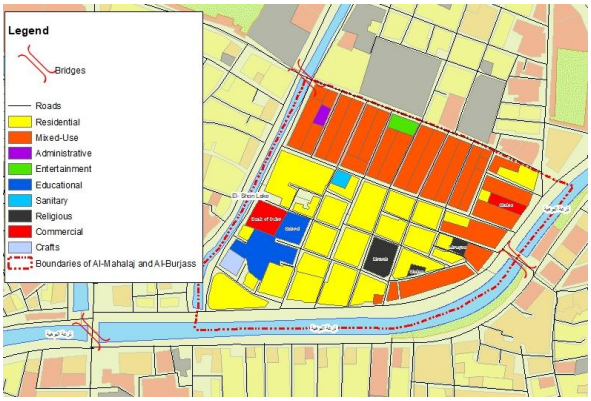


Fig (12) Al-Mahalaj and Al-Burjass land use plan

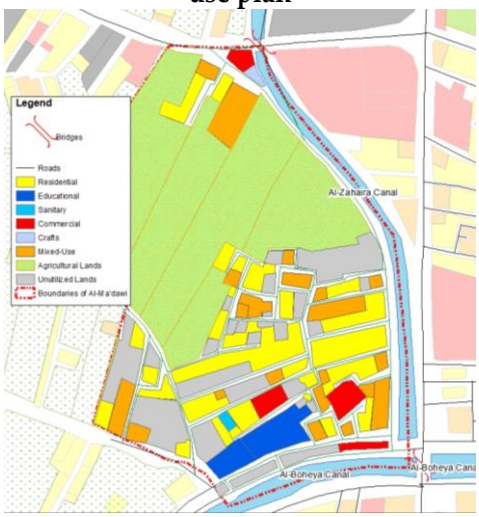


Fig (13) Al-Ma'dawi land use plan

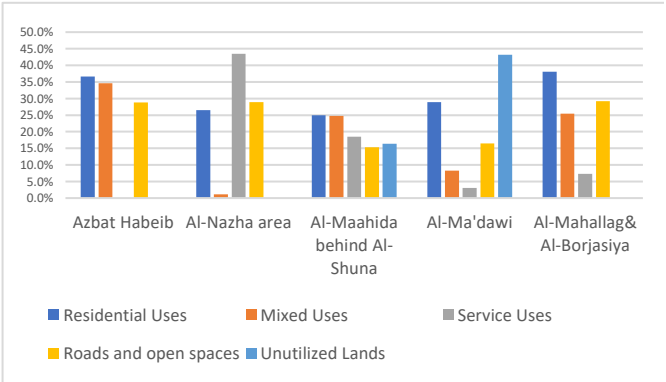


Fig (14) Land Use Budget

From the previous figure, it is noticeable that land use in the Azbat Habib area has decreased to four uses, which are residential, mixed, services, and roads. On the other hand, the Mahtat Khalf Al-Shouna area appears to have a more balanced land use mix, including residential, mixed use, services, roads, open spaces, and vacant land.

6-3 Housing Sector Characteristics:

The housing sector is one of the essential sectors for urban maturity. Providing housing options at reasonable prices for various social and economic levels is crucial. Mature cities encourage real estate developers to stabilize property prices. **Fig (15)** shows the characteristics of housing units in the study areas in Sinbellawin.

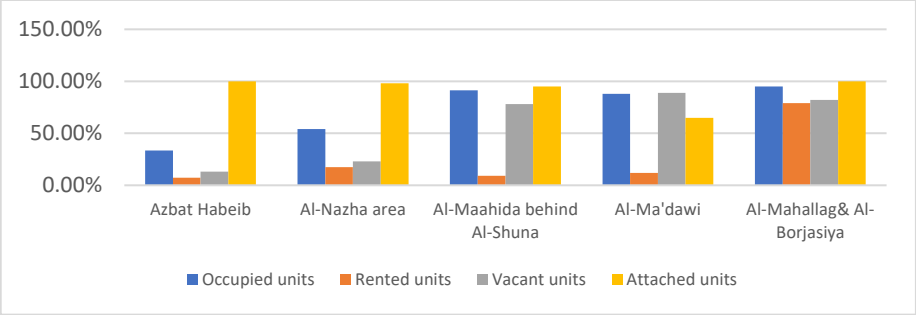


Fig (15) the characteristics of housing units in the study areas in Sinbellawin

From the previous figure, it can be observed that the area of Ardh Al-Mahlaj and Al-Barjasya has the highest percentage of occupied and rented units, while the area of Azbat Habib has the lowest percentage of occupied and rented units. The percentage of attached units is higher in the Al-Mahtat area, while the percentage of poor and dilapidated units is higher in the Azbat Habib area, followed by the Al-Nuzha area.

6-4 Services Sector Characteristics

Mature cities focus on providing diverse and integrated services to support their cultural, historical diversity, encourage innovation, and enhance social and economic stability. **Fig (16)** shows the range of the impact of public services in the study areas in Sinbellawin.

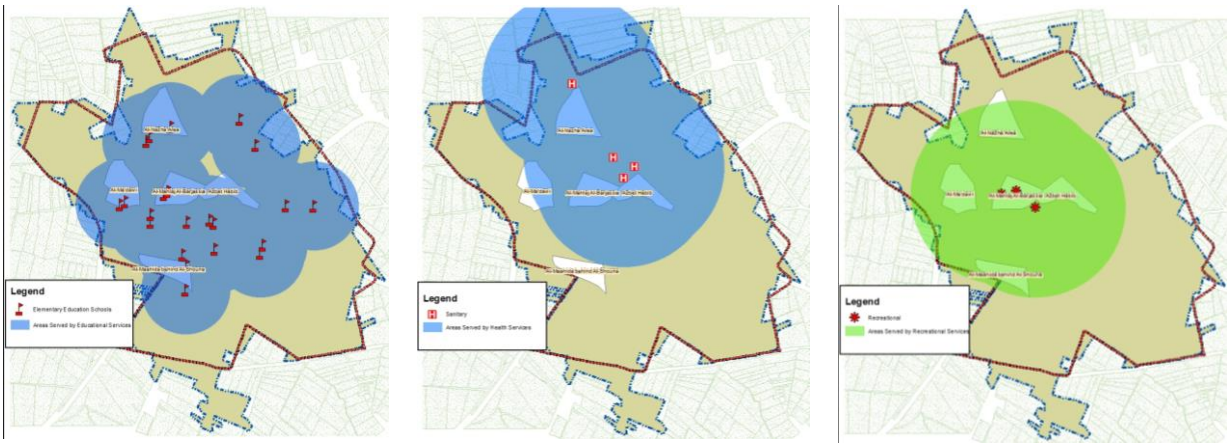


Fig (16) the range of the impact of public services in the study areas in Sinbellawin

6-5 Road and Transportation System Characteristics

Mature cities rely on planning various patterns and models of road networks to enhance urban connectivity, vitality, and environmental sustainability. They provide integrated transportation systems supported by well-thought-out strategies to ensure easy and safe mobility for the population. This includes implementing guided transport

policies and urban designs that support walking and cycling, as well as striking a balance between public and private transportation.

The different regions of the city of Sanbelawin possess diverse road network patterns, such as circular, grid-like, and tree-like designs. **Table (4)** illustrates the road network patterns in the study areas of Sanbelawin.

Table (4) the road network patterns in the study areas of Sanbelawin

	Azbat Habeib	Al-Nazha area	Al-Maahida behind Al-Shuna	Al-Ma'dawi	Al-Mahallag& Al-Borjasiya
Area circumference (km)	1.4	1.4	1.3	1.3	1.1
Road network length	3.2	2.2	2.1	3	3.5
Sidewalk length	0%	50%	0%	0%	0%
Average road width	4.1	6.2	4.2	4.8	7.1
Percentage of good roads	5%	22%	0%	0%	45%

From the table above, it is evident that the Al-Nazha area has the highest percentage of good roads and sidewalk lengths, while the Al-Mahlej and Al-Burjasya areas have the highest average road widths. The Habibah area has the lowest average road width among the study areas.

6-6 Utilities Sector Characteristics

A well-developed infrastructure for utilities is crucial for social and economic development. It serves as a fundamental pillar for urban growth and sustainability. The maturity of the utilities sector depends on clear strategic plans and technologies that enhance resource management and control, along with the provision of financial and investment resources for sustainable maintenance. The utilities sector in Al- Sinbellaween provides supplies to most urban areas but faces some shortcomings in network quality, particularly in older areas.

6-7 Urban Activities Characteristics

Providing urban activities, both in general and specifically commercial activities, is essential in the city's master plan to meet the basic needs of residents, enhance their comfort, and support vibrancy. From the corresponding figure, we can observe the availability of weekly activities within the areas of Habibah, Al-Ma'dawi, Al-Mahlej, Al-Mahlej and Al-Burjasya. However, most parts of the Institute area behind Al-Shuna fall outside the influence of weekly activities. **Fig(17).**

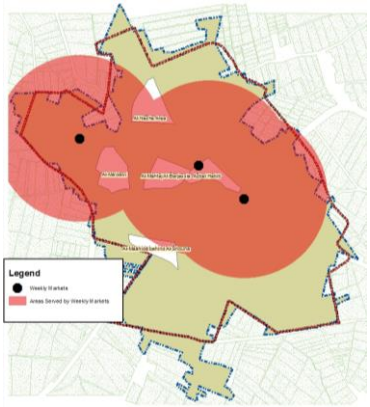


Fig (17) urban activities for study areas in Sinbellaween City 2022

6-8 Urban Regulations System

Mature cities strictly enforce urban regulations and laws to ensure organized and controlled urban development. **Table (5)** highlights the characteristics of the urban regulations system for the study areas in Sinbellaween.

Table (5) the characteristics of the urban regulations system for the study areas in Sinbellaween.					
	Azbat Habeib	Al-Nazha area	Al-Maahida behind Al-Shuna	Al-Ma'dawi	Al-Mahallag& Al-Borjasiya
Average residential plot area	56	180	150	120	350
Average side setbacks	0	1.25	0	0	01.2
Average height (in floors)	1.2	3	3.2	2.8	7.5
Average setbacks from highways	0	3	2	2	3

From the previous table, the results of applying urban regulations on the areas of Al-Senbellawein are apparent. It can be observed that the Habibah area is dominated by narrow and single-story divisions, whereas the Al-Mahlej and Al-Burjasya area differs with a different pattern.

6-9 Urban Design Characteristics

Urban design maturity reflects support for environmental, social, and economic aspects in addition to identity and culture within communities. It also relies on technological advancements to create more sustainable and efficient designs. Quality urban design is reflected in the availability of urban spaces and open areas, as well as in inspiring and adaptable designs that can accommodate heritage sustainably and flexibly.

Areas such as Habibah, Mahadah behind Al-Shuna, and Al-Ma'dawi are characterized by semi-rural urbanism, along with winding streets where natural landscapes fade. In the Al-Nazha area, grid patterns for streets are prevalent, with a significant amount of green areas on street sidewalks and around houses. On the other hand, the Al-Mahlej and Al-Burjasya area falls into the chessboard pattern category, with a depth-to-width ratio of 1:5 and a building ratio of up to 80%.

6-10 Development Programs and Systems Characteristics

Development programs aim to continuously improve the urban environment concerning residential, service, governmental, and infrastructure aspects. Their objective is to enhance sustainability, preserve the city's natural, social, economic, and urban resources. Therefore, development programs play a crucial role in achieving comprehensive development, sustainability, and quality of life. The signs of urban development for the study areas in Sinbellaween are fading, and relevant authorities support mixed uses in Al-Mahlej and Al-Burjasya.

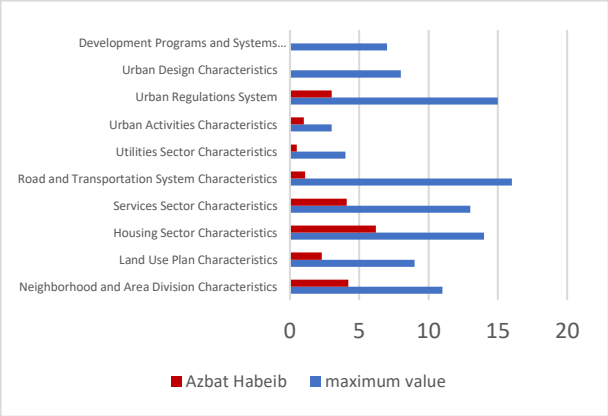
7. Evaluation of Urban Maturity for Study Areas

Applying the urban component maturity assessment scale to the study areas in Al-Sinbellaween reveals variations in urban maturity values. The assessments range from 21.6% to 27.1%, indicating that Sinbellaween's areas vary between emerging and thriving.

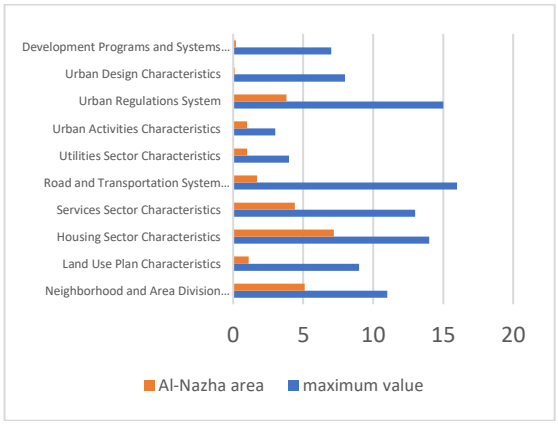
Table (6) shows the urban component maturity assessment for the study areas in Sinbellaween.

Table (6) the characteristics of the urban regulations system for the study areas in Sinbellaween.					
	Azbat Habeib	Al-Nazha area	Al-Maahida behind Al-Shuna	Al-Ma'dawi	Al-Mahallag& Al-Borjasiya
Regions Division Characteristics	4.2	5.1	4.8	4.6	5.2
Land Use Plan Characteristics	2.3	1.1	1.8	1.1	2.4
Housing Sector Characteristics	6.2	7.2	6.8	6.3	8.1
Services Sector Characteristics	4.1	4.4	4.2	4	4.6
Road and Transportation System	1.1	1.7	1.6	1.4	2.1
Utilities Sector Characteristics	0.5	1	1	1	1
Urban Activities Characteristics	1	1	0.6	0.4	1
Urban Regulations System	3	3.8	3.5	2.8	2.7
Urban Design Characteristics	0	0.1	0	0	0
Development Programs and Systems Characteristics	0	0.2	0.1	0	0
Urban maturity ratio for the area	23.1%	25.4%	24.3%	21.6%	27.1%
Classification	Developing Area	Developed Area	Developing Area	Developing Area	Developed Area

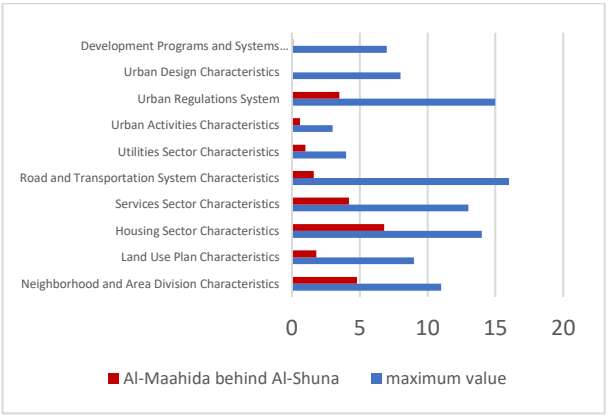
Despite the variations in urban characteristics among the study areas in Al-Sinbellaween, the areas of Al-Ma'dawi, Azbat Habib, and Al-Mu'addah behind Al-Shuna have less than 25% in terms of urban maturity. This could be attributed to the urban characteristics of Azbat Habib and the informal growth in some parts of Al-Ma'dawi and Al-Mu'addah, which lack certain services. The city of Al-Nuzha represents a region with different urban characteristics as it is primarily a service area lacking diversity in land uses. On the other hand, the Al-Mahlej area scores the highest in urban maturity, benefiting from the implementation of urban regulations in its development and its central location that provides coverage with services and activities. **Fig from (18) to (23)** represent the degrees of urban sector maturity for the study areas and the percentage of urban maturity.



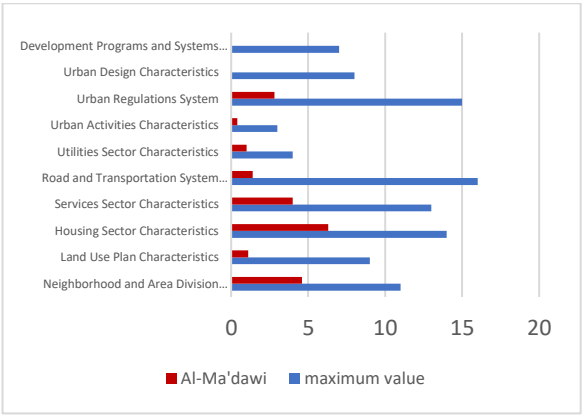
Fig(18) the degrees of urban sector maturity for Azbat Habib



Fig(19) the degrees of urban sector maturity for Al-Nazha City



Fig(20) the degrees of urban sector maturity for Al-Maahida behind Al-Shouna



Fig(21) the degrees of urban sector maturity for Al-Ma'dawi

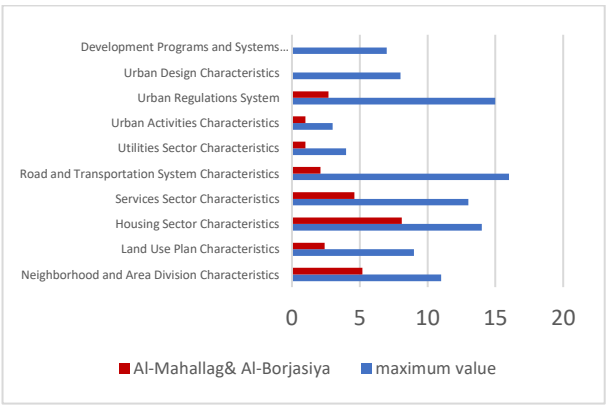


Fig (22) the degrees of urban sector maturity for Al-Mahalaj and Al-Burjass

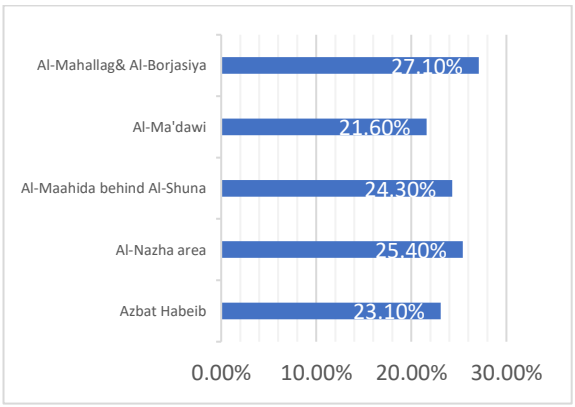
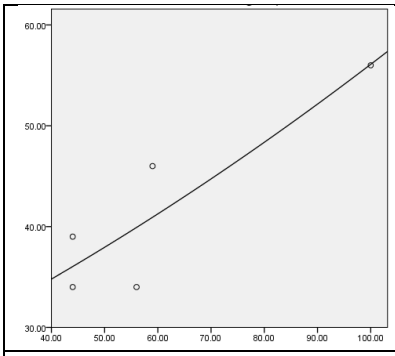


Fig (23) Total degrees of urban maturity

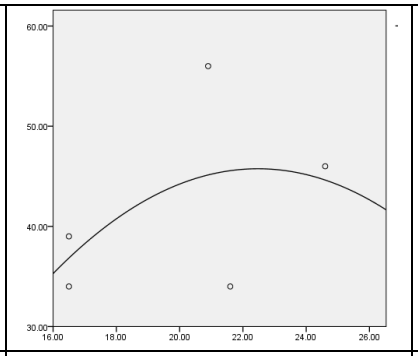
Therefore, the reason for the maturity of Azbat Habib area can be attributed to the maturity of the land use and services sector. The reason for the maturity of Al-Nuzha area can be attributed to the maturity of the housing sectors and building regulations. The reason for the maturity of Al-Mu'addah area behind Al-Shuna and Al-Ma'dawi can be attributed to the maturity of the housing and services sectors. The reason for the maturity of the Al-Mahlej and Al-Barjasiya area can be attributed to roads, housing, and development programs.

8. Analysis of Urban Maturity Assessment in Sinbellaween

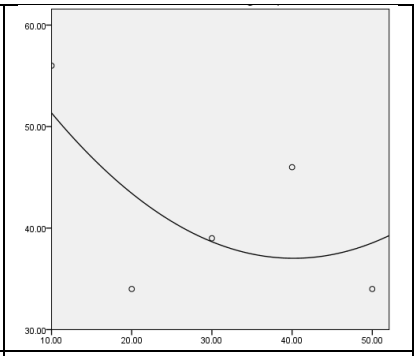
By conducting multiple regression analysis between the degree of urban maturity as an independent variable and (area creation time, area, population density) as dependent variables, the study aims to determine the most significant and influential factors. This method was chosen to assess the impact of urban maturity on multiple independent variables simultaneously. **Fig from (24) to (26)** illustrate the importance of the variables associated with urban maturity in the study areas.



Fig(24) Urban Maturity Relationship with Area Density



Fig(25) Urban Maturity Relationship with Area Size



Fig(26) Urban Maturity Relationship with Area Origin Time

From the previous results, it can be affirmed that the area creation time has a negative impact on the urban maturity of the study areas in Sinbellaween up to 40 years, while the area has a positive influence on urban maturity in the study areas (20 acres), and the relationship between population density and urban maturity is semi-linearly positive.

9. Research Results

As a result of applying the urban maturity assessment scale to the areas of Al-Sinbellaween city:

- Azbat Habib area received an urban maturity rating of 23.1%, which is a low indicator due to several urban problems, including the lack of a clear mechanism for area development and addressing urban deterioration.
- Al-Nuzha area received a general urban maturity rating of 25.4%, which is an average indicator, due to several urban problems, including the lack of a clear mechanism for vertical densification of the area.
- The Al-Mu'addah area behind Al-Shuna received an overall urban maturity rating of 24.3%, which is a low indicator, due to several urban problems, including the adoption of a non-urban development pattern.
- The Al-Ma'dawi area received an overall urban maturity rating of 21.6%, which is a low indicator, due to several urban problems, including informal urban development.

- The Al-Nuzha area received an overall urban maturity rating of 27.1%, which is an average indicator, due to the presence of a mechanism to utilize the area's spatial potentials.

Recommendations

Based on the previous results, the study recommends the following:

- Establish a set of criteria and principles to activate urban maturity for cities, based on values that take into account the particularities of the existing Egyptian urban condition.
- Study the urban maturity as a specialized study and include the stages of preparing laws and regulations that regulate urbanism and should be linked to environmental, social, and urban conditions.
- Focus on activating the role of urban observatories in monitoring and tracking urban indicators to support decision-making.
- Build local capacity through training, education, qualification programs, and study successful international experiences in activating and sustaining urban maturity.
- The need to work on a methodology that provides recurrent corrective measures to control indicators under the best conditions, taking into account the current circumstances and challenges through sustainable planning, flexibility, and adjustment.

References

[1] Michael Batty& others (2008), Cities as Complex Systems: Scaling, Interactions, Networks, Dynamics, and Urban Morphologies”, The Encyclopaedia of Complexity & System Science, Springer, Berlin.

[2] محمد سالم سيد محمد (2014) "التحولات الحضرية بالمناطق البينية في الأقاليم الحضرية الكبرى: دراسة حالة إقليم القاهرة الكبرى" كلية التخطيط الإقليمي والعمراني-جامعة القاهرة-مصر

[3] وزارة الإسكان والمرافق والتنمية العمرانية - الهيئة العامة للتخطيط العمراني(2008) "المخطط الإستراتيجي العام لمدينة السنبلاوين 2022 -محافظة الدقهلية" تقرير الوضع الراهن

[4] Remi Jedwab (2019) “How Should We Measure City Size? Theory and Evidence Within and Across Rich and Poor Countries*- IMF Working Paper: Research Department- International Monetary Fund.

[5]City of Winnipeg, (2020) “Small-Scale and Low-Rise Residential Development Guidelines for Mature Communities”, winnipeg.ca

[6] Ruchika Prasad, (2020)” Maturity Model and Assessment for Indian Cities”, Research Gate.

[7] رضوى أغا & أحمد نجيب (2021) "استنتاج مؤشرات لتقييم نضج العمران المصري" Journal of Al-Azhar University Engineering Sector- Vol.16, No. 60.

[8] Hiroaki Ohashi (2018) “Suburban Fortunes: Urban Policies, Planning and Suburban Transformation in Tokyo Metropolis” Faculty of the Built Environment-University College London.

[9] Fabiano L. Ribeiro& others (2021) “Zipf ’s law and urban scaling: Hypotheses towards a Unified Urban Theory” ca-dr@rybski.de

[10] Michael Robinson &others, (2015)” Complete Communities: Winnipeg’s Guide to Land Use and Development”, The city of WINNIPEG

[11] Matjaz Ursic, Heide Imai, (2020) “Creativity in Tokyo: Revitalizing a Mature City”, Springer Nature Singapore Pte Ltd.

[12] Graham Floater &others, (2014)” Cities and the New Climate Economy: the transformative role of global urban growth”, LSE Cities, London School of Economics and Political Science

[13] Apostolos Lagarias (2013) Dynamics of Urban Sprawl: Applying a CA-based Model to Explore Future Development Scenarios in Thessalonik- 53rd Congress of the European Regional Science Association: "Regional Integration: Europe, the Mediterranean and the World Economy",Italy.

[14] Wilhelm Lerner &others, (2011)” The Future of Urban Mobility: Towards networked, multimodal cities of 2050”, Arthur D. Little Lab.

[15] Czamanski, D., & Broitman, D. (2018). “The life cycle of cities” Habitat international-page 13.

[16] Ricardo Alexandre Afonso& others, (2015)” Brazilian Smart Cities: Using a Maturity Model to Measure and Compare Inequality in Cities”, Research Gate.

[17] Yu Ye & Akkelies van Nes, (2013)” Measuring urban maturation processes in new Dutch and Chinese towns: Combining Street network configuration with building density and degree of land use diversification through GIS”, The Journal Space Syntax.

[18] Davisi Boontharm, (2019)” Urban Design for Super Mature Society”, The Journal of Public Space

[19] Elaine M. Dennehy (2014) “Carrying Capacity A New Model for Mature Cities City of Arlington, Texas” Community Development and Planning Research & Analytics