

Executive framework of sustainable brownfield redevelopment, Applying to the cities of Al-Mahalla al-Kubra and Kafr al-Zayat

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Abstract

Brownfield redevelopment is regarded as one of the most essential approaches to sustainable urban growth, as many cities suffer from a shortage of urban expansion regions other than agricultural areas, necessitating the optimum use of existing urban blocs. When we examine Egyptian cities, we discover a high demand for a brownfield approach in Egyptian delta cities. Because of the high value of agricultural land in exchange for expansion, as well as the huge demand of these cities to localize certain essential services, as well as the necessity of investors for plots of land, as well as to raise some environmental rates, such as the per capita share of green spaces. The main question for the research is: What is the executive framework for the Brownfield redevelopment applying to case studies as sample of the delta cities in Egypt? The research reviews the theoretical background on the brownfield approach in terms of its definition, historical evolution, most important benefits, types and classifications, and the most significant barriers to its application and brownfield principles. The research also discusses the analysis of brownfield from a sustainability perspective, with a review of the most important criteria, indicators, factors, phases and stages affecting the development of brownfield. Finally, the research is applied to the cities of Al-Mahalla al-Kubra and Kafr al-Zayat in the Delta to reach an executive framework for developing the brownfield in case studies. The research has identified several practical and implementable steps that can be applied to the case studies using the Brownfield approach. According to its unique characteristics, nature and considering its need for redevelopment and development of certain sites that are no longer utilized.

Keywords: Urban Brownfields, Sustainable Brownfield redevelopment Planning, Kafr El-Zayat city, Al-Mahalla al-Kubra city, Brownfield sites

1. Introduction

Urbanization and population growth present unprecedented challenges to cities worldwide, necessitating innovative approaches to sustainable urban development. In this context, brownfield redevelopment emerges as a critical strategy for optimizing existing urban spaces, addressing the scarcity of expansion areas, and ensuring efficient land use. This research focuses on the executive framework of brownfield redevelopment planning, with a specific application to The cities of Al-Mahalla al-Kubra and Kafr El-Zayat in Egypt.

The cities of Al-Mahalla al-Kubra and Kafr El-Zayat, situated in the fertile Nile Delta, represents a microcosm of the broader challenges facing delta cities in Egypt. The city's unique characteristics, including its economic dynamics, land value, and the demand for essential services, create a compelling case for the application of brownfield redevelopment. Understanding the complexities of brownfield planning in those cities offers valuable insights that can be extrapolated to similar urban contexts.

The primary objective of this research is to delineate a comprehensive executive framework for brownfield redevelopment in the case studies. This framework aims to provide a strategic roadmap that considers the city's specific needs, environmental concerns, and the potential for sustainable growth. By investigating the theoretical underpinnings, historical evolution, benefits, classifications, and barriers associated with brownfield redevelopment, this research endeavours to offer a nuanced and context-specific approach to urban revitalization.



Through the analysis of sustainability perspectives, including criteria, indicators, factors, and developmental stages influencing brownfield projects, the research seeks to establish a robust foundation for the executive framework. The ultimate goal is to contribute not only to the academic discourse on brownfield redevelopment but also to offer practical guidelines for policymakers, urban planners, and stakeholders involved in shaping Kafr El-Zayat's urban future. This research aspires to be a beacon illuminating a path toward sustainable and resilient urban development in delta cities, with Al-Mahalla al-Kubra and Kafr El-Zayat serving as a focal point for exploration and application.

2. Literature review of Sustainable Brownfield Redevelopment Planning

In recent years, the idea of planning for sustainable brownfield redevelopment has become a crucial aspect of urban development. This involves the revitalization of areas that were once underutilized or contaminated, transforming them into dynamic, environmentally friendly spaces. Brownfield redevelopment aims not only to breathe new life into these former industrial or commercial sites but also to promote economic growth, environmental sustainability, and community well-being. Throughout this exploration, we'll delve into the complex dynamics of environmental, economic, and social considerations, recognizing the importance of each element in creating urban spaces that are resilient, inclusive, and ecologically responsible. Sustainable brownfield redevelopment planning offers cities the opportunity to reclaim abandoned spaces and lead the way towards a future where urban development seamlessly integrates with environmental care and social fairness

2.1. Definition

Sustainable brownfield redevelopment, as defined by the U.S. EPA, is "the process of reusing a brownfield property in a way that is consistent with the principles of sustainability, which include: the responsible use of resources; protection of the natural environment; maintenance of community vitality; and fulfilment of the societal and economic needs of present and future generations." [1]

The National Brownfield Association defines sustainable brownfield redevelopment as "the transformation of contaminated, blighted, or underutilized properties into productive, sustainable assets for a community, providing economic, social, and environmental benefits while protecting public health and the environment." [2]

ICMA defines sustainable brownfield redevelopment as "the process of revitalizing formerly developed sites in ways that promote environmental stewardship, economic vitality, and social well-being. It involves assessing, cleaning up, and redeveloping contaminated or underutilized properties for productive uses while mitigating their environmental impacts." [3]

2.2. Historical evolution of Sustainable Brownfield redevelopment Planning

Early Industrialization (Late 19th to Early 20th Century): The roots of brownfield redevelopment can be traced back to the rise of industrialization in the late 19th century and early 20th century. During this period, many industrial facilities were established in urban areas, often along waterways and railroads. These sites became contaminated due to industrial processes, and as industries declined or moved, they left behind blighted and polluted areas. [3] [4]

Post-Industrial Decline (Mid-20th Century): During the mid-20th century, the decline of industries in numerous Western countries brought attention to brownfields as visible symbols of economic downturn and environmental degradation. These abandoned areas posed health hazards to nearby communities and became focal points for environmental concerns. [2] [5]

Regulatory Responses (1970s and 1980s): The 1980 introduction of environmental legislation, including the United States Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), marked a significant turning point. These regulations mandated the cleanup of contaminated locations and assigned



responsibilities for the associated expenditures. They also paved the way for addressing brownfield sites and evaluating contaminated properties. [1] [6]

Rise of Sustainable Development (1990s): In the 1990s, sustainability gained prominence, prompting urban planners and environmentalists to explore ways to incorporate environmental responsibility, social equity, and economic viability into brownfield redevelopment efforts. This era marked a shift from solely focusing on environmental remediation to considering the broader benefits and potential uses of these sites.[7]

Brownfield Redevelopment Programs (Late 20th Century): Governments and organizations established programs and incentives during the late 20th century to encourage the cleanup and repurposing of contaminated sites. The goal was to stimulate economic development, generate employment opportunities, and enhance environmental quality in urban areas.[8]

Sustainable Brownfield Redevelopment (21st Century): In the 21st century, sustainable brownfield redevelopment gained momentum. This approach involves a more comprehensive strategy that emphasizes not only environmental cleanup but also green and sustainable design, mixed-use development, and community engagement. Sustainability principles, including green infrastructure, energy efficiency, and social inclusion, became integral components of brownfield redevelopment planning.[5][9]

Innovations and Best Practices (Present): Today, sustainable brownfield redevelopment continues to evolve with innovations in green technologies, adaptive reuse of existing structures, and a stronger focus on creating resilient and environmentally responsible urban environments. Best practices emphasize community involvement, public-private partnerships, and the integration of green and sustainable design principles. The following figure shows Historical evolution of Sustainable Brownfield redevelopment Planning.[9]



Fig 1 Historical evolution of Sustainable Brownfield redevelopment Planning

- 1- **Environmental Remediation**: Clean-up and restoration of contaminated brownfield sites contribute to improved environmental quality by removing hazardous substances and preventing further pollution of soil, groundwater, and air. [10][8]
- 2- **Resource Conservation**: Sustainable redevelopment often involves the reuse of existing infrastructure and buildings, which conserves resources and reduces the need for new construction and land development. [10][5]
- 3- Urban Infill: Brownfield redevelopment encourages infill development, which minimizes urban sprawl, preserves open spaces, and reduces the pressure to develop greenfield sites.[10]
- 4- **Economic Growth**: Redeveloped brownfield sites can stimulate economic growth by attracting businesses, creating jobs, increasing property values, and generating tax revenue.[10]
- 5- **Improved Infrastructure**: Redevelopment projects may lead to upgraded infrastructure, such as roads, utilities, and public transit, benefiting both the local community and the environment.[11]
- 6- **Community Revitalization**: Sustainable brownfield redevelopment often includes mixed-use developments, parks, and cultural amenities, revitalizing neighborhoods and enhancing community well-being.
- 7- Green Spaces: Projects often incorporate green spaces, parks, and green infrastructure, improving air quality, promoting biodiversity, and enhancing the quality of life for residents.[12]



8- **Walkability and Accessibility**: Sustainable redevelopment encourages pedestrian-friendly environments and accessibility, reducing the reliance on automobiles and promoting healthier lifestyles.[12] The following figure shows the Impacts of Sustainable Brownfield Redevelopment



Fig 2 Impacts of Sustainable Brownfield Redevelopment

2.4. Types and classification of Brownfields

1. Industrial Conversion: Heavy Industry to Mixed-Use: Transformation of former industrial sites, such as factories or warehouses, into mixed-use developments that may include residential, commercial, and recreational spaces. Industrial Heritage Preservation: Adaptive reuse of historical industrial buildings for cultural or commercial purposes, preserving the architectural and historical significance of the site.[13]

2. Commercial and Retail Redevelopment: Shopping Mall Revitalization: Refurbishing and repurposing shopping malls or retail centers to remain competitive in changing markets. Downtown Revitalization: Redevelopment of commercial districts within city centers, often involving the conversion of vacant or underutilized buildings into offices, shops, and apartments.[13]

3. Residential Redevelopment: Affordable Housing Initiatives: Converting brownfields into affordable housing units to address housing shortages and promote social equity. Suburban Redevelopment: Reclaiming brownfields in suburban areas for residential developments, reducing urban sprawl.[14]

4. Green and Sustainable Infrastructure: Green Space Creation: Transforming brownfields into parks, green corridors, or urban gardens to enhance the urban environment and promote biodiversity. Green Energy Installations: Installing renewable energy facilities, such as solar farms or wind turbines, on brownfield sites to generate clean energy.[15]

5. Transportation and Transit-Oriented Development (TOD): Transit Hubs: Developing brownfield sites near transit stations or transport corridors to create transit-oriented developments, reducing car dependency. Active Transportation Infrastructure: Converting brownfields into pedestrian and cycling pathways, enhancing urban connectivity and reducing traffic congestion.[15][8]

6. Waterfront Redevelopment: Waterfront Revitalization: Transforming contaminated waterfront areas into mixed-use developments, including residential, recreational, and commercial spaces. Riverfront Parks: Creating public riverfront parks and promenades to improve access to water bodies while preserving natural habitats.[15]

7. Environmental Restoration: Eco-Remediation: Focusing on ecological restoration by reintroducing native vegetation and restoring natural habitats while addressing contamination. Wetland Restoration:



Rehabilitating wetlands on brownfield sites to provide flood control, improve water quality, and enhance biodiversity.[16]

8. Educational and Institutional Facilities: Campus Expansions: Expanding educational institutions or medical campuses onto brownfield sites to accommodate growth and development. Research and Innovation Hubs: Developing brownfields for research and innovation centers, often in collaboration with universities and technology companies.[16]

9. Mixed-Use Developments: Comprehensive Mixed-Use: Creating vibrant, sustainable communities by combining residential, commercial, retail, and recreational components within a single development. The following figure shows types and classification of Brownfields



Fig 3 Types and classification of Brownfields

2.5. Challenges

Successful brownfield redevelopment requires a multidisciplinary approach that addresses these challenges through careful planning, stakeholder engagement, risk assessment, and innovative financing strategies. Collaboration among government agencies, private developers, community organizations, and environmental experts is crucial to overcoming challenges and unlocking the potential benefits of sustainable brownfield redevelopment. Here are some common hurdles associated with this type of redevelopment: [17]

- 1. **Environmental Cleanup Costs:** Rectifying contamination on brownfield sites can be costly, putting a strain on project budgets as pollutants in soil, groundwater, and structures need identification, assessment, and remediation. [17]
- 2. **Funding and Financing:** Securing adequate funding for brownfield redevelopment, encompassing grants, loans, tax incentives, and private investment, poses challenges, especially for smaller communities or nonprofit organizations. [18]
- 3. **Regulatory Complexity:** Navigating intricate environmental regulations, liability concerns, and permitting processes at federal, state, and local levels is time-consuming and expensive. [19]
- 4. **Uncertainty in Site Assessment:** The full extent of contamination on a brownfield site might remain unknown until assessment and remediation efforts are in progress, leading to potential delays and additional costs. [19]
- 5. **Community Engagement:** Garnering community support and addressing concerns related to health, safety, and property values is challenging. Local opposition or lack of engagement can impede project progress. [19][9]
- 6. **Gentrification and Displacement:** Successful redevelopment may result in gentrification, displacing lower-income residents and altering neighborhood character. Balancing revitalization with affordable housing presents a significant challenge. [19]
- 7. **Infrastructure Upgrades:** Redevelopment often requires infrastructure improvements, such as roads, utilities, and public transit. Coordinating these upgrades can be complex and costly.
- 8. **Public Health and Safety:** Ensuring that remediation efforts adequately protect public health and safety during and after redevelopment is crucial. Inadequate cleanup can lead to ongoing health risks.



- 9. **Zoning and Land Use Challenges:** Aligning brownfield redevelopment plans with existing zoning regulations and land use policies can be challenging. Zoning changes may be necessary to accommodate new land uses.
- 10. Market Demand: Assessing and responding to market demand for proposed redevelopment, including commercial, residential, or recreational components, is essential for project success. [20]
- 11. **Legacy Liabilities:** Unresolved legal or financial liabilities from past property ownership can complicate brownfield transactions and discourage potential developers.
- 12. **Community Perception:** Overcoming negative perceptions linked to brownfield sites, such as concerns about contamination or safety, can be a hurdle in attracting investment and support. [20]
- 13. **Natural Resource Conservation:** Balancing the preservation of natural resources, such as wetlands or wildlife habitats, with development goals can be challenging when redeveloping brownfields.
- 14. **Sustainability Standards:** Meeting sustainability goals, like green building certifications or energy efficiency targets, may require additional investment and expertise.
- 15. Market Competition: Brownfield sites may face competition from other development opportunities, including greenfield sites, impacting the feasibility of redevelopment.
- 16. Gentrification and Displacement: Successful redevelopment can lead to gentrification, causing the displacement of lower-income residents and changing the character of neighborhoods. Balancing revitalization with affordable housing is a significant challenge. [23]
- 17. **Historical Preservation**: When redeveloping historic brownfield sites or adaptive reuse of historical structures, balancing preservation requirements with modern building codes and sustainable design principles can be complex.

2.6. Principles of brownfield redevelopment

- 1- Environmental Responsibility: Minimize and remediate contamination while preserving and enhancing natural resources, including green spaces and biodiversity. [21]
- 2- Economic Viability: Promote economic growth, job creation, and increased property values through brownfield redevelopment.
- 3- Social Equity: Prioritize inclusive development that benefits the entire community, addresses affordable housing needs, and minimizes negative impacts on vulnerable populations. [21]
- 4- Community Engagement: Involve residents, businesses, and stakeholders in the planning and decisionmaking process, ensuring their input is considered.
- 5- Adaptive Reuse: Embrace adaptive reuse of existing structures whenever possible to conserve resources and honor the history and character of brownfield sites.
- 6- Infrastructure Sustainability: Upgrade infrastructure to be resilient, energy-efficient, and capable of supporting sustainable transportation options.
- 7- Smart Growth: Implement principles of smart growth, such as mixed-use development, walkability, and transit-oriented design, to reduce sprawl and encourage sustainable urban living.
- 8- Green Building and Design: Incorporate sustainable building practices, energy efficiency, and green technologies into redevelopment projects.
- 9- Brownfield Inventory and Prioritization: Develop a structured list of brownfield sites and determine their redevelopment priority by considering potential advantages, contamination severity, and community requirements.
- 10- Risk Assessment and Management: Perform comprehensive risk assessments to recognize potential hazards and create plans for managing these risks, aiming to protect public health and the environment.
- 11- Long-Term Monitoring and Maintenance: Put into action plans for ongoing monitoring and maintenance to ensure the sustained safety and sustainability of redeveloped brownfield sites. [21]
- 12- Public Awareness and Education: Engage in initiatives to inform the public about the benefits and significance of brownfield redevelopment and encourage awareness of sustainable urban living.

2.7. Brownfield analysis from perspective of sustainability

The following table shows Brownfield analysis from perspective of sustainability



Г	Table 1 Brownfield analysis from perspective of sustainability		
perspective of sustainability	Brownfield analysis		
Sustainuointy	Contamination Assessment: Assess the extent and severity of contamination on the brownfield site. Determine if remediation is necessary to protect the environment and public health.		
Environmental Sustainability	Remediation Strategies: Evaluate remediation options that prioritize the use of sustainable and environmentally friendly technologies and methods. Consider strategies like phytoremediation, natural attenuation, or sustainable excavation practices. Green Infrastructure: Explore opportunities to incorporate green infrastructure elements, such as green roofs, bioswales, and sustainable drainage systems, to manage stormwater, reduce heat islands, and promote biodiversity. Resource Efficiency: Assess how sustainable building practices, energy-efficient technologies, and materials selection can minimize resource consumption and reduce the environmental footprint of the redevelopment project. Habitat Preservation: Identify and protect critical habitats and ecosystems on or near the brownfield site, and consider strategies for ecological restoration and biodiversity conservation. Remediation and Contamination Management: Effective cleanup and remediation of contamination to restore the environmental integrity of the site.		
	Green and Sustainable Design: Incorporating principles of sustainable design, energy-efficient technologies, and environmentally conscious construction materials. Biodiversity and Ecosystem Restoration: Preserving and restoring natural habitats, fostering biodiversity, and creating green spaces. Water Management: Implementing sustainable stormwater management, wastewater treatment, and water conservation		
	Financial viability: Assess the project's economic feasibility, taking into account elements such as construction costs, potential revenue streams, and return on investment.		
Economic Sustainability	Market Demand: Analyse market demand for the proposed land use to ensure the project aligns with current and future market trends and preferences. Job Creation: Assess the potential for job creation and economic		
	growth resulting from the redevelopment, including both short- term construction jobs and long-term employment opportunities. Tax Revenue: Estimate the expected increase in property tax revenue and other local revenues resulting from the redevelopment, which can benefit local governments and services.		
Social Sustainability	Engage with the local community and stakeholders to obtain input, create trust, and ensure that the redevelopment project matches with residents' needs and values. Affordable Housing: Consider the inclusion of affordable housing options within the redevelopment to address housing affordability		
	and promote social equity.		

Table 1 Brownfield analysis from perspective of sustainabilit



perspective of	Brownfield analysis		
sustainability			
	Health and Safety: Prioritize public health and safety by addressing any potential health risks associated with contamination and ensuring safe construction and occupancy of the site.		
	Historical and Cultural Preservation: If applicable, incorporate strategies for preserving and celebrating the historical and cultural		
	heritage of the site through adaptive reuse of existing structures or public art installations.		
	Maintenance and Monitoring: Develop plans for long-term maintenance and monitoring to ensure the ongoing sustainability and safety of the redeveloped brownfield site.		
	Green Certifications: Consider pursuing green building certifications (e.g., LEED) to demonstrate the sustainability and environmental performance of the redevelopment.		
Long Torm	Energy Efficiency: Implement energy-efficient technologies, renewable energy sources, and energy management systems to reduce long-term energy consumption and operational costs.		
Long-Term Sustainability	Community Resilience: Design the redevelopment to enhance community resilience to environmental challenges, such as flooding or extreme weather events, by incorporating resilient infrastructure and sustainable urban design.		
	Sustainable Transportation: Promotion of sustainable transportation options, such as public transit, walking, and cycling, to reduce car dependency.		
	Green Certifications and Standards: Pursuit of green building certifications (e.g., LEED) to demonstrate sustainability performance		
Community	Smart Growth Principles: Incorporation of smart growth principles,		
Integration	including mixed land uses, walkability, and transit-oriented		
and Livability	development, to promote sustainable urban living.		
	Cultural Integration: Fostering a sense of place and cultural identity within the redeveloped site, enhancing community connectivity and cohesion.		
	Accessibility and Inclusivity: Ensuring that the site is accessible to		
	all residents, including those with disabilities, and promotes inclusivity		
	Public Spaces and Green Amenities: Creation of public spaces		
	parks, and recreational amenities that enhance community well-		
	being and livability.[24]		
Source: By Authority	Source: By Authers depending on [5], [7] and [24]		

2.8. Sustainable Brownfield indicators

The following table shows Brownfield indicators

Indicators		Methods of measurement
Environmental Indicators	Contamination Remediation	Conduct regular site assessments to monitor contamination levels over time, comparing pre-redevelopment and post-redevelopment data.



Indicators		Methods of measurement	
	Biodiversity Enhancement	Conduct biodiversity surveys to identify and quantify changes in plant and animal species diversity on the redeveloped site.	
Resource Management		Monitor and track water and energy consumption on the redeveloped site, comparing usage patterns with established benchmarks for efficiency.	
	Air and Water Quality	Regularly monitor air and water quality at and around the brownfield site using air quality monitors and water testing to assess improvements.	
	Investment Attraction	Track and analyze the amount of private and public investment secured for the redevelopment project over time.	
Economic	Job Creation	Collect data on the number of jobs created both during construction and post-redevelopment, categorizing them by direct, indirect, and induced employment.	
Indicators	Property Value Increase	Analyze property value assessments before and after redevelopment to determine the percentage increase in property values in the vicinity.	
	Tax Revenue Generation	Calculate the additional tax revenue generated by the redeveloped site by comparing pre-redevelopment and post-redevelopment tax income.	
	Community Engagement	Measure community participation levels in public meetings, workshops, and surveys, and assess the incorporation of community feedback into the redevelopment plan.	
Social Indicators	Affordable Housing	Evaluate the percentage of affordable housing uni provided within the redeveloped site and compare it t established affordable housing targets.	
mulcators	Public Access and Amenities	Conduct surveys to gauge local residents' usage of public spaces, recreational areas, and amenities on the redeveloped site.	
	Cultural Preservation	Monitor the integration of historical elements and artifacts within the redevelopment, ensuring they are preserved and made accessible for public viewing.	
Sustainability criteria for the management of contamination and the reuse of soil and debris		To reduce the site's and the neighborhood's negative environmental impacts, including human health concerns. To reduce waste while increasing recycling and reuse of soil and debris	
		In order to assure cost effectiveness and technical feasibility. Improve societal acceptance by identifying all	
		stakeholders and communicating risks. To give decision-making aids for risk-based land management.	
management of contamination and the reuse of soil and debris Sustainability criteria for the management of existing buildings and infrastructures		To reduce energy usage and generate renewable energy on the Site To minimize water demand and wastewater production	
		To reduce trash creation from buildings and civil infrastructure (via increased recycling and reuse). Using industrial legacy to promote cultural and regional identity	
		In order to assure cost effectiveness and techn feasibility. Improve societal acceptance by identifying stakeholders and communicating risks. To give decision-making aids for risk-based 1 management. To reduce energy usage and generate renewable energy on the Site To minimize water demand and wastewater production To reduce trash creation from buildings and civil infrastructure (via increased recycling and reuse). Using industrial legacy to promote cultural and regional identity	



Indicators	Methods of measurement	
	To improve compliance with health and safety laws	
	for repurposed buildings and infrastructure.	
	To encourage land use functions that correspond to	
	regional socioeconomic demands and needs.	
	Incorporating brownfield redevelopment into regional	
	land management	
	Incorporating the reuse of brownfield areas into urban	
	development	
	Obtaining benefits for and avoiding negative	
Sustainability criteria for land	consequences for the local community	
use and urban design on	to create and protect jobs and economic development	
brownfield sites	To encourage land use functions that are compatible	
	with the natural and man-made environments of the	
	site and its surroundings	
	To conserve resources	
	To make former brownfield sites more permeable	
	Access to all modes of transportation	
	To reach high levels of urban design excellence	
	To generate and preserve flexibility and adaptability in	
	urban design.	
	To improve the quality of the information itself To	
	improve the quality of the information flow within the	
	decision-making process and to make better use of	
	information	
	To have a more equitable conversation process and	
	better dispute resolution	
	to boost the credibility of the decision-making process	
Sustainability criteria for	to increase the grades of finite or in terms of denotion	
planning processes and methods	to increase the process's efficiency in terms of duration	
10f Citizen participation	To approver citizens, particularly those who represent	
	non-organized interests	
	Delegating responsibility to lower decision levels and	
	encouraging a sense of ownership	
	To improve the quality of the information itself To	
	improve the quality of the information flow within	
	the decision-making process and to make better use	
	of information	
	To form an interdisciplinary project team	
	To make project delivery more efficient	
	Promoting and managing stakeholder participation	
Sustainability criteria for the	To provide a framework for decision-making	
management of brownfield	transparency, information flow, and improved	
projects	communication mechanisms.	
	To safeguard human health and safety while on the job.	
	To take a holistic approach that considers social,	
	economic, and environmental factors	
Source: By Authers depending on [9], [13] and [22]		

3. Case Studies:



3.1 Al-Mahalla al-Kubra city

3.2.1 Spatial relations of Al-Mahalla al-Kubra city

Al-Mahalla al-Kubra city is located in the northeastern part of the Gharbia Governorate, between the Rasheed and Damietta branches, about 6 km to the west of the Damietta Branch, and to the southeast of Kafr El-Sheikh city (the capital of Kafr El-Sheikh Governorate), about 27 km, and to the northeast of Tanta city (the capital of the Gharbia Governorate by about 26 km, In addition to its relationship with the Al-Mansoura city, the capital of Dakahlia Governorate, on the other bank of the Damietta branch, which is located 18 km away as it is the main entertainment city for the residents of Al-Mahalla al-Kubra city.

3.2.2 Al-Mahalla al-Kubra city's need for brownfield

Brownfield is considered one of the most important development approaches for the development of Al-Mahalla al-Kubra city, due to many lands that were previously used and are not architecturally compatible with the successive development changes in Al-Mahalla al-Kubra city.

Therefore, the development of Brownfield is considered one of the most important development approaches in Al-Mahalla al-Kubra city because it helped meet the development needs of land to meet the urban, economic, social and environmental needs of Al-Mahalla al-Kubra city. The following figure 4 shows the spatial distribution and classification of brownfield lands in Al-Mahalla al-Kubra city



Figure 4 The spatial distribution and classification of brownfield lands in Al-Mahalla al-Kubra city Source: By Authors depending on the satellite image and [25]

By reviewing the current situation of the city of Mahalla al-Kubra and using satellite images, the following became clear:



- The number of slum areas in Al-Mahalla al-Kubra city is 10, with a total area of 617.1 acres.
- There are some non-urban uses (such as cemeteries in distinct locations in the old city), which loses the value of the land, especially in the center of the city, next to areas where services are concentrated.
- The random urban growth of the urban bloc towards the main roads of the city causes the loss of some areas of agricultural land in addition to the blurring of the boundaries of the city's urban bloc.
- The large balance of vacant lands within the urban space, with a total area of about 82.9 acres, as well as the spread that characterizes the lands, in addition to the great diversity in the areas of these lands.
- There are many waterways that border the city, which can be used as parks for residents and provide green and open areas.

3.2 Kafr El-Zayat city

3.2.1 Spatial relations of Kafr El-Zayat city

Kafr El-Zayat city is the capital of its markaz, which is located in the far southwest of Gharbia Governorate. It is 18 km away from Tanta city, the capital of the governorate, and 108 km away from Cairo city. The markaz is bordered on the northern side by markaz Basyoun, on the east by markaz Tanta, on the west by Rasheed Branch, and on the south by Menoufia Governorate, and passes by it Cairo-Alexandria Agricultural Road, Al-Gharbia Governorate is located in the Delta Region with all of the governorate, to the west by Beheira Governorate (affiliated with the Alexandria Region), to the north by Kafr El-Sheikh Governorate, and to the south by Menoufia and Qalyubia Governorates .[26].



3.2.2 Kafr El-Zayat city's need for brownfield

Brownfield is considered one of the most important development approaches to the development of Kafr El-Zayat city, due to its location in the Delta region, where agricultural lands surround all cities, which makes it difficult to have an urban sprawl other than agricultural lands, which is considered a major development loss.

Therefore, the development of brownfield lands is considered a matter of utmost importance in Kafr El-Zayat city and in all the cities of the Delta, because it adds new lands to meet the urban needs of Kafr El-Zayat,



whether in terms of services, activities, or housing, and it also adds new economic and investment values to Kafr El-Zayat. The following table 3 shows the current use, area and classification of brownfield lands in Kafr El-Zayat city.

Туре	No.	Current Use	Area (m2)	Area (Acre)
	1	Abandoned land	30500	7.3
	2	Abandoned land	64165	15.3
Undeveloped	3	Abandoned land	42453	10.1
areas	4	Abandoned land	96906	23.1
	5	Cemeteries	50496	12.0
	6	Abandoned land	11607	2.8
	А	Unplanned areas	244854	58.3
Unplanned	В	Unplanned areas	42265	10.1
areas	С	Unplanned areas	18171	4.3
	D	Unplanned areas	62240	14.8
Water Front	#	Water Front	262035	62.4
TOTAL			925692	220.4
Source: By Authers depending on the satellite image and [26]				

Table 3 The current use, area and classification of brownfield lands in Kafr El-Zayat city

The following figure 7 shows the spatial distribution and classification of brownfield lands in the city of Kafr El-Zayat





Figure 7 The spatial distribution and classification of brownfield lands in the city of Kafr El-Zayat Source: By Authors depending on the satellite image and [26]

4. Results

4.1 The main and subsidiary steps, procedures and recommendations necessary to develop brownfield sites on the case strides:

The following table 4 explains the main and subsidiary steps, procedures and recommendations necessary to develop brownfield sites on the case strides

Main steps	Sup steps	Procedures / Recommendations	
1-Preliminary Site Assessment:	1- Identify and inventory potential brownfield sites within the community	This is through a land use map and updating it through urban survey and satellite images in order to determine the brownfield classifications.	
	2- Conduct a preliminary assessment to determine the history, extent of contamination, and potential environmental risks associated with each site.	This is through identifying potential sources of pollution, in addition to taking samples of soil, water, and other materials to determine the extent of pollution.	
	3- Prioritize sites based on factors such as environmental impact, community need, and economic potential.	Prioritizing sites is based on the needs of the community first, whether in terms of localizing services or seeking to raise some environmental indicators to improve environmental performance, such as increasing the area of green areas, or to meet the needs of investors.	
2- Feasibility Study	1- Conduct a comprehensive feasibility study for the selected brownfield site, considering technical, financial, and market factors	After setting priorities, development sites are selected, and a comprehensive feasibility study is conducted for the selected sites to ensure the urban, environmental, and economic sustainability of those sites, with the participation of financial, marketing, and technical specialists. The main output of this step is a comprehensive report to study the feasibility of the selected sites in all dimensions.	
	2- Assess the costs and benefits of redevelopment, including remediation, infrastructure upgrades, and potential revenue streams.	In this step the costs and benefits of redevelopment are evaluated, including repair and upgrading of infrastructure and potential revenue sources.	
	3- Analyze market demand and evaluate the	The economic feasibility of the proposed use of the land is confirmed in this step, which was developed	

Table 4 The main and subsidiary steps, procedures and recommendations necessary to develop brownfield sites



Main steps Sup steps		Procedures / Recommendations	
	economic viability of the proposed land use.	based on the needs of the community, based on an analysis of market demand with the assistance of economic experts.	
3- Environmental Assessment and Remediation	1- Conduct detailed environmental assessments to determine the extent and severity of contamination.	The main outcome in this step is to determine the extent and severity of pollution through sensitive devices that measure pollution within the limits permitted by competent organizations such as the World Health Organization.	
	2- Develop a remediation plan that outlines the cleanup strategy, including sustainable remediation practices and technologies.	This is done by establishing procedures to control sources of pollution and improve their drainage in a sustainable manner	
	3- Obtain necessary permits and approvals for remediation activities.	In this step, the concerned authorities are addressed to obtain the necessary approvals and permits to reuse these lands within the framework of economic feasibility and community needs.	
4- Stakeholder Engagement	1-Engage with the local community, residents, businesses, and stakeholders to gather input, address concerns, and build support for the redevelopment project.	Hold public meetings, workshops, and consultations to involve local residents, businesses, and community organizations in the planning process. Gather feedback to understand community needs, concerns, and aspirations. Address community input and integrate it into the redevelopment plan.	
	2-Create opportunities for public participation and transparency throughout the planning process.	Informing Stakeholder of the outcomes of each step in the project to create effective participation and reach outcomes that contribute to solving community problems	
5- Master Planning and Design	1-Develop a master plan for the brownfield site that integrates sustainability principles.	Develop a master plan based on the principles of eco-cities, the most important of which are mixed land uses, green infrastructure, and energy- efficient design.	
	2-Collaborate with architects, urban designers, and engineers to create a comprehensive master plan for the site's redevelopment.	Hiring architects, city designers and engineers to create a comprehensive master plan for the redevelopment of the site.	
6- Infrastructure Development		Plan and design necessary infrastructure such as roads, utilities (water, sewer, electricity), and public transportation options.	



Main steps	Sup steps	Procedures / Recommendations
		Ensure that infrastructure supports the new land uses and is designed with sustainability in mind. Coordinate with relevant agencies and utilities to implement the infrastructure improvements.
7- Financing and Funding:	1-Secure funding from a mix of sources, which may include government grants, private investment, tax incentives, and public- private partnerships.	Announcing the offer of financing participation in the project, clarifying the benefits and obligations, in order to diversify the sources of financing participation
r ununig.	2-Explore creative financing mechanisms to cover remediation and infrastructure costs.	Seeking economic experts to explore creative financing sources to ensure the success of the project.
	1-Ensure compliance with all relevant environmental regulations, zoning codes, and land use ordinances.	Creating an organizational regulation for the implementation of the project to ensure the commitment of all individuals and relevant parties within the framework of binding regulatory laws.
8- Regulatory Compliance	2-Work closely with regulatory agencies to obtain necessary approvals and permits.	Continuous coordination with the concerned authorities to obtain the necessary approvals and permits and review existing zoning regulations and land use plans to ensure they align with the proposed redevelopment. Work with local authorities to update zoning codes and regulations if necessary.
	1-Begin site preparation, infrastructure upgrades, and construction of the redevelopment project.	Preparing working drawings approved by specialists that are necessary for the implementation of the project
9- Construction and Implementation: 2-Monitor construction activities to ensure compliance with environmental and safety standards.	Appointing specialized observers to follow up the implementation process to ensure compliance with occupational safety and health standards. Attract developers and investors who align with the redevelopment goals and vision.	
10- Environmental Management and Monitoring:	1-Implement long-term monitoring and maintenance plans to ensure the continued safety and sustainability of the redeveloped site.	Implement ongoing monitoring and maintenance of the site to ensure that any remaining contamination is managed and controlled.
	2-Monitor environmental conditions and address	Regularly assess the site's environmental performance and address any issues that arise. Maintain



Main steps	Sup steps	Procedures / Recommendations	
	any issues that may arise over time.	open communication with the community to address concerns and maintain support.	
11- Community Integration	1-Integrate the redeveloped brownfield site into the existing community fabric, enhancing connectivity and accessibility through pedestrian-friendly design and transportation options.	Multiple of transportation and design of a pedestrian network to ensure the integration of the developed site into the existing urban fabric, and community participation ensures the integration of the site into the existing community fabric.	
	2-Celebrate the site's history and cultural heritage through public art, interpretive signage, or historical preservation efforts.	Supporting the visual image of the site and urban harmony to support the identity and culture of the site.	
12- Evaluation and	1-Continuously assess the success of the redevelopment project in meeting its sustainability goals and community objectives.	Continuous evaluation to adjust for new variables and accomplish community goals.	
Feedback	2-Collect feedback from stakeholders and the community to make any necessary adjustments and improvements.	Designing forms to collect community feedback on developing areas	

4.2 The impact of brownfields development on the case studies:

• Economically:

Brownfields add new lands that can be used in sorting and grading potatoes for export, as Kafr El-Zayat city considered the largest station for sorting, grading and exporting potatoes, and it is also considered a large market for the rural sector.

Brownfield can be used in Kafr El-Zayat city as a logistical and service area supporting the industrial sector, as Kafr El-Zayat exports its industrial products to all cities in Egypt, especially the neighboring Delta countryside.

Brownfield can be benefited by strengthening the economic base of the textile industry in Al-Mahalla al-Kubra city using the eco-industry approach

Environmentally

Brownfield is an opportunity to control low environmental indicators such as green land per capita.

The per capita number of green areas in Al-Mahalla al-Kubra city can be increased by repurposing brownfield lands

Urban

Brownfield is considered an opportunity to add more services to compensate for the lack of service rates in Kafr El-Zayat city.



It is also considered an opportunity to add new housing areas that relieve pressure on urban crawl on agricultural land.

New service lands can be provided to raise the level of services in some areas of Al-Mahalla al-Kubra city.

socially:

Adding open areas and public spaces based on brownfield increases social connections.

4-3 the proposed plan for the role of governments in the sustainable redevelopment of brownfield areas:

It is essential for governments to play a crucial role in the sustainable redevelopment of brownfield areas, this role can be summarized in the following points

- **Regulation and Policy Development:** Governments establish regulations and policies to guide the redevelopment process, ensuring that it aligns with environmental standards and sustainability goals. Zoning and land-use policies may be updated to encourage brownfield redevelopment and mixed-use developments.
- Environmental Assessment and Remediation: Governments are responsible for conducting environmental assessments to identify and assess contamination on brownfield sites. They may provide financial incentives or grants to support the cleanup and remediation of contaminated sites, making them suitable for redevelopment.
- **Financial Incentives:** Governments often offer financial incentives, such as tax credits, grants, or lowinterest loans, to developers willing to invest in brownfield redevelopment projects. These incentives help offset the higher costs associated with cleaning up contaminated sites.
- **Community Engagement:** Governments facilitate community engagement processes to gather input from local residents, businesses, and other stakeholders. This helps ensure that redevelopment plans align with community needs and concerns.
- **Infrastructure Investment:** Governments may invest in infrastructure improvements in and around brownfield areas to enhance accessibility and support sustainable development. This could include upgrading transportation systems, utilities, and public spaces.
- **Public-Private Partnerships (PPPs):** Governments can engage in partnerships with private entities to leverage resources and expertise for brownfield redevelopment. PPPs can help share the risks and responsibilities associated with complex redevelopment projects.
- Smart Growth Planning: Governments may incorporate brownfield redevelopment into broader smart growth and urban planning initiatives. This involves creating sustainable, mixed-use developments that promote efficient land use and reduce urban sprawl.
- Monitoring and Compliance: Governments play a role in monitoring ongoing redevelopment activities to ensure compliance with environmental regulations and sustainability standards.

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