

Factors should be considered for the sustainable redevelopment of a Brownfield to an Industrial Use.

Amina B Karim, Navya Ann Thomas

¹Student, T.K.M. College of Engineering, Kollam, Kerala

²Assistant Professor, T.K.M. College of Engineering, Kollam, Kerala.

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ABSTRACT: Brownfield sites present significant opportunities for sustainable redevelopment, particularly for industrial use, due to their existing infrastructure and strategic locations. However, such redevelopment requires careful consideration of various factors to ensure long-term environmental, social, and economic sustainability. This paper identifies and examines key factors that should be considered for the sustainable redevelopment of Brownfield sites into industrial facilities. Factors such as environmental remediation, land use planning, stakeholder engagement, economic viability, and regulatory frameworks are explored in depth. Drawing on case studies and expert insights, this paper provides a comprehensive framework to guide stakeholders involved in the redevelopment process. By integrating these factors into decision-making processes, stakeholders can maximize the potential of Brownfield sites while minimizing negative impacts on the environment and surrounding communities. This research contributes to the broader discourse on sustainable urban development and offers practical guidance for policymakers, developers, and community members seeking to transform underutilized land into productive and environmentally responsible assets.

KEYWORDS: Brownfield site, Sustainable redevelopment, Industrial use, Urban development, Regulatory framework.

I. INTRODUCTION

[1] Brownfield redevelopment is a critical and dynamic facet of urban planning and environmental restoration that holds the potential to transform blighted and underutilized areas into thriving, sustainable, and economically vibrant spaces. Brownfields are abandoned or underutilized properties, often located in urban areas, that have a

history of industrial or commercial use and may be contaminated with hazardous substances. Brownfield redevelopment refers to the process of revitalizing these neglected sites for new purposes, such as housing, commercial ventures, parks, or renewable energy projects.

[2] Depending on the location and characteristics of the property and market factors, a brownfield site often can be redeveloped for uses ranging from housing, retail, industrial, or mixed-use to public and non-profit uses such as parks, recreational areas and municipal facilities. Brownfields redevelopment offers benefits over greenfield development, such as: a) Reducing blight and improving the local environment by cleaning up contamination. b) Removing abandoned or underused sites into beneficial reuses. c) Reducing sprawl and preserving greenspace. Brownfields can be redeveloped by private developers, local governments or through public-private partnerships.

[3] India is on the verge of massive urban and industrial development and it can be predicted that soon India will face the problem of Brownfield at large scale. According to the report of National Programme for Rehabilitation of Polluted Sites (NPRPS) India, there are 73 Hazardous waste contaminated dump sites in India. The approach of NPRPS is to identify and provide mechanism for remediation of contaminated site only. The identification of Brownfield in urban area is still not done. NPRPS has proposed National Priority List (NPL) which will only include contaminated land based on the severity of contamination and effect of such contamination to human health, no information on derelict or abandoned land is available in this list.

[4]. At present India is at beginning stages of land redevelopment and organization, hence no specific guideline for redevelopment is available.

The classification system is mainly based on the activities and type of contamination. It does not include the parameter of party causing the contamination. There is no specific legislation for Brownfield is available in India. However Environment (Protection) Act 1986 (EP Act) and Construction and Demolition Waste Management Rules, 2016 are followed for management of contaminated sites. Ministry of Environment, Forest and Climate Change, Central Pollution Control Board and State Pollution Control Board are responsible for management and regulation of soil pollution in India. Detailed liability for remediation of hazardous waste site is available in the Hazardous Waste Rules, 2008.

[5].Industrial brownfields refer to abandoned or underutilized industrial sites that may have been contaminated or face other challenges that impede their redevelopment or reuse. These sites are typically characterized by the presence of old, obsolete, or vacant industrial facilities, and they may have environmental issues such as soil or water contamination from past industrial activities. Reclaiming and revitalizing industrial brownfields is an important aspect of sustainable urban development and environmental stewardship.

Governments, businesses, and communities often work together to assess and remediate environmental contamination, demolish or repurpose old structures, and redevelop these sites for new uses such as residential, commercial, or recreational purposes.

[6]. Brownfield regeneration is imperative for sustainable urban development, as it allows for the revitalization of abandoned or underutilized industrial and commercial facilities in towns. Brownfields, as dominant products of global processes, are interpretations of various disruptions and restrictions, but they also hold potential for sustainable development and the creation of new values in urban spaces. Strategic actions, such as setting up criteria and control mechanisms, strengthening public-private partnerships, and adopting a holistic approach, are necessary for proper brownfield regeneration. It emphasizes the need for awareness about the importance of brownfield regeneration, addressing the high costs of restoration, and overcoming the lack of experts and weakening economies. The distribution and increasing dominance of brownfields worldwide highlight the need for sustainable regeneration and development strategies.



Location of development sites in Wellstone.



Old factory building at Waterbury.

II. CASE STUDY ANALYSIS

[7]The first Case study discuss about the success of the abandoned industrial sites of the Wagner Electric Company and the ABEX Foundry site. These sites were deserted in the early 1980s and were left to deteriorate for nearly twenty years. Currently, the site is being redeveloped, with an established alliance between the City of Wellston and County of St. Louis. The case study was chosen due to its successful recovery of a city which “once overlooked is fast becoming a place to call home”. During the time of the early 1900s St. Louis and the surrounding area began establishing

factories in the electrical industry such as the Emerson Electric, Century Electric and Wagner Electric Manufacturing Company. The Wagner Plant acted as a major employer across the area, providing 4,500 jobs during World War I. With the numerous industrial plants as anchors, the City was reestablished in 1949 as a vibrant neighborhood, offering many amenities. These amenities included theaters, a hardware store, dance hall, and a variety of numerous retail stores for the community to utilize. Unfortunately, since the 1970s, these amenities have deteriorated due to numerous economic and social hardships.

[8] In the second one The Scovill Brass Works site at Waterbury was used as a factory as far back as the early 1800s. When Scovill's successor, Century Brass, declared bankruptcy in 1986, no other responsible party with deep pockets entered the picture to pay for cleanup and remediation. Few buildings were suitable for reuse; many were structurally unsound; and all were filled with lead paint residue and asbestos. More than half the building space was used for one enormous rolling mill. In 1986, Scovill's successor finally shut down, leaving behind 87 acres contaminated by industrial pollutants and 2.2 million square feet of space in obsolete historic buildings. Century Brass partially remediated the site and contained sludge that was contaminated with metal hydroxide off site in a hazardous waste landfill. Other types of contamination included oily soils, volatile organic compounds, and PCBs. All told, 15 to 20 percent of the site contained soils contaminated with hazardous materials.

The lessons learned from the Wellston project convey the importance of community support, use of multiple resources and finally, to always expect the unexpected. Although hesitant to change their first approach, the city is now becoming a vibrant industrial corridor, inspiring surrounding cities to also take action. In order to take action, surrounding cities, as well as cities throughout the nation, may look to the development in Wellston as a successful example of how to promote job creation, economic development, aesthetic improvements and educational opportunities for the communities. Firstly-

- The redevelopment spurred revitalization across the city.
- The community began to show its support for the development by taking steps to 70% decrease the apparent blight in the area.
- Many residents are now taking pride in the community, showing this pride by improving and taking care of their own property.
- The improvement across the city has encouraged others to relocate to the area, allowing the new residents to take advantage of the many assets the city now provides, including a park, mass transit and job / education centers

Second-

- Wellston was able to combine resources from county, state and federal levels, to accomplish a successful project.
- The county, represented by the St. Louis County Economic Council, acted as the main

force behind the development. It was able to use state (Missouri Department of Natural Resources) and federal (Environmental Protection Agency) entities as leverage to persuade the city to back the development.

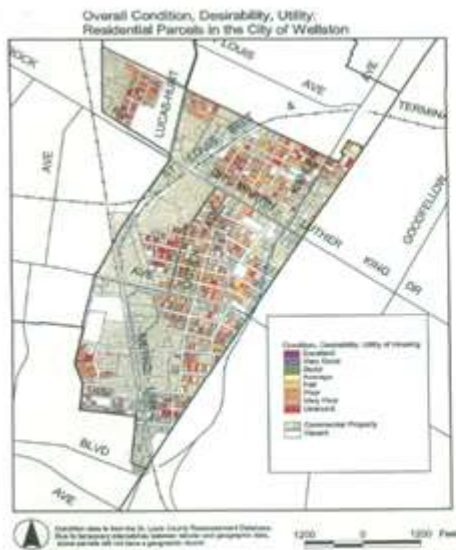
- The county established the Wellston Redevelopment Corporation to allow representatives from each entity to have a stake in the development process.
- This action allowed for a cohesive comprehensive plan to be created for the entire city, resulting in a successful development.

From the second case study the project demonstrates that brownfields can offer substantial economic and social potential. At the same time, there is considerable sentiment that brownfield redevelopment must be nursed along by a combination of strong market demand, superior location, a friendly regulatory environment, public monies for incentives and remediation, and bold but sensitive developers. Rehabilitated properties also can help reclaim the environment. Further, brownfields can capitalize on existing sites and infrastructure. Unlike a typical suburban regional mall—and almost all of GGP's 114 regional malls are in the suburbs— Brass Mills is an infill project designed to complement rather than drain a traditional city center. The demolition of nearly 2 million square feet of industrial buildings and the cleanup of 118,000 tons of contaminated soil required special incentives and financing, which were brokered through an innovative partnership of the developer, Chicago-based General Growth Properties, Inc. (GGP), with the nonprofit sector, the state of Connecticut, and the city of Waterbury. Public funding and subsidies exceeded \$40 million. All environmental remediation work was performed under the management of Brass Center Limited (BCL), a nonprofit corporation created for that purpose and also to protect the developer from environmental liability. The economic prospects for Brass Mills Mall appear to be excellent.

- A 12-screen theater complex and about 150 other shops covering 330,000 square feet.
- In addition to the regional mall, the project includes a 200,000-square-foot community shopping center featuring a Barnes & Noble bookstore, Office Max, a grocery store, and restaurants.
- Smaller stores in the regional mall pay rents of about \$35 a square foot, triple net.
- Rents in the community shopping center range from \$14 to \$16 per square foot, triple net, meeting or exceeding industry standards.

In short, the project’s brownfield past appears not to have impaired its ability to market space to

tenants.



Housing condition in Wellstone.



Developed Brass Mill Mall

Results after the redevelopment of the Industrial brownfields at Wellstone and Waterbury.

III. LAND SUITABILITY CONDITIONS(11 BOLD)

[9]When considering the suitability of Brownfield sites for sustainable redevelopment for industrial use, several land suitability conditions should be taken into account. These conditions help ensure that the site is appropriate for industrial activities while minimizing environmental and social impacts. By carefully evaluating the land suitability conditions stake holders can make informed decisions about the sustainable redevelopment of the brownfield sites for industrial use, balanced economic development objectives with environmental protection and community engagement.

Environmental Contamination: Assessing the extent and nature of contamination on the site and determining the feasibility of remediation to meet regulatory standards for industrial land use.

Infrastructure Availability: Evaluating the adequacy of existing infrastructure, such as transportation networks, utilities (water, electricity, sewage), and telecommunications, to support industrial operations.

Zoning and Land Use Regulations: Reviewing local zoning ordinances and land use regulations to ensure compliance and identify any restrictions or special considerations for industrial development.

Site Accessibility: Considering the accessibility of the site for transportation of goods

and materials, as well as access for employees and visitors, including proximity to highways, ports, railroads, and airports.

Surrounding Land Uses: Assessing the compatibility of surrounding land uses with industrial activities and evaluating potential conflicts or impacts on adjacent properties and communities.

Site Size and Configuration: Evaluating the size, shape, and topography of the site to determine its suitability for industrial development, including considerations for layout, expansion potential, and environmental buffers.

Natural Resource Constraints: Identifying any natural resource constraints, such as protected habitats, wetlands, floodplains, or geological hazards, that may affect the suitability of the site for industrial use and require mitigation measures.

Community Acceptance: Considering the perspectives and concerns of local communities and stakeholders regarding the proposed industrial redevelopment, including potential impacts on quality of life, public health, and property values.

Economic Feasibility: Assessing the economic viability of industrial redevelopment, including factors such as market demand, job creation potential, investment costs, and potential return on investment.

Sustainability Criteria: Incorporating sustainability principles into site selection and redevelopment planning, including considerations

for energy efficiency, waste management, water conservation, and green infrastructure

PROPOSED REDEVELOPMENT	INDUSTRY	Land use Land cover	Vacant land	Highly suitable	(Johar, 2013) (Baghel, 2022) (Tsala, 2022) (Kaur, 2022) (Muhsin, 2017)
			Shrub land	Moderately suitable	
			Commercial site	Less suitable	
			Recreation	Not suitable	
			Settlement	Not suitable	
		Slope(%)	0-5%	Highly suitable	
			6-10%	Moderately suitable	
			11-15%	Less suitable	
			>15%	Not suitable	
		Elevation(m)	>15	Highly suitable	
			11-15	Moderately suitable	
			6-10	Less suitable	
			0-5	Not suitable	
		Proximity to road network(m)	100-500	Highly suitable	
			500-1000	Moderately suitable	
			1000-1500	Less suitable	
			1500-2000	Not suitable	
			>2000	Not suitable	
		Distance from river(m)	750-1000	Highly suitable	
			500-750	Moderately suitable	
		Distance from settlements(m)	0-500	Less/Not suitable	
			Area outside 1200m buffer	Highly suitable	
			800-1200	Moderately suitable	
			600-800	Less suitable	
Distance from agricultural land(m)	400-600	Not suitable			
	<400	Not suitable			
	0-50	Not suitable			
Proximity to urban areas(m)	>50	Suitable			
	>500	Highly suitable			
	300-500	Moderately suitable			
	200-300	Less suitable			
Railway proximity(m)	100-200	Not suitable			
	0-100	Highly suitable			
	0-2000	Moderately suitable			
	2000-5000	Less suitable			
	5000-10000	Not suitable			
	10000-20000	Highly suitable			
	>20000	Moderately suitable			
		Less suitable			
		Not suitable			

FRAMEWORK FOR THE REDEVELOPMENT OF BROWNFIELD TO

[10]Brownfield sustainable redevelopment is a balanced approach that consists of environmental, social and economic aspects. There are various approaches and projects experiences in application of brownfields sustainable regeneration concept. Based on international successes and the strategic improvement in Brownfields planning, such projects may be expected to become increasingly attractive. Regarding the implementation of brownfields regeneration projects, the sustainability issues are considered not just in planning phase, but in every possible phase. Practical implementation of brownfields regeneration requires consideration of a range of factors including: the economic drivers of real estate development, the land use regulation, and skills of urban planning. Many of countries having brownfields have been required to cooperation between the activities of planning and environment protection agencies, and frame specific legislation

AN INDUSTRIAL SITE

to facilitate such cooperation and shared control. Many planning interventions are designed to address the challenges facing brownfields regeneration using legal, financial tools, moreover regulations incentives to encourage brownfield regeneration. There is no one tool or method that is guaranteed for success, but a combination of tools based on different locations and situations.

Environmental Considerations.

- Pedestrian Oriented Redevelopment: offers a lifestyle that is ecologically friendly and sustainable, resulting in a public space that is welcoming, safe, and beneficial to the community.
- Provision of Open spaces & Green corridors.
- A system of bike lanes, walkways and sidewalks that connects every area of the town, tying residential neighborhoods to government, business and recreational spaces

as well as necessary services . **Social Considerations.**

- To make it possible for the community's government and residents to prepare for societal changes.
- The plan comprises goals and objectives for the future along with an analysis of past trends and development and current conditions.
- Provision of affordable housing.

Economic Considerations.

- There should be a balance between the housing and job opportunities they are providing .
- Develop a balance between residential and commercial use
- For social justice, environmental quality, and economic growth, Communities must now engage in regional decision-making due to economic restructuring and demographic shifts.
- Brownfield development should utilise the local potential to launch commercial operations .

IV. CONCLUSION

In conclusion, the development of a comprehensive framework for the sustainable redevelopment of industrial brownfields represents a critical step toward creating resilient and vibrant urban environments. This dissertation has delved into the multifaceted challenges posed by industrial brownfields, emphasizing the intricate interplay of environmental, social, and economic factors in their transformation. By synthesizing insights from environmental science, urban planning, and community engagement, the proposed framework provides a roadmap for stakeholders engaged in the complex task of revitalizing these neglected spaces. The inclusion of case studies and comparative analyses has enriched the framework by offering real-world examples and practical insights into successful brownfield redevelopment projects across the globe. As cities continue to grapple with the legacy of industrialization, the insights derived from this research can serve as a valuable guide for policymakers, urban planners, and environmental practitioners. In essence, this dissertation advocates for a holistic and collaborative approach to brownfield redevelopment—one that reconciles environmental responsibility, social inclusivity, and economic vitality. Through the application of this framework, cities have the opportunity to not only reclaim and repurpose abandoned industrial spaces but also to foster resilient communities that thrive in harmony with their surroundings.

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