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Research paper



Practices in sustainable industrial infrastructure and technology: A case study of Gujarat, India

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Abstract

Sustainable industrialisation is one of the seventeen Sustainable Development Goals formulated by the United Nations. It has a crucial role to play in achieving sustainability, because it is the driving mechanism for development of a country's economy and instrumental to several environmental and social problems. For a developing country like India, it can ensure development in the right direction. Gujarat is one of the most industrialised states in India with high economic returns from the industrial systems but high levels of pollution as well. Some of the most polluted industrial towns in India and the world have been listed from Gujarat. For the past few decades, practices in sustainable industrial infrastructure have been playing a vital role in providing innovative solutions to complicated environmental problems, globally. Gujarat has been a leading State in India to promote these initiatives. The research paper intends to study and understand the direction of sustainable industrial development in Gujarat and presents the SWOT analysis of the existing situation. It includes case discussion of various cleaner production techniques, eco-efficiency and waste management practices.

Keywords: *Cleaner Production Technology; Environmental Engineering; Gujarat; Industrial Infrastructure; Sustainable Development.*

1. Introduction

The industrial sector serves as the backbone for the growth of a country's economy and it has been the same for a developing country like India, but with growing industrialisation, the need for sustainable practices in technology, sources of energy, resource management etc. is also required. The 17 Sustainable Development Goals (SDGs) formulated by the United Nations (UN) includes sustainable industrial infrastructure as well. Now the approach towards industrial infrastructure by developed countries is primarily focussed on sustainability. Therefore, learning from the development model of more industrialised nations, India must fathom the outlay of such practices in a more sustainable manner. [1], [2] [3]

Hitherto, the road to industrialisation has been a prolonged and parochial one for India. Incepted with the growth of individual industries or small clusters, to modern industrial estates, the contemporary practice had been development by the means of National Investment and Manufacturing Zones (NIMZs), Special Investment Regions (SIRs), and even mega industrial corridors. All of these are under the gamut of latest initiatives from the Government of India, namely, 'Make in India' and National Manufacturing Policy, which envisages transformation of India into a manufacturing hub by increasing the share of manufacturing in Gross Domestic Product (GDP) to 25 per cent by 2022 and providing large number of additional jobs in the sector [4], [5].

The Indian State of Gujarat has been one of the most industrialised states in the country. The pace of industrial growth in this State has been consistent and competitive over the past few decades having utilised the benefits of liberalisation and globalisation, which marked major economic reforms for India in 1991. The State has been a forerunner in development practices not only in the past but present as well. It was one of the first states to enact SIR laws, which proposes the establishment of a regional development authority in each SIRs to take care of a balanced industrial development. However, the rapid industrialisation has had environmental consequences for Gujarat. According to a study done in 2006, Vapi and Ankleshwar (Gujarat, India) were ranked among the most polluted industrial areas in the world [6]. In an approach to cope with the skyrocketing levels of pollution caused by heavy industrialisation, the State has formulated several action plans and strategies.

In the developed countries, the practices in sustainable industrial infrastructure are primarily based on the concepts of Industrial Ecology (IE). Under the gamut of IE, Eco-Industrial Development (EID) has paved a way towards sustainable industrialisation very successfully. The concept has been globally popularised and has attracted interest in less developed, industrialising, as well as developed countries [7], [8]. In the Indian context, Gujarat has been actively following and implementing various concepts of IE for economic benefits in the past. Now, there has been a remarkable shift towards balancing economic and environmental aspects by the State.

2. Understanding sustainable industrial infrastructure

In terms of sustainable development, the industrial infrastructure has a pivotal role to play. It has a critical position, where it is the reason for many of the environmental and social problems, but also the driving mechanism for growth and development through economic prosperity. Many developed countries are using concepts of IE to achieve sustainable industrial infrastructure. The most popular and successful among them is by the Eco-Industrial

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Development (EID). The concept of EID was first described during a presentation at the United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro in 1992.
The United States of America (USA) went ahead with the EID concept and created Eco-Industrial Park (EIP) as models for industrial efficiency [9]. Although there are various definitions of EIP, but widely used and accepted definition was given in the Eco-Industrial Park Handbook for Asian Developing Countries as 'An Eco-Industrial Park or Estate is a community of manufacturing and service businesses located together on a common property. Member businesses seek enhanced environmental, economic, and social performance through collaboration in managing environmental and resource issues. By working together, the community of businesses seek a collective benefit that is greater than the sum of individual benefits each company would realize by only optimizing its individual performance. The goal of an EIP is to improve the economic performance of the participating companies while minimizing their environmental impacts. Components of this approach include green design of park infrastructure and plants (new or retrofitted); cleaner production, pollution prevention; energy efficiency, and inter-company partnering. An EIP also seeks benefits for neighbouring communities to assure that the net impact of its development is positive.'[10]–[12]
Table 1 discusses potential benefits of eco-industrial development from the perspective of business, community and environment, contributing towards sustainable development. Over the next decade, eco-industrial development may extend its benefits beyond the physical boundaries of EIPs with newer industrial trends and its integration with city planning [13], [14].

Table 1: Benefits of Eco-Industrial Development

Business	Communities	Environment
Improved efficiency	Improved tax base	Innovative environmental solutions
Enhanced market image	Reduced waste disposal costs	Reduced pollution
High performance workplaces	Enhanced local business opportunities	Continuous environmental improvement
Higher profitability	Community pride	Increased protection of natural ecosystems
Access to financing	Improved environment and habitat	More efficient use of natural resources
Regulatory flexibility	Recruitment of higher quality companies	Protection and preservation of natural habitat
Higher value for developers	Improved health of employees and community	
Reduction of operation costs (i.e. energy, materials)	Partnership with business	
Reduction of disposal costs	Minimized impact on infrastructure	
Income from sale of by-products	Enhanced quality of life near eco-industrial development	
Reduction of environment liability	Improved aesthetics	
Improved public image	Better job market	
	Increased employee productivity	

Source: Adapted from Handbook on Codes, Covenants, Conditions, and Restrictions for Eco-Industrial Parks [15]

3. Methodology

The research paper is a part of ongoing doctoral research of the primary author. A field-visit to the industrial areas of Gujarat State and meeting with industrial estate stakeholders, government body officials was conducted to collect primary data. The author/s have collated reports from various state and national agencies namely Central Pollution Control Board (CPCB), Gujarat Industrial Development Corporation (GIDC), Gujarat Cleaner Production Centre (GCPC), among others.
The methodology involved literature review of relevant national and international publications and input from field experts and industry managers followed by SWOT analysis of the existing condition. The SWOT analysis has been done considering various parameters namely infrastructure, financial resources, manpower availability, research support, role of government and industries, economic performance, community and health, energy and material usage with input from relevant experts.

4. Case of Gujarat

In India, Gujarat has been a leading State in industrial development and one of the favourites for investors. The State's ongoing work-plan to achieve sustainable industrial development includes execution in a phased manner by implying the suitable approaches and innovative strategies. The framework extends integration of energy needs, climate change and hazard issues, and supporting capacity development of the key stakeholder/organizations for sustainable industrial development.
The primary action plans under implementation include the following:

- Promotion of cleaner production technology and infrastructure in the existing industrial parks: Technology upgradation in existing industrial parks.
- Planning of new eco-Industrial parks: To plan the future industrial parks on sustainable development models integrating environment, energy and climate issues.
- Capacity development: Capacity development of the involved key stakeholders including individuals and organisations.

5. Promotion of cleaner production technology and infrastructure in existing industrial parks

This section discusses implied strategies within existing industrial parks in the State of Gujarat. It includes several initiatives in cleaner production technology, resource efficiency, waste management etc.

5.1. Naroda industrial estate, Ahmedabad

Naroda industrial estate was established in 1964 by GIDC. The major industries in this estate are chemical, pharmaceuticals, engineering, textiles, dye and dye intermediates and food production. With approximately 900 industries now, they employ nearly 35,000 employees and operate on 3.5 square metres of land. This makes it one of the biggest sites to have eco-industrial development [16]. The initiative of eco-industrial networking in this estate was a joint project by Naroda Industrial Association (NIA) in collaboration with the University of Kaiserslautern (Germany). It was a sponsored project called "Workshop on Industry and Environment" which took place at the Indian Institute of Management in Ahmedabad in 1999. The primary objective was to comprehend the typology and quantities of wastes generated by the industrial units in the estate. A survey on material flow was conducted involving 500 industrial units. The majority of waste generated comprised of the following materials:

- Chemical gypsum
- Biodegradable waste
- Mild steel scrap
- Waste acids in particular sulphuric and hydrochloric acids
- Chemical iron sludge

Chemical gypsum was generated by 19 chemical industries after the processing of neutralization of their acidic wastewater with lime. The produced gypsum was identified to be utilised by the cement manufacturing companies in the vicinity, based on certain specifications. The analysis conducted for the recovery process of gypsum as a raw material established that it could be commercially used. The total amount of biodegradable waste generated was 10,000 kg of solid material and 90,000 litres of liquid wastes per year. The generated waste was identified as a source of biogas and an energy resource for the industrial estate or for a housing development in the vicinity. An economic analysis showed that this energy recovery process is very fruitful. The sulphuric acid and mild steel scrap were identified as raw materials to make ferrous sulphate, a chemical used in primary wastewater treatment at the Common Effluent Treatment Plant (CETP) [17]. All of the partnerships described above are in successful operation with the support of NIA. The other symbiotic networks involved in the industrial estate now, are as follows:

- Using sulphuric acid in the manufacture of phosphate for fertilizer.
- Using iron sludge to prepare synthetic red iron oxide.
- An alternative application for chemical gypsum in the production of plaster board.
- Reduction in raw material and energy use in the ceramic sector.

5.2. Sachin industrial estate, Surat

The industrial estate at Sachin is located in the town of Surat. It was started in 1984. The town houses one of the largest industrial areas of Asia and has many Special Economic Zones (SEZs). The major industries include diamond polishing, textiles, dyes and intermediates, chemicals & pharmaceuticals, engineering and miscellaneous. The estate is sprawled in 749 hectares of area and has 600 industries with a working population of 45,000, approximately.

The resource efficiency and cleaner production initiatives include:

- Manufacturing and re-use of ferrous sulphate, catalysed hydrogenation using steel scrap and fabric.
- Waste water treatment (Industrial water consumption: 100 Million Litres / Day, Waste water generation: 55 Million Litres / Day)
- Industries have adopted multi cyclone, cyclone, dust collector/ scrubbing system for the flue gas/process emission as a measure for air pollution control.
- The disposal site for hazardous solid waste was provided with financial assistance from the State and Central Government.

The companies have been playing a part in improving the quality of life by adding to social benefits as well. The involvement in community benefits such as health, education, infrastructure development (drinking water, village infrastructure, construction of schools etc.), landscaping and tree plantation [18]. One such example is the association of textile industry providing training to the female workers and funding other programmes for community welfare.

The waste management initiatives have been very effective in nature. It includes segregation of effluents which reduces effluent loads at the Common Effluent Treatment Plant (CETP), separate CETP for textile and chemical industries, enhanced treatment efficiency reduces the use of chemicals, establishment of local Cleaner Production Centre (CPC), setting up of Treatment, Storage & Disposal Facility site (TSDF) in vicinity to the estate and decontamination of drums and containers.

5.3. Vapi industrial estate, Vapi

The industrial estate was established at Vapi in 1968, with primary objective of economic boom of the state, as issues of environmental degradation were not an issue in retrospective. The estate was established by GIDC and it houses 1500 industries on 1100 hectares of land, as of now. The estate majorly has chemical plants, mainly for chemical distillation and the production of pesticides, dyes, dye intermediaries and paints. Other major industries include pulp & paper, pharmaceuticals, plastics, rubber, textiles, wood, computer hardware and software, engineering workshops, glass, and food products.

The waste management infrastructure of the estate is being upgraded and expanded. The initiatives include expansion of CETP to 100 MLD and establishment of own research centre for cleaner production. GIDC and Vapi Industries Association (VIA) has been pivotal in all the development activities. As a part of pollution control measure by the cluster units, an end-of-the-pipeline TSDF unit for hazardous solid waste management has been established within the estate area. The estate is making a gradual shift towards pollution abatement by adopting, developing and promoting cleaner production mechanisms.

These are the steps taken for pollution control and waste management:

- Establishment of Vapi Waste & Effluent Management Company Limited (VWEMCL) for upgrading waste and effluent management in the estate.
- Technical support from a German organization 'The Deutsche Gesellschaft für Internationale Zusammenarbeit" (GIZ) and Gujarat Cleaner Production Centre (GCPC) is being provided to the local waste management body for enhanced functioning of CETP in the estate.
- Resource efficiency and recycling practices include plastic waste recycling by the cement industries, consumption of gypsum by the cement industries, secondary sludge for composting and more.
- Cleaner production, fuel switch, sludge treatment and efficient water use are achieved in the textile sector.

Vapi was named among "critically polluted" industrial areas for last decade; therefore, the Gujarat Pollution Control Board (GPCB) has been monitoring quality & quantity of effluent from each unit and CETP as a measure in pollution abatement. It imparts heavy penalty and even closing down of the unit for not maintaining the permissible limits. According to the data collected throughout the year from 20 stations, which included monitoring of ambient air and samples, an action plan was prepared to improve air quality. In addition, with all of these, monitoring also includes sampling of ground water from 10 representative tube wells within the estate and 10 wells on periphery of estate and sampling of surface water from River Daman Ganga, where treated effluent is disposed off.

6. Planning of new eco-industrial parks

This section discusses environmental management policies, institutions and various pipeline projects in action for establishment of new eco-industrial parks in the State.

6.1. Policy and management initiatives

The quantum of industrial activity in Gujarat has an important role to play in every aspect of policy formulation and resource management. It has been taken seriously by the State government, regulatory body, scientific community and civil society members including community at local, national and international level in recent times, because of the environmental degradation [19]. This is because of rapid industrialisation and myopic policy adopted by the State, for the sake of sustaining high economic growth and attracting maximum foreign direct investment. The rapid industrialisation has also contributed towards employment to a significant

section of the population and has facilitated in reducing poverty [20]. However, it has also resulted into grossly polluted environment, which needs immediate effort of policy maker and planner to take counteractive measures. The policy and management reforms for the development of new industrial parks are as follows:

- General development control regulation has been developed specially for SIR regions, along with the detailed master plan.
- Regional development authority has been established in each SIR to look after the physical planning and environmental issues through master plan and zoning regulation.
- Common facilities to be provided in each industrial estate with separate parking facility in up to 10 percent of the total area of GIDC estates.
- Environment Impact Assessment is made compulsory for upcoming industrial estate.
- Tree plantation has been made compulsory for upcoming GIDC industrial estates
- Recycling of waste for large industries is now mandatory
- Initiatives like road expansion, utility corridors improvement, provisions of drainage system have been taken for infrastructure improvement in old GIDC estates.
- Initiatives for environment management improvement by increasing green belt, providing solar systems in old GIDC has been undertaken.

The State government has been revising the industrial policy for the betterment of environment. During 1980s and 1990s, in order to accelerate the industrial growth, industries availed with sales tax benefits under various fiscal incentives. The better performing industrial units in the backward areas were given capital investment subsidy (which included small-scale industries, mostly), this has led to the growth of small-scale industrial units in the State. Additionally, there were several other positive changes in the industrial policy, where upgradation of technology and environmental prevention measures were promoted. The Industrial Policy formulated in 2015 gives more prominence to improvement of environmental infrastructure. It aims for holistic development, responding to the changing dimensions of national and global environment, which has provided a new direction to sustainable industrial development in the state, in recent times.

As reported in the Annual Report of 2016, GPCB identified 22 illegal hazardous waste dumping sites and had shifted 34,395.44 Metric Tonnes (MT)of hazardous waste lying on those sites to various TSDFs [21]. However, at present, due to rapid urbanization numbers of resident colonies and commercial complexes are coming up in and around those areas. GPCB has issued closure directives under section 5 of Environmental Planning Act, 1986 (EPA, 1986) for the closure of the unit and sealed the premises. There have been 96 notices and 157 closure directions issued between 2008 and 2016 to defaulter industrial units under EPA, 1986, by GPCB.

6.2. Initiatives with United Nations Industrial Development Organization (UNIDO)

The State government of Gujarat is taking forward the initiative by UNIDO. The mentoring agency on resource efficiency and cleaner production techniques namely, Gujarat Cleaner Production Centre (GCPC) is working on pilot projects to promote planning of eco-industrial parks, initiated by UNIDO with a goal to improve economic and environmental balance in industrial production. The industrial estates for the execution of the aforementioned project are Dahej and Nandesari in Gujarat. The primary benefit of the project will be reduction in environmental pollution levels and the project will also foster corresponding business opportunities in Gujarat and effectively improve environmental performance and resource efficiency through existing and new industrial parks [22]. The project will concentrate on creating a potential of industrial symbiosis between industries, where industries can resourcefully utilize the available resources, reduce the amount of wastes (air emissions, energy loss, waste water generation, and hazardous waste generation), identify and exchange the waste material and the by-products with other firms in vicinity, leading to development of an Eco–Industrial Park; and by doing so, it would also reduce the effect on the environment, occurring due to the existing method of transportation and logistics.

7. Capacity development

Sustainable industrial development requires capacity development of the people involved in it, because the actual application is a subject to the manpower involved; representatives from industries, government officials, managers of industrial parks/estates and companies as well as employees. The knowledge, awareness and training about the operations and practices leading to resource efficiency and cleaner production affirms the whole idea of such development and assures the benefits in future. For the purpose of capacity development, not only educational workshops, programmes and certificate courses but innovative approaches like web-based applications and tools have demonstrated successful results [23]. Capacity development also involves necessary training and providing supportive information material such as guidelines, tool kits, etc. to facilitate firms in identifying the opportunities of resource efficiency and take specific measures for cleaner production. It intends to build the capacity of the firm or group of firms involved in addressing the challenges in economy and environment from their own level or in managerial effort.

With technical support from relevant foreign experts and organisations, Gujarat Cleaner Production Centre (GCPC) is taking actions towards capacity development in the State. The major initiatives involve certificate courses in the operation and maintenance of effluent and sewage treatment plants and cleaner production assessment, which is also a part of the national programme namely Green Skill Development Programme (GSDP). GCPC maintains a Knowledge Management System (KMS), which has an e-library and web-based communication services of training documents, toolkits, manuals, guidelines, cases studies, research papers, indicators and benchmarks, etc.

8. SWOT analysis

SWOT analysis is an instrumental tool for research and analysis of holistic aspects surrounding any situation. It can be performed in order to reach a systematic understanding of a strategic management situation [24].

There are multiple dimensions of SWOT analysis. According to Daft and Marcic, ‘Strengths’ are internal positive characteristics that the organisation can exploit to achieve its goals. ‘Weaknesses’ are outlined as internal characteristics that may inhibit the organisation from achieving its goals. ‘Threats’ refer to the characteristics of the external environment that may prevent the organisation from achieving its strategic goals, whereas ‘opportunities’ are described as the characteristics of the external environment that have the potential to help the organisation to achieve or exceed its strategic goals.[25]

Table 2: SWOT Analysis

Strengths	Weaknesses	Opportunities	Threats
1) Available infrastructure: Gujarat is a frontrunner in industrialisation and has already initiated research in	1) Insufficient financial resources: India is a developing country and the funding available for research and development in this area is	1) Model of development: The sustainable industrial practices implemented in Gujarat could become a	1) Rapid Industrialisation: Gujarat has been a leading State in industrialisation for the past five dec-

resource efficiency & cleaner production. The industrial infrastructure of the State is one of the best in the country. 2) Manpower: India is the second most populous country in the world with a mammoth working population of youth. Gujarat being one of the most industrialised states in the country attracts huge number of workers. 3) Economic growth: India is attracting a lot of foreign direct investments and domestic industrialisation is booming, especially due to National Manufacturing Policy, investment from BRICS countries, etc. Under these circumstances, economic momentum for funding industrial ecology research and promoting sustainable industrial development in the country is on the rise. 4) Knowledge & awareness: The knowledge & awareness about sustainable development from global cases inspires to adapt similar practices for the people involved. The interests of corporates, citizens and the government are rising in this direction. 5) Research: Dedicated centres for research in resource efficiency and cleaner production like GCPC in Gujarat are an ideal stage for the setting up Industrial Ecology research and education centres to cater eco-Industrial planning and development. 6) Role of government: At the national level, India has several policies under implementation for promoting sustainable development and achieving SDGs by the UN. Gujarat has been a frontrunner in this area. It has been reflected in the State Industrial Policy, initiatives under Green Skill Development Programme, etc.	meagre. 2) Lack of data for development of industrial ecology-based models: For sustainable industrial development, it is a prerequisite to understand the flows of resources and their interaction with socio-economic groups in any area, which is being developed, especially in the unorganized/informal sector. The benchmarks and indicators more suitable for not only Gujarat but the country should be identified. An info-base supportive of this development, especially that of Life Cycle Inventories (LCIs) for Life Cycle Assessments (LCAs) are lacking. 3) Obscurity in the role of ministries/government bodies: Good governance has a lot of role to play in resource management. It is affected due to unclear roles of various government bodies. In a country like India, the central and state governments have a range of ministerial portfolios and organisations but there is an overlap in the roles and responsibilities of these bodies/institutions. Good resource management is a subject to integrated and collaborative effort of government organisations. 4) Overdependence on conventional technology: The available industrial infrastructure has marginal inclusion of green technology for cleaner production. There is a lack of innovation in applied technology. 5) Insufficient implementation: It is not just the case of Gujarat but at the national level, the policies supporting sustainable development fail to achieve the full results due to lack of enforcement. 6) Lack of educational programmes: Although, there are a number of initiatives in capacity development of people, but there is a need of mainstream degree programmes in Industrial Ecology for nurturing the research and development.	'model of development' to be followed by other States. 2) International support: Industrial Ecology is relatively a younger science, with roots in developed and highly industrialised countries. The concept of eco-industrial planning should be widely promoted with collaborative support from these nations. This provides an opportunity of greater avenues in international collaboration. 3) Indigenous approach to Sustainable Development: There is a number of unacknowledged practices in manufacturing and production already contributing to better resource management. It can be identified and presented at the global platform. 4) International relations: The adaptation of sustainable industrial infrastructure would not only cater to environment and economy, but work as binding factor between developing nations. The alliance between developing countries could have common goals of sustainable development leading to better relations. 5) Social change: The concept of Industrial Ecology caters economy, ecology and social aspects. The better practices in production and manufacturing would improve the community benefits. 6) Aesthetics: It is a promising approach to improve the aesthetics of the cities. This also builds a positive image of Gujarat. 7) Energy and material use: It would reduce the energy demands for production process and amount of wastes produced. 8) Economic performance: It would improve the overall economic performance of industries through commercialisation of usable waste material, by-products and surplus energy. 9) Human Health: It would be transformative for the environment and result into better health conditions in the region.	ades. The strong emphasis on economy has already damaged the ecological health of the State. Rapid industrialisation leads to a lot of economic benefits but the environment is neglected. 2) Ignorance towards industrial ecology: The absence of a focused approach from the central government in the policy making, governing spheres and the public domain. 3) Myopic approach in pollution abatement: Majority of approaches for industrial pollution abatement are remedial for few years due to lack of full enforcement of sustainability policies and techniques. 4) Obsolete policies: It has been seen that sometimes policies inhibit effective eco-industrial implementation. For example, "Zero discharge policy" in India prohibits water cascading among a group of industries. Because of such legal boundaries, formation of waste exchange networks and industrial symbiosis is hindered. 5) Insufficient data for better resource management: The lack of sufficient data from micro to macro level i.e., industrial unit, group of industries, region/state and national level is continuing to hinder sustainable industrial development. Due to unavailability or obsolescence of data, the formulated strategies fail to produce the desired results. 6) Corrupt Practices: Corruption in public and private organisations lead to inefficient resource management and restricts scope of development.

9. Discussion

The research paper is a part of ongoing doctoral research of the primary author. The paper intends to discuss and understand the direction of Gujarat's approach in sustainable industrial infrastructure. The cases discussed in the paper are not the only example of sustainable industrial practices from India. There has been successful applications in Karnataka [26] and Andhra Pradesh [27] as well. But Gujarat has been a frontrunner in industrial development in the country and therefore, one of the few states to implement the concept of Industrial Ecology to achieve sustainable industrial development. It is a promising strategy for sustaining the econom-

ic thrust with providing parallel protection to the environment and ecology.

The efforts in planning of new eco-Industrial parks require more attention. Because, not only it helps to reduce pollution, better resource management and environmental impacts; but it also leads to systematic planning and development by placing the industries at appropriate location, with better infrastructure promoting industrial synergy and social acceptance. In addition to the environmental and social benefits, a new eco-industrial park would attract more and more global collaborators and investors, as IE is more in practice in developed countries.

The discussion in the paper leads to a four-dimensional understanding in the form of SWOT analysis, inferred from the implemented and pipelined strategies in Gujarat. The SWOT analysis focuses on the strengths from the consistent economic growth, weaknesses from the lacking efforts in enforcement, opportunities from the ambition of sustainable development goals, threats from the obsolete policies and rapid industrialisation.

10. Conclusion

The industrial sector is a pivotal element of Gujarat's remarkable economic growth, and with support from the Central government and foreign direct investment, it will continue to expand. The current environmental challenges have started to affect each and every corner of the world. The Indian government and the corporate sector are paying much attention to sustainable development in recent times. The initial results of various action plans for balancing economic development, environmental protection and social progress are already visible. But the benefits of such development should not be restricted to a limited region.

The implemented actions in Naroda, Sachin and Vapi were not entirely aimed for environmental benefits in the beginning but more for economic performance and business motives. Over the years, these practices have grown from micro to macro level applications and resulting into multifaceted benefits. It has also improved the image of these cities in the state and country.

Gujarat is proving to be a role model for other states to follow in development, but the full-scale planning and enforcement is still in dearth. Therefore, more ambitious national policies on sustainable industrial development should be formulated and robust enforcement must be assured with better implementation framework.

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