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Urban Development of an Eco-Industrial City, Om Yai Municipality Nakhon Pathom Province in Thailand

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ABSTRACT

The objective of this research is to analyse the problems and potential of the area, as well as the changes that will occur from the expansion of industries and the influx of immigrant populations in the large urban area of Om Yai. It also aims to propose ideas and strategies for the development of an environmentally-friendly industrial city that can accommodate green industries alongside the community. This research is of both qualitative and quantitative nature, using mixed research methods. Qualitative research is based on document analysis while quantitative research is based on surveys. The data was collected through in-depth questionnaires. The results of the study show that the municipality of Om Yai has the potential to develop into an environmentally-friendly industrial city due to the high concentration of industries that coexist with trade and agricultural communities. This potential can be used to promote and develop environmentally-friendly industries, coupled with the development of quality residential areas to support future expansion and changes. Therefore, the research proposes a development plan with five dimensions: physical/infrastructure dimension, economic dimension, social dimension, environmental dimension, and management dimension.

Keywords: Development, Eco-Industrial Town Development

Introduction

At present, both globally and in Thailand, water and air pollution—including PM2.5—have become serious problems, partly attributable to the industrial sector. As a result, many communities in Thailand have attempted to oppose industrial activities in their local areas, leading to conflicts between communities and industries. Addressing these issues requires cooperation among the government, the industrial sector, and local communities in order to achieve improved urban quality and a better quality of life for urban residents. However, industrial development in specific areas has led to labor migration in the form of a floating

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population. In 2019, Om Yai Municipality recorded a floating population of 5,990 people, accounting for 25.3% of the total population in the area, driven by industrial labor demand. The large floating population has increased the demand for resources and basic public utilities beyond the area's development capacity, resulting in the deterioration of infrastructure and inadequate provision of basic services. All relevant stakeholders have continuously sought to address these issues through various measures, including pollution reduction and mitigation, improvement of community quality of life, and public health surveillance. The concept of the eco-industrial town has been applied as a tool to address problems arising from industrial development in many countries, such as Japan, the United States, China, and member states of the European Union. Each country adopts different approaches to eco-industrial town development, and definitions and implementation strategies may also vary. Generally, these approaches emphasize waste reduction based on the 3Rs principle, the use of technologies to generate bioenergy from waste and by-products (waste-to-energy), and the application of the eco-efficiency concept (Department of Industrial Works, 2010). Therefore, the development of areas toward eco-industrial towns represents an important tool that has begun to be studied and piloted in several locations in Thailand.

This initiative is undertaken with the expectation of sustainably addressing problems arising from industrial development while fostering national economic growth by applying the concept of the 'Eco-Industrial Town' to industrial estate development. The approach is grounded in the principle of industrial symbiosis and the sustainability of natural ecosystems, adapted to suit the context of industrial estate development in Thailand. The organizational vision is defined as 'to be a leading organization in creating balanced and sustainable eco-industrial towns.' Accordingly, a policy on eco-industrial town development has been announced, together with clearly defined goals to develop and upgrade industrial estates toward eco-industrial towns. The development plan targets the transformation of three industrial estates per year, emphasizing urban design that enables industries to coexist with local communities without causing adverse impacts.

This model promotes sustainable industrial development based on a balanced integration of economic, environmental, and social dimensions, legal compliance, and technological feasibility. It focuses on reducing resource and energy consumption, optimizing the efficient use of resources and energy, and minimizing waste emissions, while enhancing production efficiency and gaining community acceptance. Ultimately, the approach seeks to improve the quality of life of local communities and the surrounding environment through collaborative and interdependent partnerships among industrial operators, industrial estate developers, local government agencies, and communities, working collectively toward the common good.

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Om Yai Municipality has been designated as a target area for eco-industrial town development and serves as a pilot area for Nakhon Pathom Province in central Thailand. The area's major industries are classified into three groups: (1) textile and garment manufacturing, (2) plastics manufacturing, and (3) food and beverage processing. The area faces key challenges arising from industrial development and related activities in a densely concentrated industrial zone. These challenges include aging factories with outdated machinery and technologies, a high concentration of communities with increasing safety risks, and traffic congestion caused by the expansion of industrial facilities and residential estates extending outward from Bangkok, the capital city of Thailand. Additional problems include industrial pollution, particularly the discharge of industrial and domestic wastewater into rivers, leading to the degradation of tributary canals, as well as insufficient infrastructure to meet the needs of both communities and industries. In response to these issues, the development of an eco-industrial town in Om Yai Municipality, Nakhon Pathom Province, is proposed as an approach to improve the management and development of the Om Yai area, addressing social inequality, inadequate management, and the need for more environmentally friendly industries. This approach aligns with the provincial development plan, which emphasizes promoting and transitioning industries toward eco-industrial and environmentally friendly practices while reducing social inequality. Ultimately, this initiative is expected to lead to an improved quality of life and to position Om Yai Municipality as a model eco-industrial town for Thailand's central region in the future.

Literature Review

The Concept of a Livable City refers to urban and rural residential communities that offer a good environment and quality of life, characterized by a caring and strong social fabric, safety and convenience in life and property, a stable and sound economic system, and distinctive cultural and spiritual identities of the city and community (Thai Community Architects Association, 2004). A livable city comprises 11 characteristics, which can be summarized into five main dimensions (Rujiront, 2004):

1. a city with sound and sustainable physical characteristics, environment, and ecosystems;
2. a city that meets basic needs and possesses a diverse economic system;
3. a city with a supportive social system that encourages public participation, collective thinking, coordination, and collaboration;
4. a city where people are healthy and have access to health service systems; and
5. a city with cultural heritage, good ways of life, and a distinctive community identity.

The Concept of Universal Design refers to the design of environments, buildings, and facilities so that all people in society can use them fully and equitably, without the need for special or

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specific adaptations for particular groups. This applies regardless of gender, mobility (walking or wheelchair use), visual ability, age, or literacy. Universal Design emphasizes inclusive and efficient use for everyone. Given the diversity of users, especially tourists, spaces must be designed to accommodate all people in society, ensuring equality, flexibility, convenience, safety, simplicity, ease of understanding, minimal physical effort, and appropriate size and spatial arrangement.

An Eco-Industrial Town refers to a city whose growth is driven primarily by industrial activities as the main economic engine, while maintaining a balance with social development and residents' well-being, and minimizing impacts on quality of life and the environment. This represents sustainable development across five dimensions: physical, economic, social, environmental, and governance and management. Such development requires strong collaborative efforts among local stakeholders and can be implemented at multiple levels, including:

1. the individual level, such as households and factories (Eco Family / Eco Factory);

2. the industrial cluster or community level, such as industrial estates, villages, or subdistricts (Eco-Industrial Zone / Estate); and

3. the city level, including cities or networks of cities or provinces (Eco Town / Eco City).

Fig.2 Eco-industrial town development framework"

Source: http://ecocenter.diw.go.th/images/Download_Document/61-64.pdf

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The eco-industrial town development framework is divided into five dimensions and 20 aspects, as follows (Criteria and Indicators for Eco-Industrial Towns, 2019). The concept of eco-industrial town development comprises three main components: (1) the development of eco-industrial town areas; (2) the improvement of the quality of life of existing communities located in and around industrial zones; and (3) the development of new towns or eco-cities, as illustrated in Figure 2.

Approaches to Eco-Industrial Town Development in Foreign Countries

The development of Eco-Industrial Towns in Japan originated from the **Zero-Emission Concept** proposed by the United Nations University in 1994. This concept significantly influenced Japan's industrial development policies by promoting integration between industry, the local environment, and communities, leading to environmental well-being. At the same time, communities and local authorities affected by industrial development began to recognize these issues and actively participate in addressing them, emphasizing sustainable and environmentally friendly social development. This approach involves the use of clean technologies to control waste emissions, energy conservation, and recycling to reduce resource consumption and waste generation.

As a result, Japan introduced the **Eco-Town** concept, which is based on five key principles:

1. sustainable development and a recycling-based society;
2. environmentally friendly business (eco-business) utilizing environmentally sound technologies;
3. energy conservation;
4. zero-emission practices; and
5. the 3R principles: Reduce, Reuse, and Recycle.

A prominent example of an eco-industrial town in Japan is **Kitakyushu Eco-Town**. The environmental problems in Kitakyushu originally stemmed from three main factors: (1) excessive production aimed at economic growth, (2) insufficient pollution control, and (3) inadequate preventive systems. Kitakyushu successfully transformed its image from a "Sea of Death" into an international leader in environmental management, becoming a learning and study center for pollution management for various international organizations.

Key strategies implemented in Kitakyushu include:

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1. the establishment of **Zero-Carbon Zones**, designating areas such as green zones, residential construction restriction zones, household carbon monitoring zones, low-carbon residential areas, recreational zones, and nature-oriented living spaces;

2. the establishment of the **Kitakyushu Next Generation Energy Park**, aimed at enhancing public awareness of energy through the use of renewable energy sources such as wind and solar power, and promoting industries that adopt new energy technologies. Facilities include solar power plants, waste-incineration thermal power generation, and wind power generation;

3. the development of strategies to support environmentally friendly industries, education, and research at the **Kitakyushu Science and Research Park**, including technological and applied research and business development in the **Hibiki Recycling Area**; and

4. the implementation of the **Kitakyushu Eco-Town Project**, which focuses on practical environmental research and development, transforming areas into environmental industrial zones under the concept of a "resource recycling society." This project emphasizes networking among local residents, entrepreneurs, and government agencies, utilizing local resources and vacant land for eco-town development in the Hibikinada area.

Eco-Industrial Town Development in the United Kingdom

In the United Kingdom, the concept of Eco-Industrial Town development can be interpreted in two main contexts:

1. Eco-Towns as Sustainable Cities

Eco-towns are understood as sustainable cities that operate within limited and renewable resource and energy use. Residents adopt sustainable lifestyles while maintaining a high quality of life. This approach includes the development of energy-efficient buildings, the use of renewable energy, resource-conserving infrastructure and utilities, and the promotion of local employment and services to reduce travel needs.

2. Eco-Industrial Parks / Eco-Parks

Eco-industrial parks focus on resource recovery and recycling (resource/recycling eco-parks), a concept that emerged in the late 20th century. This approach is based on the principles of industrial ecology, aiming to minimize environmental impacts while maintaining business operations and competitiveness. Implementation relies on effective environmental and resource management, including energy, water, raw materials, and cooperation among industrial enterprises within industrial zones.

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The Concept of Eco-Towns

According to Witoon Simachokdee (2011), an eco-town is a principle for area development—particularly residential communities or cities—that emphasizes balance among economic, social, and environmental dimensions. Japan is widely regarded as a global model for eco-town development (Rapeepat Phasbutr, 2010).

Under Japan's approach, an **Eco-Town** refers to a community or city that systematically utilizes circular resources to minimize waste generation, aiming for zero waste. Industrial production serves as the primary driving mechanism, supported by clean technologies based on the 3R principles (Reduce, Reuse, and Recycle), and strong collaboration among the tripartite stakeholders: government, private sector, and the public. In the development of eco-cities, the government generally plays a key role in driving urban planning and development through collaboration with the private sector and local communities. This collaborative approach involves joint brainstorming and the formulation of a shared vision, supported by clear urban planning, active engagement of industrial businesses and target communities, and the systematic planning of public utilities and infrastructure. (Witoon Simachokdee, 2011)

Research Methodology

This research employed a mixed-methods approach, integrating both qualitative and quantitative methods to comprehensively examine eco-industrial town development in Om Yai Municipality, Nakhon Pathom Province. The research methodology consisted of the following components.

1. Conceptual and Documentary Review

The study began with a comprehensive review of relevant concepts, theories, research studies, and official documents obtained from government agencies and private organizations. This review served as the foundation for developing the conceptual framework of the study and for identifying key factors related to eco-industrial town development.

2. Data Collection

Primary data were collected using multiple research instruments to ensure data triangulation and reliability. These instruments included questionnaires, in-depth interviews, surveys, and direct observation. The data collection process focused on gathering information from relevant stakeholders involved in or affected by industrial development within the study area.

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3. Data Analysis

The analysis was conducted based on five key dimensions influencing the roles and implementation of stakeholders in eco-industrial town development, namely:

3.1 physical dimension,

3.2 environmental dimension,

3.3 social dimension,

3.4 economic dimension, and

3.5 governance and management dimension.

In addition, SWOT analysis was applied to assess both internal and external environmental conditions of industrial development in Om Yai Municipality. This analytical approach was used to identify strengths, weaknesses, opportunities, and threats, as well as to analyze potential trends and problems that may arise from industrial development in the area.

4. Synthesis and Policy Development

The findings from the conceptual review and empirical analysis were synthesized to formulate concepts and policy approaches for eco-industrial town development. The synthesis aimed to propose guidelines that support the achievement of an eco-industrial town model, emphasizing coexistence between local communities and industrial activities.

5. Scope of the Study

The scope of the research was defined as follows:

5.1.Content Scope

The study examined the types of industries and physical characteristics of the Om Yai area to identify its role as an industrial urban area. This included an analysis of transportation connectivity and the radius of goods and raw material transportation to and from industrial factories. The findings were used to identify trends in industrial change and anticipated expansion, which informed the formulation of recommendations for eco-industrial town development.

5.2 Spatial Scope

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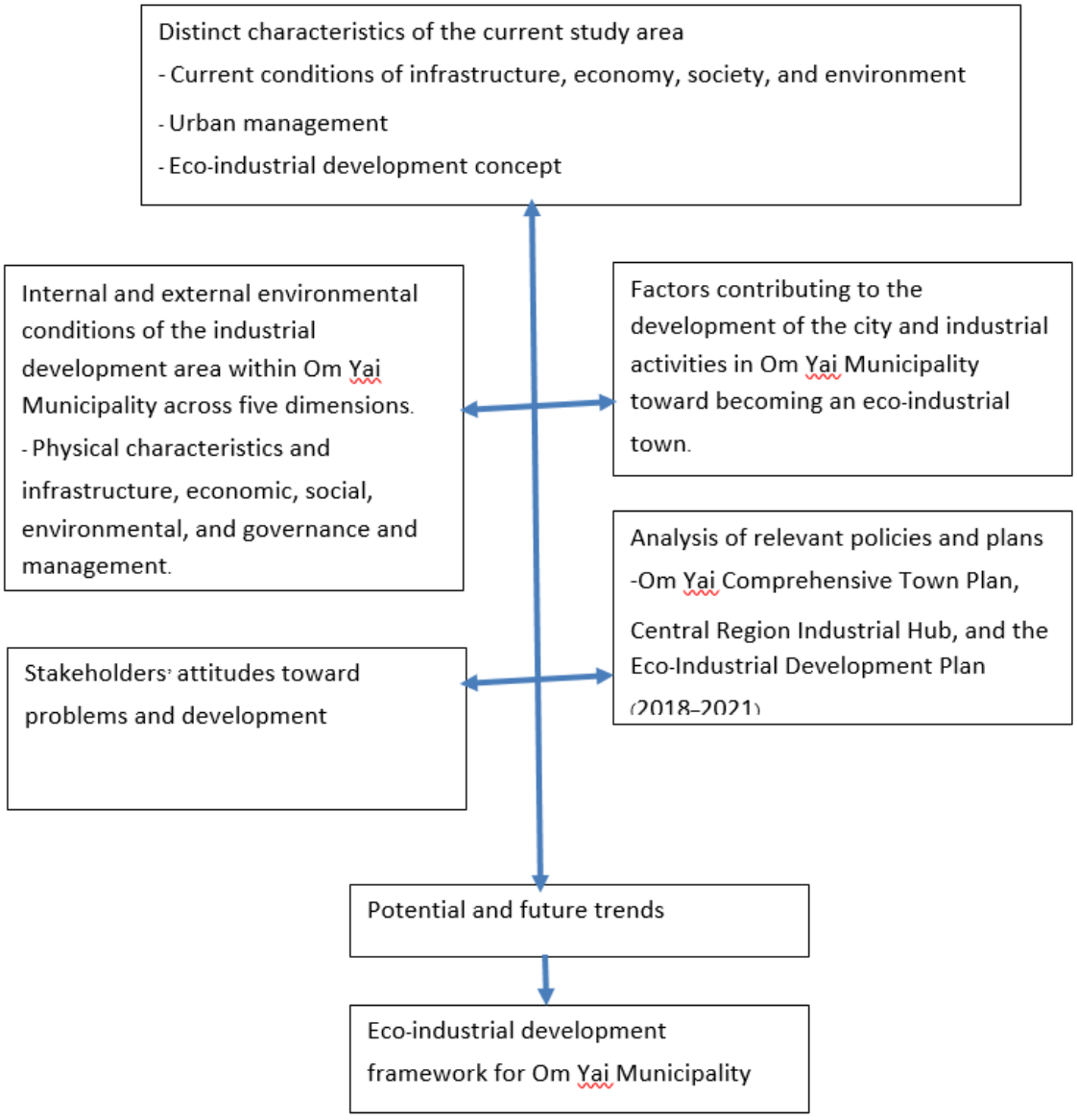
The spatial scope of the study covered Om Yai Municipality, Sam Phran District, Nakhon Pathom Province, with a total study area of approximately 12 square kilometers. The delineation of the study area was primarily based on the continuity of freight transportation activities and major transportation routes within and surrounding the municipality.

Fig. 1 Research conceptual framework



The scope of the research project on eco-industrial development in Om Yai Municipality, Nakhon Pathom Province, includes:

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1. To study the types of industries and the physical characteristics of the Om Yai area in order to identify its role as an industrial urban area, including the radius of connectivity for the transportation of goods and raw materials in and out of industrial factories. This aims to understand trends in change and anticipated industrial expansion, which will be used to formulate guidelines and recommendations for eco-industrial town development.

2. Spatial scope: Om Yai Municipality, Sam Phran District, Nakhon Pathom Province, with a study area of 12 square kilometers. The delineation of the study area is based primarily on the continuity of freight transportation activities and transportation routes.

Research results

This study, entitled ***Eco-Industrial Town Development: A Case Study of Om Yai Municipality***, involved the collection and examination of basic data through documentary research related to the characteristics of the study area, its potential, problem analysis, and anticipated changes resulting from industrial expansion and the growth of the floating population in the Om Yai area. The objective was to propose concepts and development approaches for an eco-industrial town that can accommodate future green industrial expansion while enabling coexistence with local communities. The study also included a review of relevant literature, interviews with community representatives, and analysis of questionnaire data collected from relevant stakeholders, such as officials of Om Yai Municipality, local administrators, and local residents involved in eco-industrial town development in the area. The analysis of the study results was organized according to the study area, focusing on an assessment of the internal and external environmental conditions related to eco-industrial town development in Om Yai Subdistrict. Data were collected from stakeholders involved in driving eco-industrial town development, including government agencies, local administrative organizations, and residents from Villages No. 1, 2, 4, and 8, with a total population of 10,058 people. The findings are summarized as follows.

No.	Question	Community perceptions	*Village No.*
1	Understanding of the Eco-Industrial Town concept	Eco-industry is an approach in which industrial activities coexist harmoniously with the environment, while local communities live in balance with both the environment and industrial development	2,4,8
2	*Do you think Om Yai Municipality will experience changes resulting from*	A great deal, because there is an increase in industrial factories, employees, and employee	2,4,8

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No.	Question	Community perceptions	*Village No.*
	industrial expansion?	housing.	
3	What are your opinions on the components of an eco-industrial town in each dimension, and how should they be?	In development, the design must be environmentally friendly	2,4,8
4	How does your agency carry out activities related to eco-industrial cities?	*Public relations through loudspeaker announcements and leaflets to provide knowledge about eco-industrial development.*	2,4,8
5	What role should an industrial city play in developing toward becoming an eco-industrial city?	Integrate efforts collaboratively to create well-being while minimizing environmental impacts.	2,4,8
6	Relying on the interconnection between the city and industry, what do you think this connection is?	It is development that moves in the same direction.	1,2,4,8
7	Regarding the governance and management of an eco-industrial town, which sectors should be responsible, and what roles should they play?	*All sectors, including the public sector and the community, have roles to play in moving in the same direction.*	2,4,8
8	Are policies for the development of an eco-industrial town important to changes in the city and industry, and what role should the government play?	*They are important, and the government should formulate policies that encourage all sectors to work together in development and then disseminate and implement development plans in accordance with those policies.*	2,4,8
9	Does the area have the potential to be developed into an Eco-Industrial Town?	Yes, and it is likely to be ready for development.	2,4,8
10	Can becoming an eco-industrial town be implemented at the local level, and is the implementation of local policies feasible?	Yes, and it is likely to be ready for implementation.	1,2,4,8
11	What major problems or obstacles might arise in the	It is that people in the area still lack access to understanding and	2,4,8

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No.	Question	Community perceptions	*Village No.*
	development of the city and industry in the area?	to funding for development.	
12	The development of the city and industry in the area still lacks what factors to drive development?	People who understand the plans, the level of understanding among people in the area, and funding for development.	1,2,4,8
13	Do you have any suggestions on how to address the problems and obstacles in developing the city and industry toward becoming an eco-industrial town?	Support knowledgeable and well-informed personnel, allocate development budgets, and implement development plans in a transparent and straightforward manner, with cooperation between the community and the municipality to jointly drive development.	2,4,8
14	Recommendations	-	-

Table. 1: Summary of opinions from questionnaires of stakeholders involved in driving the development of an Eco-Industrial Town, including government agencies, local administrative organizations, and communities in Villages 1, 2, 4, and 8 of the study area.

SWOT Analysis

An analysis of strengths, weaknesses, opportunities, and threats using SWOT analysis is as follows:

1) Strengths

Om Yai Subdistrict has an accessible transportation network, with Phetkasem Road serving as a major arterial route providing urban-level access. The area functions as a center for commerce and industry. Industrial land development can be realized to its full potential due to the availability of infrastructure and public utilities, and land-use planning regulations are conducive to development. The area is also a significant source of employment.

2) Weaknesses

In terms of transportation, local roads and alleys are narrow and unsuitable for efficient use. Community access points from Phetkasem Road do not adequately meet users' needs, and there is a lack of parking space. Regarding land use, some residential buildings are abandoned and underutilized, while industrial buildings lack adequate pollution control. There is a shortage of

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recreational spaces. Commercial activities in traditional community areas lack diversity, and social inequality persists.

3) Opportunities

Historically, Om Yai was a high-quality agricultural area located near Bangkok. Consequently, parts of the area and its surroundings still retain agricultural activities, making it suitable for promotion as an eco-industrial area. In addition, there are government policies supporting Om Yai as a pilot area for eco-industrial development.

4) Threats

With respect to transportation, traffic congestion during peak hours poses a barrier to area accessibility. In terms of land use, land ownership concentration has occurred, leading to low land prices that favor external investors establishing industrial factories. However, the area lacks effective regulations for controlling industrial operations. Moreover, an influx of new labor has increased the floating population, which further complicates development efforts.

Based on the analysis using both tools, the strategies can be summarized into four aspects as follows:

Proactive strategy for the development of Om Yai Municipality involves integrating strengths and opportunities and applying them to promote industrial development toward eco-industrial, pollution-free industries, as well as developing residential areas to support future employment centers.

Defensive strategy involves combining strengths and threats and applying them by allowing external investors to establish pollution-free industrial factories in the area in order to stimulate the economy and create employment opportunities.

Corrective strategy involves combining weaknesses and opportunities and applying them by improving the quality of life of community residents through the development of Smart Communities, as well as enhancing recreational and public spaces as places for community leisure and relaxation.

Preventive strategy involves combining weaknesses and threats and applying them by fostering a collaborative society in which all sectors work together for the public good, leading toward sustainable urban development.

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Design Concept for Eco-Industrial Urban Areas

The design concept for eco-industrial urban development focuses on improving quality of life, promoting industrial businesses, and fostering an ecological culture. Based on the study and analysis of the area, it was found that the project area has high development potential and opportunities for growth derived from surrounding areas. However, the area still has certain weaknesses that require development and improvement due to various spatial issues.

Based on the development concept, detailed design programs can be formulated to guide development and improvement, with an emphasis on transforming the Om Yai area into a space where communities and industries coexist and mutually support one another, ultimately leading the area toward becoming an eco-industrial city.

1. Land Use

The project area still lacks appropriate land-use development aligned with its potential. Planning should consider future residents who will come to work or live in the area, as well as existing residents. Development must be integrated and focus on investment efficiency by allocating adequate space for industrial, commercial, public utilities, public services, and residential uses to accommodate future expansion.

2. Transportation and Mobility

Pedestrian and bicycle mobility should be promoted, as these are currently lacking in the project area. Improvements are also needed in the connectivity of secondary roads and alleys that currently lack efficiency. Transportation routes should be designed to align with the Third Industrial Ring Road project, ensuring convenient access to the project area and surrounding zones. This approach supports policies aimed at reducing private vehicle use and promoting a low-carbon city.

3. Environment

As the project area is predominantly industrial, environmental considerations are critical to minimizing impacts on surrounding communities. Industrial development should incorporate modern technologies, clean energy use, and pollution-free processes to guide the area toward becoming an eco-industrial city. Anticipated population growth in Om Yai and increasing demands for a higher quality of life necessitate urban planning and design that prioritize environmental conditions. Therefore, the design of public open spaces and urban landscapes should be integrated throughout the area, aligned with activity zones, and optimized to ensure the most efficient and beneficial use of space.

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