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# Assessment of Industrial Cluster Infrastructure and Recommendations for Improvement in Hanoi, Vietnam

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**Abstract**

The quality of industrial infrastructure not only reflects the efficiency of investments but also significantly affects productivity and business results during the use of these facilities. In 2018, research by Slaper et al. showed a positive correlation between GDP growth and the trade growth of industrial clusters. This study examines the factors affecting the quality of industrial infrastructure, focusing on proposing strategies for improving the quality of projects, especially during the stages of surveying, design, and bidding. It emphasizes the need to expedite the development of industrial park infrastructure and emphasizes the crucial role of human resources in driving industrial growth and infrastructure development. The study identifies the key characteristics of the industrial workforce and provides solutions to enhance human resource training to support the progress of industrial development and infrastructure projects.

**Keywords:** Vietnam, Industrial cluster, Infrastructure construction, Recommendations, Environment, Hanoi.

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## Introduction

There is currently a divergence in the understanding of industrial clusters between Vietnamese and international scholars and organizations. The term “Industrial districts” or “Geographical clusters” was first introduced by Alfred Marshall in the late 19th century, based on his research on the concentration of industrial production in Northern England. Marshall identified three primary advantages of industrial clusters: the widespread exchange of information, the specialization and division of labor across establishments, and the creation of a diverse skilled labor market. Over time, this concept evolved into 2 distinct approaches. French scholars, including Courlet, Pecqueur, and Colletis, referred to them as local production systems, while British and American scholars, including G. Becattini and Michael Porter, continued to use the terms “Industrial Cluster” or “Industrial districts.”

**Table 1** presents an overview of industrial cluster development in Vietnam up to 2010, showing that the average occupancy rate in the East and Northwest regions, concerning the completed construction area, stands at 47%.

**Table 1.** Current status of industrial cluster development in Vietnam to 2010

| No | Local | Industrial cluster as planned | | Industrial cluster building infrastructure and operating | | | | Average occupancy rate compared to the finished construction area |
|---|---|---|---|---|---|---|---|---|
| | | Quantity | Area as planned | Quantity | Area as planned | Completed area | Land area for rent | |
| | | Cluster | Ha | Cluster | Ha | Ha | Ha | % |
| 1 | Whole country | 1785 | 81.872 | 873 | 38.680 | 22093 | 9646 | 44 |
| 2 | East, Northwest region | 201 | 7820 | 104 | 4321 | 2141 | 1005 | 47 |
| 3 | Red river delta | 719 | 29059 | 396 | 11723 | 7807 | 3222 | 41 |
| 4 | Central coast | 349 | 8033 | 151 | 3880 | 2372 | 1024 | 43 |
| 5 | Tây nguyên-highland | 60 | 3574 | 30 | 1814 | 517 | 205 | 40 |
| 6 | South East | 245 | 12089 | 76 | 4173 | 1071 | 342 | 32 |
| 7 | South West | 211 | 21298 | 116 | 12769 | 8185 | 3848 | 47 |
| 8 | Hà Nội | 225 | 3681 | 105 | 2678 | 1932 | 643 | 33 |

Source: Department of Local Industry, Ministry of Industry and Trade

This study focuses on the infrastructure development of industrial clusters in Hanoi, Vietnam.

### *Research Questions*

1. What is the current state of industrial cluster infrastructure in Hanoi?
2. What improvements can be made to the industrial cluster infrastructure in Hanoi, Vietnam?

### *Literature Review*

### *Industrial Cluster Infrastructure*

In the Vietnamese language, “infrastructure” refers to systems that support the construction of roads, energy supply, water and waste management, and other utilities necessary for development within a particular area. More broadly, infrastructure represents the essential components that ensure the continuity of production and societal activities. Unlike general construction, infrastructure focuses specifically on creating functional spaces for economic operations.

In the broader economic context, infrastructure is part of the national economy’s material and technical systems, primarily responsible for providing the essential conditions needed for ongoing economic growth and continuity. It includes technical, physical, and architectural structures that are fundamental to supporting socio-economic operations.

Hank Tomlinson, President of the American Chamber of Commerce, identifies two types of infrastructure: hard infrastructure (such as energy, roads, and electricity) and soft infrastructure (which includes education and workforce development). He underscores the need for enhancing soft infrastructure, especially labor quality, to attract high-tech investments. Tomlinson further points out that high-tech investors are unlikely to invest in areas where the workforce lacks the necessary skills. Additionally, soft infrastructure also encompasses the government’s economic policies, which need to be continually refined to make business and production activities safer and more efficient [1].

A detailed review of past studies is presented in **Table 2**.

**Table 2.** Related previous studies

| Authors | Year | Content, results |
|---|---|---|
| Porter [2]; Hallencreutz & Lundequist [3] | 2003 | Regional economists argue that regions should recognize and cultivate their existing competitive advantages. |
| Narula [4] | 2004 | SMEs often suffer from limited resources and low capabilities to generate development in internal activities. Therefore, interfirm networks are crucial to SMEs’ innovation processes (https://journals.sagepub.com/doi/full/10.1177/21582440211031604). |
| Batterink *et al*. [5] | 2010 | Hub firms with the highest number of contacts within a cluster significantly contribute to facilitating social exchange across the network. |
| Huy [6] | 2015 | There remains a need to improve risk management and governance practices within corporations. |
| Slaper *et al*. [7] | 2018 | Cluster theory, although challenging to model econometrically, remains valuable for understanding regional industry dynamics. |
| Ye *et al*. [8] | 2021 | The study focuses on two primary approaches: STI (science, technology, and innovation) and DUI (doing, using, and interacting), which are crucial for knowledge learning. |
| Soloveva *et al*. [9] | 2021 | To unlock the socio-economic potential of regional development, it is necessary to focus on investment and innovation activities. |

(source: author synthesis)

Several studies have examined the practical application of Porter's concepts, focusing on the development practices of regional clusters, supported by empirical evidence [10-13].

## Materials and Methods

The research mainly draws on case studies, observations, and practical experiences of industrial clusters in Hanoi, Vietnam, integrating qualitative analysis, synthesis, and explanatory methods. The study further employs historical and dialectical materialism approaches, alongside data and statistics specific to Hanoi, Vietnam.

## Results and Discussion

### *Main Findings*

#### *Overview of Industrial Cluster Development in Hanoi*

As indicated in **Table 3**, completion ratios remain low in certain regions, including Son Dong, Binh Minh, and Dong Giai.

**Table 3.** List of industrial clusters under construction until 2010

| Industrial Cluster | Location | Size (ha) | Completed (ha) | Completion ratio | Note |
|---|---|---|---|---|---|
| Bích Hoà | Bích Hoà, Thanh Hoai Commune | 10,3 | 5,1 | 50% | The remaining area has not been cleared due to lack of investors. |
| Town Phúc Thọ | Town Phúc Thọ, Phúc Thọ | 40 | 24 | 60% | Phase II (16ha) is being implemented. |
| Ngọc Hồi | Commune Ngọc Hồi, Thanh Trì | 75 | 56 | 75% | Phase II (14ha) land clearance is ongoing. |
| Bình Phú - Phùng Xá | Bình Phú - Phùng Xá - Thạch Thất Commune | 103 | 40 | 39% | Land clearance and technical infrastructure construction continuing. |
| Bình Phú | Bình Phú, Huyện Thạch thất Commune | 21 | 15 | 71% | The remaining land faces challenges in clearance. |
| Quất Động | Quất Động, Thường Tín Commune | 68 | 25 | 37% | Phase II land clearing and infrastructure construction. |
| Cam Thượng** | Cam Thượng, Huyện Ba Vì Commune | 15 | 6 | 40% | The area is registered by investors but not cleared yet. |
| Sơn Đông** | Sơn Đông, Sơn Tây Ward | 72 | 12 | 17% | |
| Bình Minh | Bình Minh, Huyện Thanh Oai Commune | 41 | 3,1 | 8% | Ongoing compensation and land clearance. |
| Đồng Giai | Vật Lại, Huyện Ba Vì Commune | 20 | 2,1 | 11% | Area clearance and infrastructure development are ongoing. |
| Đại Nghĩa** | Đại Nghĩa, Huyện Mỹ Đức Commune | 30 | 7 | 23% | |
| Nguyên Khê | Nguyên Khê, Huyện Đông Anh Commune | 96 | 18,5 | 19% | Phase II infrastructure construction is underway. |
| Đồng Mai | Đồng Mai, Hà Đông Commune | 225 | 200 | 89% | |
| Total | | 816.3 | 413.8 | 51% | |

*: The industrial cluster is deployed according to the specific mechanism of Ha Tay before (the investor builds the infrastructure by himself according to the approved detailed plan).

Source: Hanoi Department of Planning and Investment

- 5 CCNs **(Table 4)** and 7 FCNs are carrying out site clearance and preparing to build technical infrastructure.

**Table 4.** List of industrial clusters that are clearing land or building technical infrastructure

| No | Cluster name | Location | Size (ha) |
|---|---|---|---|
| 1 | Kim Chung | Commune Kim Chung, Hoài Đức | 49 |
| 2 | Lại Yên | Commune Lại Yên, Hoài Đức | 35 |
| 3 | Hà Hồi - Quất Động | Comune Hà Hồi - Quất Động, Thường Tín | 160 |
| 4 | Ninh Hiệp | Commune Ninh Hiệp, Gia Lâm | 64 |

| | | | |
|---|---|---|---|
| 5 | Phú Xuyên | Commune Phú Xuyên | 240 |

Source: Hanoi Department of Planning and Investment

The remaining industrial clusters in the city currently lack policies for deployment or investment preparation. Most of these clusters have only reached the stage of detailed planning approval, project selection, and investor designation. Additionally, some are undergoing planning revisions or have had their implementation paused, pending the results of these reviews. As shown in **Table 5**, there are eleven industrial clusters awaiting modifications.

**Table 5.** List of industrial clusters waiting for planning changes

| No | Cluster name | Location | Size (ha) |
|---|---|---|---|
| 1 | Đại Xuyên | Đại Xuyên, Phú Xuyên | 68 |
| 2 | Đông Phú Yên | Trường Yên, Chương Mỹ | 80 |
| 3 | Đông La | Đông La, Huyện Hoài Đức | 35 |
| 4 | Nam Tiến Xuân | Nam Phương Tiến, Chương Mỹ | 190 |
| 5 | La Phù expansion | La Phù, Hòai Đức | 40 |
| 6 | Quất Động expansion | Quất Động, Thường Tín | 43 |
| 7 | Habeco | Quất Động, Thường Tín | 76,8 |
| 8 | Phú Xuyên | Huyện Phú Xuyên | 240 |
| 9 | CCNLN Đa Sỹ | Kiến Hưng, Hà Đông | 13,2 |
| 10 | CCNLN La Dương | Dương Nội, Hà Đông | 8,2 |
| 11 | CCNLN Đại Tự | Kim Chung, Hòai Đức | 7,9 |

Source: Hanoi Department of Construction

*Currently, the primary activities within the industrial clusters in the city are as follows:*

- Manufacturing building materials and interior decor items such as ceramic tiles and ceramics.
- Food production and processing, including beverages, beer, wine, vermicelli, instant noodles, confectionery, and animal feed.
- Mechanical production and processing, such as car assembly, mechanical product manufacturing, steel rolling and pulling, agricultural machinery production, and the assembly of transportation equipment.
- The production of consumer goods, chemicals, and agricultural materials, including exported garments, footwear, construction glass, rubber processing, recycled plastic, and fertilizer.
- Forest product processing, which involves producing wooden household goods for export, plywood, and bamboo and rattan handicrafts.
- Manufacturing electrical appliances and assembling electronics and electrical equipment.

The authors provide the following observations regarding the recent development of industrial clusters in Hanoi: Firstly, industrial clusters in Hanoi have expanded significantly, both in number and size, meeting a portion of the production space requirements of enterprises, particularly small and medium-sized businesses. They also aid in relocating polluting production facilities from residential areas, thereby helping alleviate environmental pollution. In many regions, the establishment of industrial zones has contributed to the consumption of forestry, agricultural, and fishery products, which are then processed into goods. This development has created jobs, boosted income levels for local workers, and improved the quality of life for farmers, fostering rural modernization.

Secondly, industrial clusters within the city center are increasingly transitioning from industrial production to commercial services, as seen in areas like Hoang Mai, Cau Giay, and Yen Nghia. While progress has been slow, most industrial clusters have begun construction and are progressing according to plan. However, forestry-related clusters have seen sluggish development, with some areas, such as Phu Xuyen District, having not yet initiated any forestry-related programs. The findings suggest that areas with higher urban planning density tend to have a greater proportion of industrial parks that are yet to be developed.

*Suggestions for Developing Industrial Clusters*

Developing infrastructure that aligns with environmental protection requirements is crucial for industrial clusters. The environment serves as a fundamental condition for sustaining and advancing industrial and commercial activities. Pollution occurs when chemical and biological contaminants degrade environmental quality, posing risks to human health, ecosystems, and economic operations. Addressing environmental concerns is a core objective in the planning and expansion of industrial clusters, yet significant progress in mitigating pollution remains elusive.

Findings from preliminary surveys conducted in various craft villages and industrial clusters indicate that pollution levels have not declined but are instead on the rise. Specifically, water quality assessments in craft villages engaged in agricultural product processing and food production reveal that surface water contamination exceeds Vietnamese standards by significant

margins. Concentrations of COD, BOD5, NH4, and Coliform in these areas have been recorded at levels tens to hundreds of times above the permissible limits. Similarly, weaving and dyeing villages exhibit severe pollution, with COD values two to three times the standard, BOD5 levels 1.5 to 2.5 times higher, and elevated Coliform content. In bamboo and rattan craft villages, the COD concentration in surface water frequently surpasses regulatory thresholds due to the soaking process, which releases high amounts of lignin and organic matter. The excessive presence of COD, BOD5, NH4, and Coliform in these areas results in foul odors and murky water conditions.

Air quality monitoring conducted by the Center for Urban Environmental Engineering and Industrial Park further highlights excessive dust levels across most craft villages. In particular, SO2 concentrations in bamboo and rattan processing villages, as well as in agricultural product and food processing areas, exceed permissible limits. These findings underscore the need for a well-informed approach to environmental management within industrial clusters.

A case study of a microbial fertilizer manufacturing company in Duong Lieu Industrial Park (**Box 1**) presents a promising example of effective waste treatment. The waste management system implemented in this industrial park serves as a potential model for broader application in industrial clusters, warranting further study to assess its feasibility for adoption in similar contexts.

Box 1. Wastewater Treatment Practices in Duong Lieu Industrial Zone

The process of producing rice paper and vermicelli from dong flour and cassava results in substantial environmental pollution. To address this issue, a centralized wastewater treatment system has been developed for the industrial cluster, with Blue Sun Company, a fertilizer manufacturer, assigned to oversee its operation and maintenance.

To enhance waste management, Green Sun Company has contributed an additional two billion VND to install an advanced system that transforms industrial waste from craft village activities into micro-fertilizers. The company gathers waste materials from production units across the cluster and repurposes them as inputs for bio-fertilizer manufacturing. This process is based on a Japanese-imported technology designed to extract and treat organic matter from wastewater throughout the village, ultimately converting it into packaged biological fertilizers, specifically BOKASHI - MTX and NPK - MTX.

Source: Survey at Duong Lieu Industrial Park

+ Promoting Sustainable Industrial Development Through Clean Technology and Environmental Management

Encouraging businesses to adopt eco-friendly and advanced technologies is essential for reducing environmental impact. Municipal policies should prioritize and support enterprises that integrate sustainable solutions, such as replacing coal and firewood with gas in ceramic production or utilizing buckwheat residues in charcoal manufacturing. The adoption of high technology is a necessary and progressive step toward addressing pollution in industrial zones and craft villages. Additionally, fostering research and development of cost-effective environmental treatment technologies and equipment for industrial clusters can facilitate their widespread implementation, ensuring active contributions to environmental conservation.

+ Enhancing Environmental Monitoring Systems

To maintain environmental quality, industrial clusters should invest in establishing and upgrading environmental monitoring systems within their operational areas. A well-equipped monitoring framework allows for real-time assessment and control of pollution levels in air, water, odor, and noise, ensuring an accurate evaluation of environmental conditions. Effective monitoring helps in identifying pollution sources and implementing timely technical interventions to mitigate negative impacts on both the industrial cluster and surrounding regions.

+ Developing an Environmental Service Center

Management boards of industrial clusters can establish environmental service centers to support sustainability efforts, create additional revenue streams, and enhance investment appeal. These centers can offer a range of environmental services, including:

Waste management: Collection and treatment of wastewater and solid waste.

Environmental monitoring: Regular assessment of environmental quality.

Education and training: Programs focused on environmental awareness and best practices.

Information services: Providing data on environmental regulations and conditions.

To fund these services, industrial clusters may implement fee-based models, covering costs through charges for wastewater treatment, waste recovery, pollution assessments, and technical consulting. These responsibilities can be delegated to environmental service centers while management boards oversee coordination and compliance.

+ Upgrading Industrial Cluster Infrastructure

The infrastructure within industrial clusters consists of both physical and service-based components. Physical elements include roads, power grids, water supply networks, telecommunication services, and wastewater treatment facilities, while service-oriented aspects cover administrative support, security, and cultural initiatives. The development of these components

follows a structured investment process, progressing from policy planning and design to bidding, construction, and eventual operation (**Figure 1**). Ensuring high-quality infrastructure development is essential for the efficiency and sustainability of industrial clusters.

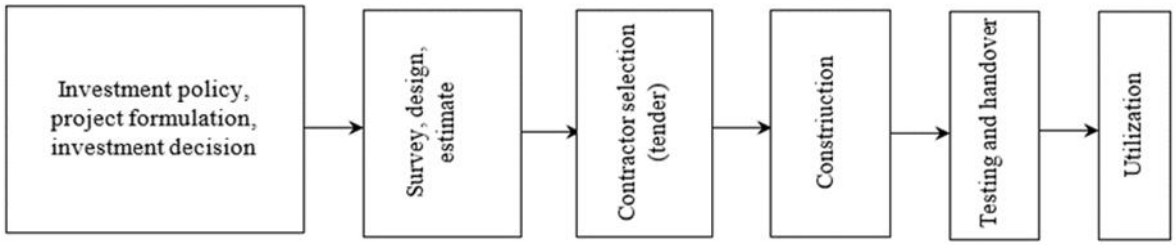


**Figure 1.** Construction process (Source: author)

The standard of construction projects, including electricity networks, internal roads, telecommunications infrastructure, and wastewater treatment systems, is determined by how well they meet both construction specifications and functional requirements.

The processes involved in quality management can be represented through a structured diagram, outlining the essential steps necessary to ensure compliance and effectiveness in construction and operational performance (**Figure 2**).

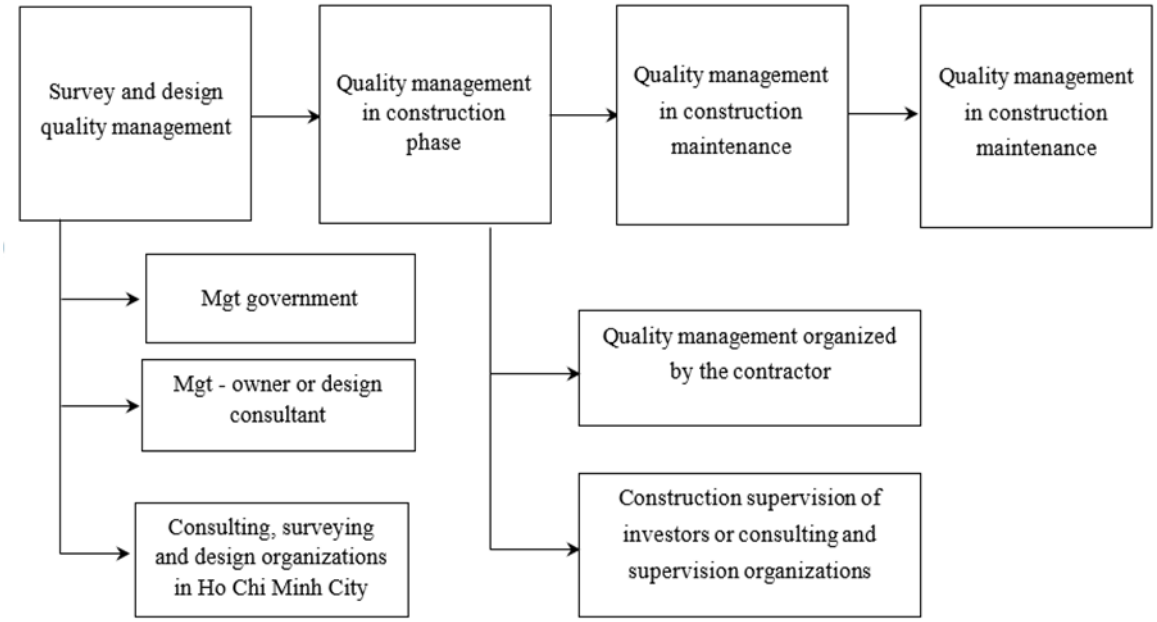


**Figure 2.** Construction-quality management (Source: author)

To improve the quality and reliability of industrial infrastructure projects, several key measures must be adopted:

The priority is the enforcement of established construction standards and technical regulations, alongside the development of additional technical guidelines specific to industrial cluster infrastructure.

Construction standards serve as a fundamental mechanism for maintaining and enhancing the quality of industrial cluster projects. These standards encompass a wide range of aspects, including survey methodologies, design specifications, construction procedures, and protocols for preservation and maintenance. Additionally, they cover various categories such as material quality, construction products, environmental impact, and procedural requirements.

Since industrial cluster infrastructure involves relatively new forms of construction, the development of additional specialized standards remains essential to address emerging requirements and ensure long-term sustainability.

**Box 2.** Key indicators from Vietnam's construction regulations on industrial cluster planning

- Water supply requirements: For centralized industrial zones and clusters, water usage is determined based on the type of industry, with a minimum provision of 20m³/ha per day and night, ensuring coverage for at least 60 percent of the total area.
- Industrial wastewater management: Wastewater discharged into surface water bodies or urban sewer systems must comply with environmental quality standards as stipulated in TCVN 5942-1995. Industrial wastewater should be categorized (e.g., contaminated water, non-polluted water, toxic water) before collection, with appropriate treatment measures in place. Sludge from wastewater treatment processes must be transported using specialized vehicles to designated solid waste treatment facilities for proper disposal.
- Power supply guidelines for industrial clusters: When planning new industrial clusters without predefined land area specifications, the following reference values for electricity supply per hectare apply:
  - Mechanical engineering and construction materials industry: 250 KW/ha

- Food processing and textile industry: 200 KW/ha
- Garment, leather, and footwear industry: 160 KW/ha
- Clusters of handicrafts and small industries: 140 KW/ha
- Handicraft production facilities: 120 KW/ha

Source: Vietnam construction code 01: 2008/BXD

*Enhancing the Quality and Management of Industrial Infrastructure Construction*

*Strengthening the Management of Survey, Design, and Construction*

Surveying and design represent crucial phases within the construction investment cycle. While improvements in these activities have contributed to enhancing construction quality and increasing project investment efficiency, challenges persist. Some projects fail to align with practical conditions, leading to inefficient investments and difficulties in operation and utilization. These issues primarily stem from inadequate awareness and responsibility in managing the quality of surveys and design. Investors, project management consultants, construction consulting firms, and regulatory authorities often do not fully comply with quality control requirements. Survey processes may not be strictly followed, leading to insufficient or inaccurate data that negatively impact the design phase. Additionally, inconsistencies in applying construction standards and regulations, along with inadequate enforcement of national technical regulations and Vietnamese construction codes, further hinder quality assurance. The lack of stringent and timely penalties for survey and design violations further exacerbates these challenges.

To address these shortcomings and enhance the quality of industrial infrastructure projects, several measures should be adopted:

- For regulatory agencies: Develop and implement training programs on construction standards and regulations related to surveying, design, and construction. Establish and enforce guidelines for management, inspection, and violation handling to prevent unauthorized activities and ensure compliance with professional certification requirements. Conduct regular inspections of industrial infrastructure surveys and design processes.
- For investors and project management units: Ensure that survey and design consultancy firms possess the necessary legal standing, technical expertise, and professional experience. When reviewing, approving, or accepting survey and design work, it is essential to evaluate the competency of involved organizations and individuals.

*Enhancing Construction Capacity and Strengthening Project Management*

Improving construction capacity involves effectively managing progress, construction volume, on-site safety, and environmental impacts during construction. These elements are fundamental to ensuring the quality and sustainability of industrial infrastructure.

*Establishing Standards and Criteria for Industrial Infrastructure Development*

To ensure high-quality industrial infrastructure, the implementation of specific criteria and performance indicators is necessary, including:

- Investment intensity per hectare of industrial clusters (CCN)
- Standardized design templates for various types of industrial clusters
- Functional zoning within industrial clusters

The allocation of functional zones should be based on the specific conditions of each area while optimizing land use efficiency and infrastructure investment. The following guidelines can be applied:

- Land for factories and production facilities: 55% – 65%
- Land for technical facilities: 1.0% – 1.5%
- Land for administrative and management centers: 1.0% – 1.5%
- Land for roads and transport infrastructure: 8% – 12%
- Land for supporting services and green spaces: 12% – 20%

Each industrial cluster must include at least one wastewater treatment facility and one power transformer station. Solid waste should be collected in designated technical treatment areas and transported for disposal according to municipal waste management plans. Industrial waste and scrap storage areas must be enclosed to prevent environmental contamination and adverse effects on nearby businesses. Hazardous waste, including flammable, explosive, or infectious materials, must undergo specialized treatment and be stored at a safe distance from operational facilities.

To enhance fire safety, roads should be planned to allow fire trucks access to at least one side of each building, ensuring proximity to fire hydrants or firefighting water storage facilities.

Industrial cluster infrastructure consists of physical, technical, and social components, which are essential for the development and efficiency of industrial zones. Infrastructure is categorized into technical infrastructure (hardware) and social infrastructure (software).
Research by Soloveva *et al.* [9] and Zohra and Mustapha [14] highlights that regions and industries can boost their competitiveness and innovation potential through effective cluster policies.
Developing industrial infrastructure requires a thorough understanding of key performance indicators, construction processes, and factors influencing infrastructure development to ensure long-term success.

## Conclusion

Government policies regarding the development of industrial zone infrastructure encompass several key areas: (i) land acquisition for industrial infrastructure projects, (ii) strategic planning for industrial development and infrastructure construction, (iii) investment policies for industrial infrastructure development, (iv) regulatory frameworks for managing construction investment projects, and (v) policies ensuring construction quality control.
Insights gained from industrial development experiences in various countries and provinces have provided Hanoi with valuable lessons for improving its industrial infrastructure. The study has examined multiple aspects, including (i) the impact of natural conditions and socio-economic factors on industrial infrastructure development in Hanoi, (ii) the current state of industrial zones, (iii) the formulation and implementation of policies, (iv) industrial development planning and detailed infrastructure plans, (v) the construction progress of industrial infrastructure components, and (vi) case studies of industrial complexes in Hanoi. Based on this analysis, the study evaluates the development of industrial infrastructure in the city.
Significant achievements in industrial infrastructure construction include a strong focus on investment and strategic planning. Over years of development, Hanoi has established a relatively well-integrated technical infrastructure system that supports industrial growth. The approach also integrates industrial cluster development with rural modernization efforts while emphasizing the role of the State in industrial infrastructure expansion.
Additionally, effective risk management within industrial clusters remains a critical consideration [15-19]. Further research in academic journals is necessary to explore various dimensions of industrial infrastructure development [20-26].

### *Research Limitations*

A comparative analysis involving other countries and markets is needed to provide a broader perspective.

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