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Industrial Location Criteria of Planners for Ho Chi Minh City, Vietnam

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Abstract
In Vietnam, planners have their criteria for choosing a suitable location for industrial parks. Because of changing times, defining a new industrial location criterion ideal for today's society is needed. By collecting data through a survey and applying the Fuzzy analytic hierarchy process, this study attempts to clarify the hierarchy and priority of industrial location criteria in industrial planning in Ho Chi Minh City (HCMC). This study emphasizes the critical role of planners. Thus, the research can reference investors and government authorities in industrial park planning and become the basis for re-evaluating industrial planning in the new era.

Keywords: Industrial location criteria; Planners; Ho Chi Minh city; Fuzzy analytic hierarchy process.

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1.0 Introduction

1.1 Overview

Industrial parks (IPs) are developed areas specializing in economic activities, research, production, and services. It is also a place to help promote the region's human and natural resources. With the participation of local authorities, IPs also help improve the connection between organizations and the business community to develop the local economy and society. Over time, the industrial zones have developed and improved their functions and the changes in the industrial park model to suit the requirements and development of society. The improvement ensures harmony between economic development while ensuring sustainable development. An appropriate project development strategy depends on the stage and potential (Le, Pham, Cu, Pham, & Dao, 2020). However, In parallel with the success, there were also failures in the planning of the industrial park, causing considerable damage to local social-economic development and directly affecting people's life. The main reason is the improper selection of the industrial planning location, which leads to the inability to attract investment.

Nomenclature

HCMC	Ho Chi Minh City
FAHP	Fuzzy analytic hierarchy process
IPs	Industrial parks

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Ezs	Export processing zones
IZs	Industrial zones

Vietnam develops in the direction of industrialization and modernization of the country. The overall development objective of Vietnam is "industrialization and modernization of the country" and striving to become an industrial country by 2020 (the proportion of industries outperformed other sectors). The focus is on shifting the labor structure from agriculture to industry and services, in which the direction of development remains on industrial action (Tuong, 2011). Depending on the stage and potential, there is an appropriate project development strategy (Freeman, 1996; Storch & Downes, 2011). With the development orientation of the theory of growth poles, industrial zones (IZs) are used as growth poles and growth centers to create the development motivation for regions (Lindfield, 1998). Vietnam also selectively knows its domestic characteristics as a country that lags and learns from developed countries' previous achievements (Tòng, 2019).

In general, industrial parks (IPs) and export processing zones (EZs) increasingly play an essential role in the locality's socio-economic development and the whole country's economic restructuring to raise the industrial proportion and attract significant investment. In particular, IPs and EZs have attracted several investment projects in the heavy industry, electronics industry, and so on. contributing to improving their operational efficiency. (Trung, 2016).

Since the criteria for selecting the site for the industrial park construction also have solid bases for construction and evaluation. Therefore, this topic focuses on selecting research criteria for land use selection of industrial parks.

1.2 Research motivation

In Vietnam, the industrial planning process is mainly under the control of the local or national authorities. Planners often follow their criteria for choosing a suitable location for IPs development. They are influenced by meeting the needs of investors and having to create a strong driving force that leads to change in the direction of a suitable living environment, economic, social, cultural, and political values, following the local and the national development orientation (Affairs, 2018; Tòng, 2019). The criteria for determining industrial location are affected by economic, political, environmental, cultural - social factors. Because of changing times, the industrial location criteria are also changed under the unstable factors. An additional study is needed to define a new industrial location criterion ideal for today's society (Lê, 2017; Tòng, 2019).

2.0 Literature Review

The criteria for selecting the IPs location have been studied and proposed a long time ago. However, with the development of society, science & technology, and production methods, more and more location criteria strongly influence successful industrial projects. The probable location has a significant influence on the success or failure of the project and the ability to call for investment afterward (UNIDO, 2019). The studies on the criteria for selecting the IP location were experimented with and further related research (Aliverdilou, Hajilou, Sabokbar, & Faraji, 2021; Saracoglu, 2013). Research is early developed based on the theory of cost and benefits (Lichfield, 1964; Wood & Parr, 2005). After that, the main factors for calculation include land, market, labor, material, entrepreneurial skill, the effect of subsidy, external economies, chance, purely personal factors, changes in price and cost, and techniques (Clark, Wilson, & Bradley, 1969; Lee & Jung, 2020). Opening the market to attract foreign investment from developed countries is also typical. The industry location criteria are also expanded according to practical needs (Saracoglu, 2013). New locations have higher requirements for cheap labor, proximity to raw materials, low transportation costs, technological developments, market size, capital, resources, political structure, quality of life, policies (Cheng & Li, 2019; He, Wei, & Xie, 2008). Accordingly, the theory of the importance of the agglomeration effect is also studied (Arauzo-Carod & Viladecans-Marsal, 2009; Cohen & Paul, 2005; Viladecans-Marsal, 2004). A differentiation of criteria has emerged in the selection of industrial locations.

The criteria can generally be classified into four categories: physical, economic, social, political, and environmental (Aliverdilou et al., 2021; Boutkhoum, Hanine, Agouti, & Tikniouine, 2015; Chattergoon & Kerr, 2022; WEBER, 2015).

Physical factors are indicated very early because they are directly related to the raw materials to produce the products and directly affect the costs and profits of the business. Physical factors include natural resources, transportation system, distance, spatial relationship, urban agglomeration (Laporte, Nickel, & Saldanha-da-Gama, 2019; WEBER, 2015).

Economic factors are critical priorities of investors. According to previous research, some economic factors have a significant influence on the selection decision of investors, such as cost, economic environment, marketing, capital, market, external economy, business-related services, economic agglomeration. The choice of a planning site should also be based on economic factors to ensure the attraction of investors (Aliverdilou et al., 2021; Qiu, Xu, & Zhang, 2015; WEBER, 2015).

Attention to creating a sustainable society and environment is a requirement of planners when implementing a project. They play a crucial role in balancing the sustainable development of the economy, community, and environment where people have a good quality of life, safety, and security. Some of the criteria belonging to social factors include population, opportunity and purely personal factors, quality of life, education (Aliverdilou et al., 2021; Curran, Lynn, & O'Gorman, 2016; WEBER, 2015). Political factors also significantly affect investors' decisions: taxes, government policies, political conditions(Qiu et al., 2015; WEBER, 2015).

This criteria system will become the basis of comparative assessment for planning experts in Vietnam and HCM. Determining order and priority also becomes imperative.

3.0 Methodology

3.1 Methods

The main application methods in this topic include data collection (depth-interview, questionnaire survey)(Singh, 2022) and the Fuzzy Analytic hierarchy process (FAHP) - Geometric mean method (DATA, 2021).

Data collection is a significant step. In this step, the data is collected through in-depth interviews and survey form with planners in HCMC about the actual situation of IZs and the pairwise comparison of the criteria. The FAHP geometric mean method will propose the priority order of criteria for selecting the industrial park planning location from planners.

3.2 Case study

The HCMC metropolitan region's planning was approved by the decision 589/QĐ-TTg signed by Prime Minister on May 20, 2008. It emphasized that the region is the area of multi-central poles in which HCMC is a central hub; prefecture-level cities are link poles for multi-direction of the development (Minister, 2008). It included eight centrally-controlled cities/provinces: HCMC, Binh Duong, Binh Phuoc, Tay Ninh, Long An, Dong Nai, Ba Ria – Vung Tau, Tien Giang.

Over time, the industrial zone planning projects have had great successes, contributing to Vietnam's economic development in recent years, especially in HCMC (Fan et al., 2019; Tuong, 2011). By the end of 2021, HCMC had more than 41 Izs in operation, significantly impacting the surrounding area, especially the development of new urban areas (See Figure 1). The study will survey planners in HCMC.

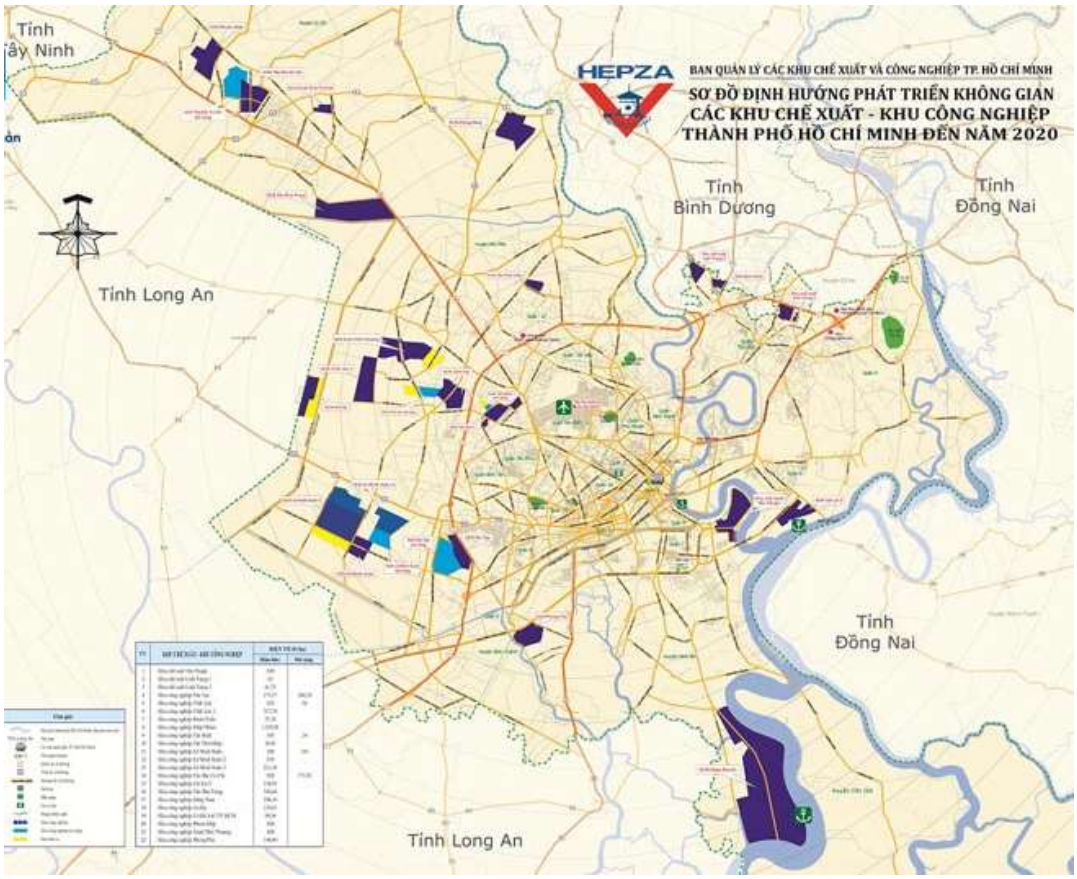

Figure 1. Industrial park location in Ho Chi Minh city.
(Source: quanlybatdongsan.vn, 2022)

3.3. Measurement of criteria

The study made a pairwise comparison of correlated factors based on levels, followed by criteria within each main factor.

There is two compared level. In level 1, there are five main factors, including physical (PF), environmental (EnF), economic (EcF), social (SF), and political factors (PF). In level 2, physical factors include natural resources (NR), the transportation system (TS), distance (DT), spatial relationship (SR), urban agglomeration (UA). Environmental factors include environmental pollution (EP), environmental protection (EPr), climate (CL). Economic factors include cost (CT), economic environment (EEv), marketing (MT), capital (CP), market (MK), external economy (EEc), business-related services (BR), economic agglomeration (EA). Social factors include population (PP), opportunity and purely personal factors (OF), quality of life (QL), education (ED). Political factors include taxes (TX), government policies (GP), political conditions (PC).

The importance of factors and criteria according to the nine levels and five convert scale (Sodhi & T V, 2012) is being described in Table 1

Table 1. Linguistic variables and corresponding fuzzy numbers

Linguistic variables	Scale	Triangular fuzzy scale	Reciprocal value Triangular fuzzy scale
Equally important	1	(1,1,3)	(1/3,1,1)
Slightly important	3	(1,3,5)	(1/5,1/3,1)
More important	5	(3,5,7)	(1/7,1/5,1/3)
Very important	7	(5,7,9)	(1/9,1/7,1/5)
Absolutely important	9	(7,9,9)	(1/9,1/9,1/7)

(Source: :Sodhi & T V, 2012)

3.4. Sample

The research team conducted combining in-depth interviews and a questionnaire survey. The respondents are planners in HCMC. They have been professionally trained in planning and working in different fields, including education, design, management, and consulting. Twelve interviewees obtained a total of 12 survey results. Therein, one response was unsatisfactory. Therefore, the research remained 11 results that gave in the calculation.

The research object is planners. They must meet the requirements of professional training or experience in industrial location criteria in HCMC. So, this group of research subjects has a limited population size. The sample of 12 probably represents the research population.

4.0 Findings

4.1 Main factors pairwise comparison

There are five main factors in level 1, including physical (PF), environmental (EnF), economic (EcF), social (SF), and political factors (PF).

Based on the survey results on the relationship between the main factors, the pairwise comparison matrix between the criteria is summarized according to table 2.

Table 2. Main factors ranking using FAHP Geometric mean method

Factors	Fuzzy geometric mean value (r_i)	Fuzzy weights (W_i)	Centre of area (COA)	Normalized W_i	Ranking
PF	(2.1736,3.1174,4.1715)	(0.2364,0.4634,0.8733)	0.5244	0.4567	1
EnF	(1.2004,1.7144,2.3373)	(0.1306,0.2549,0.4893)	0.2916	0.2539	2
EcF	(0.7148,1.0019,1.4447)	(0.0806,0.4189,0.3025)	0.1773	0.1544	3
SF	(0.4158,0.5595,0.7833)	(0.0452,0.0832,0.1640)	0.0975	0.0849	4
PF	(0.2462,0.3338,0.4581)	(0.0268,0.0496,0.0959)	0.0574	0.0500	5

4.2 Criteria pairwise comparison

In level 2, physical factors' criteria include natural resources (NR), transportation system (TS), distance (DT), spatial relationship (SR), urban agglomeration (UA). The pairwise comparison matrix between the criteria is summarized according to Table 3.

Table 3. Physical factors' criteria ranking using FAHP Geometric mean method

Factors	Fuzzy geometric mean value (r_i)	Fuzzy weights (W_i)	Centre of area (COA)	Normalized W_i	Ranking
NR	(2.2317,3.1248,3.9745)	(0.2558,0.4712,0.8170)	0.5146	0.4607	1
TS	(1.2135,1.6044,2.1326)	(0.1391,0.2419,0.4384)	0.2731	0.2445	2
DT	(0.7350,0.9808,1.3267)	(0.0842,0.1479,0.2727)	0.1683	0.1507	3
SR	(0.4180,0.5564,0.7730)	(0.0479,0.0839,0.1589)	0.0969	0.0867	4
UA	(0.2667,0.3655,0.5185)	(0.0306,0.0551,0.1066)	0.0641	0.0574	5

Environmental factors include environmental pollution (EP), environmental protection (EPr), climate (CL). The pairwise comparison matrix between the criteria is summarized according to Table 4.

Table 4. Environmental factors' criteria ranking using FAHP Geometric mean method

Factors	Fuzzy geometric mean value (r_i)	Fuzzy weights (W_i)	Centre of area (COA)	Normalized W_i	Ranking
EP	(1.8696,2.4952,3.1497)	(0.3797,0.6500,1.0817)	0.7038	0.6433	1
Epr	(0.6973,0.8965,1.1714)	(0.1416,0.2335,0.4023)	0.2591	0.2369	2
CL	(0.3451,0.4470,0.6025)	(0.0701,0.1164,0.2069)	0.1312	0.1199	3

Economic factors include cost (CT), economic environment (EEv), marketing (MT), capital (CP), market (MK), external economy (EEc), business-related services (BR), economic agglomeration (EA). The pairwise comparison matrix between the criteria is summarized according to Table 5.

Table 5. Economic factors' criteria ranking using FAHP Geometric mean method

Factors	Fuzzy geometric mean value (r_i)	Fuzzy weights (W_i)	Centre of area (COA)	Normalized W_i	Ranking
CT	(2.1589,3.2594,4.3770)	(0.1803,0.3840,0.7574)	0.4406	0.3985	1
EEv	(1.3181,1.9400,2.6136)	(0.1101,0.2286,0.4523)	0.2636	0.2384	2
MT	(0.7472,1.0817,1.6335)	(0.0624,0.1274,0.2827)	0.1575	0.1425	3
CP	(0.5691,0.8066,1.1764)	(0.0475,0.0950,0.2036)	0.1154	0.1043	4
MK	(0.4115,0.5809,0.8195)	(0.0344,0.0684,0.1418)	0.0815	0.0737	5
EEc	(0.2256,0.3120,0.4943)	(0.0188,0.0368,0.0855)	0.0470	0.0425	6
EA	(0.1767,0.2625,0.4486)	(0.0148,0.0309,0.0776)	0.0411	0.0372	7
BR	(0.1719,0.2440,0.4128)	(0.0144,0.0287,0.0714)	0.0382	0.0345	8

Social factors include population (PP), opportunity and purely personal factors (OF), quality of life (QL), education (ED). The pairwise comparison matrix between the criteria is summarized according to Table 6.

Table 6. Social factors' criteria ranking using FAHP Geometric mean method

Factors	Fuzzy geometric mean value (r_i)	Fuzzy weights (W_i)	Centre of area (COA)	Normalized W_i	Ranking
PP	(2.0774,2.8112,3.7297)	(0.2996,0.5433,0.9763)	0.6064	0.5405	1
OF	(0.9435,1.2741,1.6879)	(0.1361,0.2462,0.4418)	0.2747	0.2448	2
QL	(0.4958,0.6765,0.9491)	(0.0715,0.1307,0.2484)	0.1502	0.1339	3
ED	(0.3037,0.4127,0.5671)	(0.0438,0.0798,0.1484)	0.0907	0.0808	4

Political factors include taxes (TX), government policies (GP), political conditions (PC). The pairwise comparison matrix between the criteria is summarized according to Table 7.

Table 7. Political factors' criteria ranking using FAHP Geometric mean method

Factors	Fuzzy geometric mean value (r_i)	Fuzzy weights (W_i)	Centre of area (COA)	Normalized W_i	Ranking
TX	(1.9114,2.4594,3.1419)	(0.3854,0.6314,1.0381)	0.6850	0.6325	1
GP	(0.8101,1.0475,1.2985)	(0.1634,0.2689,0.4290)	0.2871	0.2651	2
PC	(0.3052,0.3882,0.5188)	(0.0615,0.0997,0.1714)	0.1109	0.1024	3

The factors and criteria mentioned above are calculated for normalized weights and priority ranking. These metrics show the order of priority and the importance of each factor or the criteria.

5.0 Discussion

Through the data analyzed by the FAHP, the priorities and weights of the factors and criteria for choosing the industrial park's location are listed in Table 8.

*Table 8 - T*he priorities and weights of the factors and criteria for choosing the industrial park's location

Factors	Main factors normalized weights	Criteria	Normalized weights
Physical factors	0.4567	Natural resources	0.4607
		Transportation system	0.2445
		Distance	0.1507
		Spatial relationship	0.0867
		Urban agglomeration	0.0547
Environmental factors	0.2539	Environmental pollution	0.6433
		Environmental protection	0.2369
		Climate	0.1199
Economic factors	0.1544	Cost	0.3985
		Economic environment	0.2384
		Marketing	0.1425
		Capital	0.1043
		Market	0.0737
		External economy	0.0425
		Economic agglomeration	0.0345
		Business-related service	0.0372
Social factors	0.0849	Population	0.5405
		Opportunity and purely personal factors	0.2448
		Quality of life	0.1339
		Education	0.0808
Political Factors	0.0500	Taxes	0.6325
		Government policies	0.2651
		Political conditions	0.1024

Accordingly, from the perspective of planning experts, physical factors are still the most preferred factor. Therefore, natural resources and transportation systems are two critical criteria that are paid particular attention to while choosing the location of industrial park planning.

For planners, the importance of the living environment is clearly shown in this survey. Environmental pollution factors are of particular interest when considering environmental aspects. Economic factors are often crucial to investors. The economic factor strongly influences investors' investment decisions, so it is still considered before social and political factors. However, environmental factors are still one of the top priorities for planners(Dieu, Phuong, van Buuren, & Viet, 2020).

Especially for the case in Vietnam, the political homogeneity has made the political factor almost no different between regions (from the point of view of planners), so it is a minor concern. Criteria of political factors are often considered to make appropriate operating policies rather than contributing to site selection.

In the economic factor, cost and economic environment are the two most essential criteria with relatively high weights compared to the other criteria. Similarly, in the social aspect, the labor force expressed through the population has the highest normalized weight. Besides, tax is the key criterion of political factors. The priority order of factors and criteria also clearly reflects the viewpoints of the planners in choosing the location of the industrial zone planning.

6.0 Conclusions and recommendations

The related topic has been studied since the late 18th century. Moving on to the 'industrial location criteria' work is necessary.

Although most of the topics detected new factors or the degree of those factors' impact, they lacked a thorough synthesis. Therefore, the industrial location criteria need to enumerate systematically and assess the level of their impact scientifically. This research does a literature review and generalizes the industrial location criteria. However, the criteria for determining industrial location are affected by economic, political, environmental, cultural - social factors. Under unstable factors, the industrial location criteria required are changed as well. It is needed an additional study.

These priorities may differ from investors' views. Still, they are consistent with the planning in Vietnam to ensure a balanced development between the fields of economy, society, politics, environment.

This study synthesized criteria, measured weights, and hierarchical stratification of factors and criteria. Based on these results, further studies on the practical application of location selection for industrial park planning in Vietnam through spatial analysis technique - GIS can be carried out.

7.0 Paper Contribution to Related Field of Study

This research is a very beginning step to consistent with the development of society. Along with the development of science and technology, the priority indicators of the industrial location criteria will renovate under the support of GIS tools to identify and propose feasible locations. They minimize the mistakes that should not be spent when implementing the project or choosing the wrong location leading to project failure. The project is expected to apply the research results in providing suitable solutions to develop new IZs or re-evaluate old planning projects in HCMC.

The research has specific impacts on Vietnam's industrial zone planning system and HCMC. Putting research results into practice will have the opportunity to minimize infeasible planning projects and minimize the loss of time, money, and labour effort for planning and implementing unworkable plans.

In addition, the research topic also contributes to making investors, especially foreign investors, better understand the process and selection criteria of industrial zones in Vietnam. Investors also better understand the previous selection criteria and consider the advantages of IPs in Vietnam.

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