Chapter

Applying Consistency Fuzzy Preference Relations to Select a Strategy that Attracts Foreign Direct Investment (FDI) in Developing Supporting Industries for Vietnam

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Abstract

The Vietnamese government has been focused on promoting supporting industries, which may provide a "key" solution for sustained development and thereby improve the national welfare. Coincidentally, Vietnam is also focused on an optimal strategy to attract foreign direct investment (FDI that develops a strategy for supporting industries). However, these results have not been achieved due to the weaknesses of low FDI flow, the limited number of capital projects, and the inclusion of smaller enterprises with lower technology into the mix. This negative situation begs the question as to what might be the best strategy for attracting FDI that developmentally supports the Vietnamese industry. As an intended remedy, this inquiry establishes an analytical, hierarchy framework beneficial to the Vietnamese government on a best strategic method for attracting FDI to develop supporting local industries. This study utilizes fuzzy preference relations to improve the decision-making process to be both consistent and effective. The analytical results demonstrate that institutional policies, domestic supply capacity, human resources, and technological development, coupled with innovation, are the key criteria to be considered when selecting a strategy that attracts regular FDI. Furthermore, analytical results presented in this work demonstrate that the best strategies for attracting FDI to Vietnam are those that motivate sustainable economic growth on an ongoing basis.

Keywords: attracting FDI, developing supporting industries, fuzzy preference relations, multi-criteria decision-making

1. Introduction

Vietnam's supporting industries are still less developed and less competitive than those of other Asian countries, comparatively speaking [1]. Some of the major factors leading to the weakness of supporting industries in Vietnam are a distinct

lack of capital, technological innovation, and management skills suitable for development purposes [2]. FDI increases economic growth of recipient countries by bringing physical change through the introduction of infrastructure, advanced technology, and management expertise [3]. It is also considered to increase domestic capital, create employment, raise personal incomes, promote technology, and generate the transfer of skills through foreign technology and know-how to boost host country economies; so, such investment is seen as the engine of economic growth in the long term [4]. Moreover, FDI is an important vehicle for the transfer of technology, as it contributes relatively more to overall growth than what domestic investment may accomplish [5]. Therefore, attracting FDI for developing supporting industries is seen to be the best strategy to solve the problem of much-needed capital obtainment.

In addition, Vietnam is still considered to be a developing country. The Vietnamese government has concentrated on attracting FDI to develop supporting industries which will add to further overall development throughout the nation as a whole [6, 7]. However, the FDI attraction necessary to develop supporting industries in Vietnam is still viewed as an inherent weakness due to low FDI inflows, the noticeably limited number of infrastructure projects, and the proliferation of smaller, lower-technology enterprises that do not significantly contribute to any great extent [6]. Moreover, the General Statistics Office (GSO) of Vietnam [8] states that the total cumulative FDI for developing supporting industries is approximately US $29.16 billion, accounting for a 46.19% of all FDI projects, and 72.25% of the total FDI value in industries, wherein 15.63% quantity of FDI projects and 16.87% of the total FDI value are shown in supporting industries. Therefore, this study demonstrates the key factors that will have the most important impact to attract FDI to develop supporting industries in Vietnam.

This study concentrates on selecting a workable strategy for attracting FDI to develop supporting industries in Vietnam. Moreover, it should be noted that FDI firms consistently perform better than domestic ones in order to drive the development of Vietnam's supporting industries [2]. It utilizes a theoretical study, and it examines the current situation of developing supporting industries coupled with the reality of attracting FDI to Vietnam. This examination is to be taken together with the results which are concomitant with interviews of government staff and policy-makers, economists, foreign investors, and managers from six supporting industries. The results have indicated that there are eight main criteria that influence the attraction of FDI to develop supporting industries [6]; and, there are three alternative strategies applicable to attracting FDI. The eight main criteria are as follows: (1) institutions and policies; (2) human resources (e.g., quantity, salary, education, skill, and morale); (3) infrastructure facilities (e.g., transport, power, information, communication, etc.); (4) domestic supply capability (total value and partition domestic supply chain and the quantity and size of supporting industries firms); (5) market size of supporting industries (i.e., the total consumption of supporting industries products); (6) technological development and innovation; (7) international cooperation and competition; and (8) other criteria (such as environmental policy, culture, tax policy, land support, corruption, etc.). When taken together, there exist various alternative strategy policies for attracting FDI to develop supporting industries, namely: (i) attracting FDI for developing supporting industries, which motivates the economy's sustainable growth; (ii) attracting FDI for developing supporting industries, which increases national competitiveness; and (iii) attracting FDI for developing supporting industries, which stimulates overall national technological development. Based on the results obtained, an analytical, hierarchy framework has been developed to assist the Vietnamese government and involved policy-makers to evaluate the practical influence of those criteria under

review and to choose a strategy platform which may attract future FDI to develop supporting industries by using the established eight main criteria and three alternatives posited in this study.

This study uses AHP methodology to perform complicated pairwise comparisons among the criteria at hand. It may take considerable time to obtain a convincing consistency index with such an increasing number of criteria. From that, or because of that, the study uses the consistency fuzzy preference relations (CFPR) model [6, 9–16] useful to calculate the nature of the criteria and the adjacent alternative weighting. These results are utilized to determine the most important criteria and to select the best strategy for attracting FDI.

2. Related literature

2.1 Concepts of supporting industry and developing supporting industries in Vietnam

The term "supporting industries" is derived from Japanese literature in the mid-1980s [2, 17, 18]. It first appeared in a White Paper on Economic Cooperation of the Ministry of International Trade and Industry (MITI) of Japan [19] for the promotion of industrialization as a process and as part of directing the development of small and medium enterprises (SMEs) which were part of the Association of Southeast Asian Nations (ASEAN) country structure, especially in Singapore, Malaysia, Thailand, Indonesia, and the Philippines. The term was officially defined to signify industries that supply raw materials, parts, and capital goods for assembly-type industries. Currently, the term "supporting industries" is widely used, especially in East Asia. It is interpreted differently in different fields of activities [2, 18, 20]. In Vietnam, the use of supporting industries is defined in accordance with Decision No. 12/2011/QĐ-TTg promulgated by the Prime Minister: "The supporting industries are industries producing materials, spare parts, components, accessories or semi-finished products as the means of the production of final products in production and assembly industries or of consumer products" [21]. Accordingly, Decision No. 1483/QĐ-TTg promulgated by the Prime Minister, on August 26, 2011, stated: "On promulgating a list of supporting industry products that are given priority for development" [22], there are six industries which are identified, including textile-garments, leather shoes, electronic computing, manufacturing and assembly automobiles, mechanical engineering, and supporting industry products used for and by high-tech industries.

Supporting industries can play a role in promoting economic growth [7]. A country with competitive supporting industries will contribute to economic development and national welfare even in the long run [6]. It is expressed through the following means: First, the development of competitive supporting industries will cause the dynamic effect of promoting technological innovations and developing human resources, thereby improving national welfare [23]. Second, a country with competitive supporting industries can sustain FDI for final assembly processes relatively longer than a country without competitive supporting industries. And, finally, a country with competitive supporting industries can export manufactured inputs to countries where the final assembly processes are ultimately transferred. Moreover, it should be noted that national industries will benefit most when the domestic supporting industries are able to become globally competitive, although a nation does not need to be competitive in all supporting industries if it has specialization in certain given areas [24]. Therefore, developing countries may wish to establish competitive supporting industries for long-term economic growth.

As stated, Vietnam is a developing country, and the industrialization and modernization is still progressing [25–28]. Therefore, the Vietnamese government is concentrating on promoting supporting industries wherever possible. This promotion is exemplified by Vietnam's support of industry prospects currently under assessment by Japanese enterprises [18], coupled with various decisions and policies for developing supporting industries such as: Decision No. 34/2007/QD-BCN, promulgated on July 31, 2007, by the Minister of Industry and Trade, which states: "Approving the planning of industrial development supports up to 2010 and vision to 2020" [29]; Decision No. 12/2011/QD-TTg, promulgated on February 24, 2011, by the Prime Minister, which states: "On development policies of some supporting industries" [21]; Decision No. 1843//QD-TTg, promulgated on August 26, 2011, by the Prime Minister, which states: "On promulgating a list of supporting industry products that are given priority for development" [22]; Decision No. 1556/QD-TTg, promulgated on October 17, 2012, by the Prime Minister, which states: "Development of an approval scheme, to help developing small and medium enterprises in supporting industries field" [19]; Decision No. 9028/QD-BCT, promulgated on October 10, 2014, by the Minister of Industry and Trade, which states: "Approval of a master plan for developing supporting industries up to 2020, vision to 2030" [30]; Decree No. 1111/2015/ND-CP, promulgated on November 3, 2015, by the Prime Minister, which states: "On the development of supporting industries" [31]; Decision No. 68/QD-TTg, promulgated on January 18, 2017, by the Prime Minister, which states: "On the approving of the program on development of supporting industries from 2016 to 2025" [32]; Decision No. 10/2017/QD-TTg, promulgated on April 3, 2017, by the Prime Minister, which states: "Promulgating the regulation on management and implementation of the program on development of supporting industries" [33]; and Decision No. 4572/QD-BCT, promulgated on November 7, 2014, by the Minister of Industry and Trade, which states: "Promulgating the regulation on formulation, receipt, appraisal, approval and implementation of schemes under the program on development of supporting industries" [34]. However, Vietnam's supporting industries are still in the very initial stages of development. The reality of supporting industries in Vietnam is that they are significantly lower in developmental status and weak in competitiveness [35]. This is evidenced by the lower proportion of locally finished goods. One recent Vietnamese governmental report [36] and a notice from the General Statistics Office of Vietnam [8] indicate that the proportion of localization in finished products in some supporting industries is 10.5% in manufacturing and assembly of automobiles, 17.2% in electronics, 12.5% in mechanical engineering, 9.5% in textile-garments, and 13.1% in leather shoes. This obviously underdeveloped state of the local supporting industry has negatively resulted in increased production costs, the risk of bigger trade deficits with foreign partners, and a lowered competitiveness of Vietnamese products than regional peers. This is due in large part to the importation of components and spare parts, which continues to be one of the primary factors preventing industrial development and economic growth, leading to increased national welfare. Some of the major factors which have led to overall weakness in Vietnam's supporting industries are a lack of capital expenditure, reduced technological innovation, and paucity of management skills for development [2].

2.2 Strategy for attracting FDI for developing supporting industries

Developing countries may improve national welfare by attracting FDI [37]. It is understood that FDI supports economic growth, increased personal incomes, and leads to a greater rate of employment and technological transfer on a national basis [37]. Moreover, there are five main channels of technological diffusion which are

linked to FDI flows: demonstration or imitation; labor mobility; exportation; competition; and backward and forward linkages with domestic firms [38]. These five channels, respectively, match the following situations: (i) the efforts of domestic firms to adopt successful technology used by multinational corporations (MNCs); (ii) the recruitment by domestic firms of workers with MNC experience who are able to use different technologies; (iii) access to large distribution networks and the related gain due to a better knowledge of consumer tastes in foreign markets; (iv) a more efficient usage of existing resources and technology or the incorporation by domestic firms of new technologies in the production process to compete with MNCs; and (v) the relationship between MNCs and domestic firms, where the latter can become suppliers of MNCs (backward linkages) or customers of intermediate outputs of MNCs (forward linkages) [37].

In addition, the research results produced by international case studies, in terms of the positive impact FDI flows have on the invested country, are related as follows: (i) managing the status of lack of funds and thereby increasing labor productivity, employment, and other production factors; (ii) promoting the growth by increasing total social investment; (iii) keeping the balance of payments; (iv) contributing to diversification of the production structure; (v) employment effects; and (vi) a transfer of technology [2]. The infusion of FDI creates the effect of future production and further investment both before and after subsequent production stages have been initiated. The general situation in many countries, Vietnam included, is that FDI significantly contributes to export growth and job creation, but it does not help to increase the level of national prosperity despite job creation, albeit at minimum wage, in the manufacturing sector. However, FDI flows may have the potential of causing major instability to a given marketplace environment, as follows: pinching domestic manufacturers instead of network cooperation and weakening the overall sense of prosperity through the outward transfer of profits and income to foreign countries. This situation would decidedly be in favor of the investors who make investments through massive incentive programs presented by host countries [17].

Many empirical studies support the theory that MNCs and MNEs tend to have higher productivity than domestic firms located in the same sector, thereby contributing to considerable GDP growth in developing markets. While customers of supporting industries are typically domestic assemblers, it is possible for foreign assemblers to become located in the domestic market and for foreign assemblers to also be located in adjacent foreign countries in the region [37]. It should be noted that foreign assemblers are frequently MNCs and MNEs. More importantly, it seems that developing countries expect that MNCs will have a supposed positive impact on the productivity levels of domestic firms by the potential generation of positive externalities. FDI may generate positive externalities worthy of the productivity growth of domestic suppliers through business relationships with MNCs (known as "backward linkages" afterward) and to increased output and productivity of domestic supporting industries, due to the additional demand and technological transfer caused by MNCs. Moreover, if increasing FDI causes positive externalities for domestic suppliers and concomitantly improves their productivity through backward linkages, national welfare in FDI host countries will also undoubtedly improve. Finally, developing countries may improve their national welfare through the attraction of FDI, if their supporting industries can obtain positive externalities that far exceed the negative externalities some domestic assemblers may yet encounter [2].

The role of FDI in the development of supporting industries is seen as follows: (i) to develop the infrastructure of the industry, paving the way for the development supporting industries; (ii) to expand the market scale; (iii) to create

conditions for the host country to participate in global production networks, pushing them up to higher-value stage in the value chain; (iv) to implement the international division of labor and human resource development; and (v) to develop and transfer technology to the host country. Aside from the positive impacts, FDI may also negatively impact industry in invested countries, such as (1) pinching domestic manufacturers instead of meeting network needs, as in the case of foreign manufacturers who choose to produce supporting industry products as domestic enterprises, and (2) causing environmental pollution and depleting host country resources due to involvement with supporting industry small- and medium-sized enterprises using outdated technology or with TNCs' strategies which invest overseas solely for purposes of natural resource exploitation.

Accordingly, the importance of competitive supporting industries as partners in MNCs' dynamic technology innovation and their positive roles as the recipients of technology transfer from MNCs has been stressed [24]. Additionally, domestic supporting industries may wish to take advantage of their relative geographical proximity to MNCs for purposes of rapid information flow and technical interchange. Therefore, it is important to note that for developing countries to establish competitive supporting industries, FDI-driven economic growth must occur as a prerequisite. Furthermore, domestic supporting industries are of increasing importance because they may act as a significant factor to attract FDI as well [2]. In a reverse sense, FDI will promote the development of supporting industries. Thus, attracting FDI for the development of supporting industries motivates an economy's sustainable level of growth, thus stimulating the national technological development and increasing national competitiveness on a global scale.

Evaluation criteria useful for analyzing the attraction of FDI for the development of supporting industries may be considered, as follows:

First, FDI inflows on supporting industry: The increase or decrease in FDI flow into supporting industries reflects the attractiveness of supporting industries for FDI enterprises as well as for those countries that receive the FDI. So, the FDI inflows to supporting industries are considered to be part of the capital flow on implementation, the number of projects in each industry, and the scale of FDI enterprises in those supporting industries.

Secondly, technological transfer from FDI enterprises to supporting industry enterprises: It reflects the quality of supporting industries products as well as the ability to receive technological transfer from TNCs, MNCs, and MNEs of domestic enterprises.

Thirdly, the association level between FDI enterprises and domestic enterprises: It expresses a connection between both domestic and FDI enterprises. It should be considered from two aspects: (i) the relationship between supporting industries enterprises with customers and suppliers and (ii) the correlation between supplying resources of internal businesses, importing, and domestic supplying resources.

Fourthly, development of human resources and management skills: It is wholly transferrable through FDI exchange to the host country.

Finally, environmental problems: Strict environmental regulations will nurture technological development and facilitate the creation of a "green" technology market [39].

There are two trends which are known to attract FDI for the development of industry in developing countries. These trends include, but are not limited to, (1) attracting FDI in assembly-related industries before investment in component manufacturing industries since the development of an assembly industry will promote the development of a component manufacturing industry and other

supporting industries (This is called a "linking effect" toward the inputs that will have an impact leading to the development of one industry with supporting industries in manufacturing intermediate inputs) and (2) attracting FDI in manufacturing industries before entering the component-assembling industry, so that the component manufacturing industry will develop before the assembly sector concerns; or, in other words, the development of a component industry will lead to the development of related assembly industries. As more and more facilities appear in an effort to supply intermediate equipment and materials, goods manufacturers and enterprises will soon have an even greater ability to access raw materials and component sources. Therefore, the average cost for manufacturing and assembling will decrease, and these countries shall continuously attract more multinational companies to set up new assembly plants at those relative locations [2].

Because of its status as a developing country, Vietnam has concentrated on attracting FDI to develop supporting industries. However, the attraction of FDI to develop supporting industries in Vietnam is still a weakness due to a deficient quantity of total governmental capital expenditure and qualitative infrastructure projects. The General Statistics Office of Vietnam [9] states that the total cumulative FDI for developing supporting industries is approximately US $29.7 billion, accounting for 16.8% quantity of FDI projects and 18.3% of the total FDI value in all supporting industries and main industries. This study examines the reality of developing supporting industries and attracting FDI for the development of supporting industries in Vietnam. The results indicate that there are eight important factors for making investment decisions by foreign investors whenever deciding to invest in Vietnam's supporting industries [6], including:

1. *Institutions and state policies*: This all-important factor creates just the right conditions for the development of supporting industries. The factorial impact may be expressed in two possible ways: First, it is the view of the state regarding the development of supporting industries to orient the national industrial development strategy to be consistent with the trend of globalization and international economic integration. The relationships needed to associate with the international economy must be expanded upon. It must be understood that the mutual assurance of relationships between supporting areas and industrial manufacturing sectors is not to be confined within a single country but within a regional or a global scale. Therefore, a unified view of any development regarding supporting industries is particularly important for national and industrial development of supporting industries to occur. Second, the policy on the development of industry and supporting industries in a country, which may or may not be developed, is largely dependent on the development strategies and policies decided by the state. Therefore, those policies related to promoting supporting industries, such as support for information technology, capital, provisions of association in business, etc., will greatly contribute to the promotional development of supporting industry. On the other hand, the localization policy; tax policy on importing and manufacturing semifinished products, both parts and components; the level of state-sponsored investment in scientific research and technology in supporting industry areas; the laws, standards, and technical regulations promulgated on behalf of industries; and diversification of products within the supporting industry networks can be seen to either facilitate or hinder the continued development of supporting industries. This is due in most part to the presence or the lack of a development-oriented perspective of the state as it is related to this issue [40, 41].

2. *Human resources:* Due to the manpower requirements of supporting industries, human resources are a principal factor maintaining a strong impact on future levels of industrial development and national supporting industries. The criteria of interest for determining human resources include the number, educational background, personal qualifications, absorptive capacity, self-discipline, communication skills (including language competency), drive for innovation, and professionalism of the human resources managers who are involved [2, 39, 42].

3. *Infrastructure facilities:* This remains an important influence needed to attract FDI for the development of strategic investment (SI). Any nation possessing appropriate infrastructure (i.e., transportation, power, information, and communication) conditions has an advantage in attracting FDI to develop supportive industries, while a lack of infrastructure means the opposite is inevitable [41].

4. *Domestic supply capability:* In order to ensure the domestic supply of materials, parts, and accessories for production-stage products derived from MNEs, the domestic supply chain (i.e., total value and partition of the domestic supply and the quantity and size of supporting industry firms) must have a huge number of offerings at its disposal, good quality, and cheap prices. It will greatly help MNEs to minimize the costs incurred for transportation and storage while guaranteeing the timely delivery through accurate production planning and the timely assembly of MNEs [43].

5. *Market size of supporting industries:* Market size (i.e., total consumption of supporting industries products) and outsourced procurement both play a central role in the development of SI. If a market is large enough to attract business participation in the supply of products and services, it will enable MNEs to easily facilitate partnership, make technology transfers possible, and establish business linkages [43].

6. *Technological development and innovation:* As a solid foundation for the development of principal industry, supporting industries require considerable regular investment in terms of modern machinery, capital equipment, and innovative technology. Assemblage enterprises consistently set out many stringent requirements for the technical standards involved in the production of component types and spare parts. Therefore, if the supporting enterprises do not apply modern technology and improved techniques in their manufacturing efforts, they will not be able to create products which match assemblers' exacting standards. At such a time, the assemblers will have to invest in the manufacturing of, or importation of, overseas components and parts by themselves to meet client needs [2, 18].

7. *International cooperation and competition:* The liberalization of trade and investment, through international forums and region, significantly reduces transaction costs, increases trade, and strengthens national competitiveness and international engagement. Moreover, the level of competition in attracting investment capital between countries is becoming ever more acute as global revenue pools shrink. To enhance competitiveness in attracting FDI, a growing number of countries have tried to adjust their national policies and to improve the local investment climate to become more attractive for foreign investment to occur [6].

8. *Other criteria*: The influence of attracting FDI toward the overall development of supporting industries is important. This factor (i.e., environment policy, culture, tax policy, land supporting, corruption, inclusion of MNEs) will lead to a positive ripple effect in the national economy, which, in turn, will lead to further employment opportunities, greater tax digest, and sustainable growth for the host nation [6].

When taken together, there are various alternative strategy policies possible for attracting FDI to develop supporting industries, namely: (1) attracting FDI for developing supporting industries, which motivates the economy's sustainable growth; (2) attracting FDI for developing supporting industries, which increases national competitiveness; and (3) attracting FDI for developing supporting industries, which stimulates the nation's technological development, leading to significant benefits overall.

3. Research methodology

Respective of this study, the proposed procedure utilizes the consistent fuzzy preference relations (CFPR) process to select a beneficial strategy for attracting foreign direct investment (FDI). The following section will give a brief description of the suggested CFPR method.

Herrera-Viedma et al. [9] proposed the consistent fuzzy preference relations methodology in accordance with two preference relations, namely, the multiplicative preference relation and fuzzy preference relation (10)–(16).

3.1 Multiplicative preference relations

A multiplicative preference relations A on a set of alternatives X is represented by a preference relations matrix $A \subset X \times X$, $A = (a_{ij})$, $a_{ij} \in \left[\frac{1}{9}, 9\right]$, where a_{ij} denotes the ratio of the preference degree of alternative x_i over x_j [44, 45]. As $a_{ij} = 1$ indicates no difference between x_i and x_j, $a_{ij} = 9$ indicates that x_i is strongly preferable to x_j. A is assumed to be a multiplicative reciprocal, that is,

$$a_{ij} \cdot a_{ji} = 1 \forall i, j \in \{1, \ldots, n\} \tag{1}$$

Definition 3.1. A reciprocal multiplicative preference relation $A = (a_{ij})$ is consistent if.

$$a_{ij} \cdot a_{jk} = a_{ik} \forall i, j, k = 1, \ldots, n \tag{2}$$

3.2 Fuzzy preference relation

Expert preferences over a set of alternatives where X is denoted by a positive preference relation matrix $P \subset X \times X$ with membership function $\beta_p : X \times X \rightarrow [0, 1]$, where $p_{ij} = \beta_p(x_i, x_j)$ indicates the ratio of the preference intensity of alternative x_i to that of x_j. Moreover, if $p_{ij} = \sum_{i=1}^{n} p_{ij}$ implies indifference between x_i and x_j ($x_i \sim x_j$), $p_{ij} = 1$ indicates that x_i is absolutely preferred to x_j, $p_{ij} = 0$ indicates x_j is absolutely preferred to x_i, and $p_{ij} > \frac{1}{2}$ indicates that x_i is preferred to x_i, $x_i > x_j$. Meanwhile, P is assumed to be an additive reciprocal, that is,

$$p_{ij} + p_{ji} = 1 \forall i, j \in \{1, \ldots, n\} \tag{3}$$

Proposition 3.1. Suppose that this paper has a set of alternatives, $X = \{x_1, \ldots, x_n\}$, and associated with it is a reciprocal multiplicative preference relation $A = (a_{ij})$ with $a_{ij} \in \left[\frac{1}{9}, 9\right]$. Then, the corresponding reciprocal fuzzy preference relation, $P = \left(p_{\text{ij}}\right)$, with $p_{\text{ij}} \in [0, 1]$ associated with A is given as follows:

$$p_{\text{ij}} = g(a_{\text{ij}}) = \frac{1}{2} \cdot (1 + \log_9 a_{\text{ij}}) \tag{4}$$

With such a transformation function g, this paper can relate the research issues obtained for both kinds of preference relations.

3.3 On consistency of the fuzzy preference relations

Proposition 3.2. Let $A = (a_{\text{ij}})$ be a consistent multiplicative preference relation; then the corresponding reciprocal fuzzy preference relations $P = \text{g}(A)$ verify additive transitivity property.

Proof. For $A = (a_{\text{ij}})$ being consistent, this paper has that $a_{\text{ij}} \cdot a_{jk} = a_{ik} \forall i, j, k$ or equivalently $a_{\text{ij}} \cdot a_{jk} \cdot a_{ki} = 1 \ \forall i, j, k$. Taking logarithms on both sides, it has.

$$\log_9 a_{\text{ij}} + \log_9 a_{jk} + \log_9 a_{ki} = 0 \forall i, j, k \tag{5}$$

Adding 3 to both sides and dividing by 2 yields.

$$\frac{1}{2} \cdot (1 + \log_9 a_{\text{ij}}) + \frac{1}{2} \cdot (1 + \log_9 a_{jk}) + \frac{1}{2} \cdot (1 + \log_9 a_{ki}) = \frac{3}{2} \forall i, j, k \tag{6}$$

The fuzzy preference relations $P = \text{g}(A)$, being $p_{\text{ij}} = \frac{1}{2} \cdot (1 + \log_9 a_{\text{ij}})$, verifies.

$$p_{\text{ij}} + p_{jk} + p_{ik} = \frac{3}{2} \forall i, j, k \tag{7}$$

We conclude that $P = \text{g}(A)$ verifies additive transitivity property.

In such a way, this paper considers the following definition of the consistent fuzzy preference relation:

Definition 3.3. A reciprocal fuzzy preference relation $P = (p_{\text{ij}})$ is consistent if.

$$p_{\text{ij}} + p_{jk} + p_{ki} = \frac{3}{2} \forall i, j, k = 1, \ldots n \tag{8}$$

In what follows, this paper will use the term additive consistency to refer to consistency for fuzzy preference relations based on the additive transitivity property.

3.4 Additive transitivity consistency of the fuzzy preference relations

Proposition 3.4-1. For a reciprocal fuzzy preference relation $P = (p_{\text{ij}})$, the following statements are equivalent:

$$\text{i. } p_{\text{ij}} + p_{jk} + p_{ki} = \frac{3}{2} \forall i, j, k \tag{9}$$

$$\text{ii. } p_{\text{ij}} + p_{jk} + p_{ki} = \frac{3}{2} \forall i < j < k \tag{10}$$

Proposition 3.4-2. A fuzzy preference relation $P = (p_{ij})$ is consistent if and only if.

$$p_{ij} + p_{jk} + p_{ki} = \frac{3}{2} \forall i \le j \le k \tag{11}$$

Proposition 3.4-3. For a reciprocal additive fuzzy preference relation $P = (p_{ij})$, the following statements are equivalent:

$$\text{i. } p_{ij} + p_{jk} + p_{ki} = \frac{3}{2} \forall i < j < k \tag{12}$$

$$\text{ii. } p_{i(i+1)} + p_{(i+1)(i+2)} + \ldots p_{(j-1)j} + p_{ji} = \frac{j-i+1}{2} \forall i < j \tag{13}$$

3.5 Construct a consistency of the fuzzy preference relations

If the preference matrix contains any values that are not in the interval $[0, 1]$, but in an interval $[-a, 1+a]$, being $a > 0$, a linear solution is required to preserve the reciprocity and additive transitivity, that is, $F : [-a, 1+a] \to [0, 1]$. Therefore, by Proposition 3.4, it can construct a consistent fuzzy preference relation P' on $X = \{x_1, x_2, \ldots, x_n; n \ge 2\}$ from $n-1$ preference values $\{p_{12}, p_{23}, \ldots, p_{n-1n}\}$; the steps are described in the following:

1. Compute the set of preference values B as

$$B = \left\{p_{ij}, i < j \wedge p_{ij} \notin \{p_{12}, p_{23}, \ldots, p_{n-1n}\}\right\}; p_{ij} = \frac{j-i+1}{2} - p_{ii+1} - p_{i+1i+2} - p_{j\text{-}1j} \tag{14}$$

$$a = \left| \min \{B \cup \{p_{12}, p_{23}, \ldots, p_{n-1n}\}\} \right| \tag{15}$$

$$P = \{p_{12}, p_{23}, \ldots, p_{n-1n}\} \cup B \cup \{1-p_{12}, 1-p_{23}, \ldots, 1-p_{n-1n}\} \cup \neg B \tag{16}$$

2. The consistent fuzzy preference relation P′ is obtained as $P' = f(P)$ such that

$$f : [-a, 1+a] \to [0, 1] \tag{17}$$

$$f(x) = \frac{x+a}{1+2a} \tag{18}$$

4. Framework for selecting a strategy for attracting FDI under multi-criteria decision-making

4.1 Evaluated criteria and framework of the evaluation model

As part of this study, 22 government staff members and policy-makers, foreign investors, managers of 6 supporting industries, and economists were interviewed in order to examine the current status of developing supporting industries and attracting FDI for developing supporting industries in Vietnam.

Their identifications and their attributes are summarized as follows: C_1, institutions and policies; C_2, human resources; C_3, infrastructure facilities; C_4, domestic supply capability; C_5, market size of supporting industries (total consumption of supporting industries' products); C_6, technological development and innovation; C_7, international cooperation and competition; and C_8, other criteria.

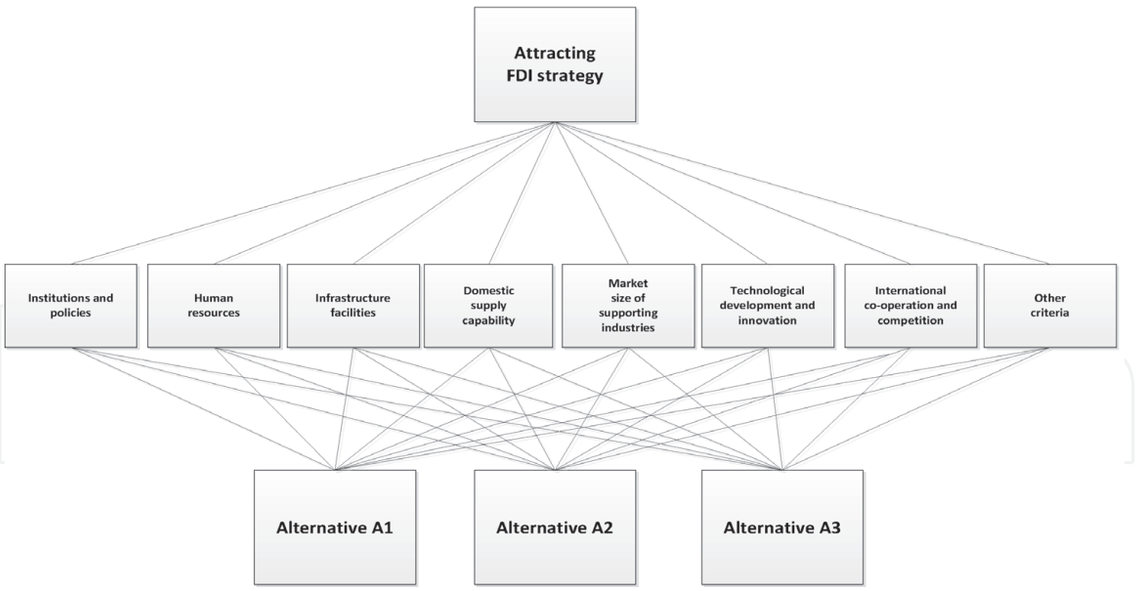

Figure 1.
Analytical framework to select a strategy for attracting FDI for Vietnam's supporting industries.

Following the analytical framework, there are candidate solutions for identifying the strategy useful toward attracting FDI and that will eventually develop supporting industries. These include attracting FDI for developing supporting industries, which motivates the economy's sustainable growth (A_1); attracting FDI for developing supporting industries, which increases national competitiveness (A_2); and attracting FDI for developing supporting industries, which stimulates the national technological development (A_3), respectively. An analytical hierarchy framework based on eight main criteria and three alternatives is established in **Figure 1**.

4.2 Hierarchical analytical process for selection of a strategy attracting FDI

4.2.1 Linguistic variables

This study compares certain pairs of criteria using expressions such as "equally important (EQ)," "moderately important (MO)," "strongly important (ST)," "very strongly important (VS)," and "absolutely important (AB)," using a 5-point Likert-type scale possessing values indicated by actual numbers (see **Table 1**).

Additionally, three linguistic variables, namely, "very high (VH)," "high (H)," and "fair (F)," are used to measure the strategy for attracting FDI to develop supporting industries in Vietnam (see **Table 2**).

Definition	Intensity of importance
Equally important (EQ)	1
Moderate important (MO)	3
Strongly important (ST)	5
Very strongly important (VS)	7
Absolutely important (AB)	9
Intermediate values between two adjacent judgments	2, 4, 6, 8

Table 1.
Linguistic terms for priority weights of influential factors to attract FDI.

Definition	Intensity of importance
Fair (F)	1
High (H)	3
Very high (VH)	5
Intermediate values use to present compromise	2, 4

Table 2.
Linguistic variables for the priority rating of attracting FDI strategy.

4.2.2 Reciprocal additive consistent fuzzy preference relations for prioritizing the evaluation criteria

AHP separates a complex decision issue into elemental problems to produce a hierarchical model. Each of these preference relations necessitates the completion of all $\frac{n\cdot(n+1)}{2}$ judgments for a preference matrix containing n elements. To reduce the judgment times, this study employs the reciprocal additive consistent fuzzy preference relation designed by Herrera-Viedma et al. [9] because it requires only $n-1$ judgments from a set of n elements.

The procedures of the reciprocal additive consistent fuzzy preference relations for prioritizing the assessment criteria are given below:

1. Establish pairwise comparison matrices among all of the criteria $(C_i, i = 1, 2, \ldots, n)$ in the dimensions of the hierarchy system. The evaluators $(E_k, k = 1, 2, \ldots, m)$ provide the more important of each of the pairs of considered criteria for a set of n-1 preference values $\left(a_{12}, a_{23}, \ldots, a_{(n-1)n}\right)$, for

$$A^k = \begin{array}{c} \\ C_1 \\ C_2 \\ \vdots \\ C_{n-1} \\ C_n \end{array} \begin{array}{c} \begin{array}{ccccc} C_1 & C_2 & \cdots & C_{n-1} & C_n \end{array} \\ \begin{bmatrix} 1 & a_{12}^k & \cdots & x & x \\ x & 1 & a_{23}^k & x & x \\ \vdots & \vdots & \ddots & \ddots & \vdots \\ x & x & \cdots & 1 & a_{n-1n}^k \\ x & x & \cdots & x & 1 \end{bmatrix} \end{array} \tag{19}$$

where a_{ij}^k denotes the preference intensity toward considered criteria i and j, which are assessed by evaluator k; $a_{ij} = 1$ indicates no difference between considered criteria i and j; $a_{ij} = 3, 5, 7, 9$ reveals that criterion i is relatively important to criterion j; and $a_{ij} = \frac{1}{3}, \frac{1}{5}, \frac{1}{7}, \frac{1}{9}$ indicates that considered criterion i is less important than criterion j. The sign "x" indicates the remaining a_{ij}^k, which can be done via inverse comparison.

2. Transform the preference value a_{ij}^k into p_{ij}^k using an interval scale $[0, 1]$, and then derive the remaining p_{ij}^k based on the reciprocal transitivity property, as follows:

$$P^k = \frac{1}{2}(1+\log_9 A^k) = \begin{array}{c} \\ C_1 \\ C_2 \\ \vdots \\ C_n \end{array} \begin{array}{c} \begin{array}{cccc} C_1 & C_2 & \ldots & C_n \end{array} \\ \begin{bmatrix} 0.5 & p_{12}^k & x & x \\ x & 0.5 & p_{23}^k & x \\ \vdots & \vdots & \vdots & \vdots \\ x & x & \ldots & 0.5 \end{bmatrix} \end{array} \tag{20}$$

where $p_{ij} = 0.5$ indicates no difference between criteria i and j, $p_{ij} = 1$ demonstrates that criterion i is absolutely important to criterion j, and $p_{ij} = 0$ illustrates that criterion i is absolutely less important to criterion j. The remaining p_{ij}^k can be calculated using Eqs. (3) and (13), but in an interval $[-a, 1+a]$, and a transformation function is required to preserve the reciprocity and additive transitivity. The transformation function is

$$f\left(p_{ij}^k\right) = \frac{p_{ij}^k + a}{1 + 2 \cdot a} \tag{21}$$

where a denotes the absolute value of the minimum negative value or maximum positive value minus one in this preference matrix.

3. The study pulled the opinions of evaluators to obtain the aggregated weights of the criteria. Moreover, let p_{ij}^k denote the transformed fuzzy preference value of evaluator k for assessing the criteria i and j. This study uses the notation of the average value to integrate the judgment values of m evaluators, namely,

$$p_{ij} = \left(p_{ij}^1 + p_{ij}^2 + \ldots + p_{ij}^m\right)/m \tag{22}$$

4. Normalizing the aggregated fuzzy preference relation matrices q_{ij} is used to indicate the normalized fuzzy preference values of each considered criteria, such as

$$q_{ij} = p_{ij} / \sum_{i=1}^{n} p_{ij} \tag{23}$$

5. Using the ϖ_i denoting the average priority weight of considered criterion i, the priority of each criterion can be obtained, that is,

$$\varpi_i = \frac{1}{n} \cdot \sum_{i=1}^{n} q_{ij} \tag{24}$$

where n denotes the number of criteria considered.

4.2.3 Obtaining the synthetic utility value for a strategy attracting FDI with respect to each criterion

The evaluators were asked to express their subjective judgments regarding the preference ratings of a strategy for attracting FDI $(A_r, r = 1, 2, \ldots, s)$ with respect to each considered criteria in linguistic terms.

1. For each considered criteria, the evaluators were asked to choose the best among three attracting FDI strategies for a set of $s-1$ preference data $(o_{12}, o_{23}, \ldots, o_{(s-1)s})$, for example,

$$ {}_iG = \begin{array}{c} \\ A_1 \\ A_2 \\ \vdots \\ A_s \end{array} \begin{array}{c} \begin{array}{cccc} A_1 & A_2 & \ldots & A_s \end{array} \\ \begin{bmatrix} 1 & {}_ig_{12}^k & x & x \\ x & 1 & {}_ig_{23}^k & x \\ \vdots & \vdots & \vdots & {}_ig_{(s-1)s}^k \\ x & x & \ldots & 1 \end{bmatrix} \end{array} \tag{25} $$

where ${}_io_{rt}^k$ represents the performance value assigned by evaluator k to attract FDI strategy r and t based on considered criterion i.

2. Next, the preference value ${}_io_{rt}^k$ is transformed within the range $\left[\frac{1}{5}, 5\right]$ into ${}_iu_{rt}^k$ in an interval scale $[0, 1]$, and the remaining ${}_iu_{rt}^k$ are obtained via the reciprocal transitivity property as follows:

$$ {}_iQ = \frac{1}{2}(1 + \log_5 {}_iG) = \begin{array}{c} \\ A_1 \\ A_2 \\ \vdots \\ A_s \end{array} \begin{array}{c} \begin{array}{cccc} A_1 & A_2 & \ldots & A_s \end{array} \\ \begin{bmatrix} 0.5 & {}_iq_{12}^k & x & x \\ x & 0.5 & {}_iq_{23}^k & x \\ \vdots & \vdots & \vdots & {}_iq_{(s-1)s}^k \\ x & x & \ldots & 0.5 \end{bmatrix} \end{array} \tag{26} $$

3. The opinions of evaluators are then taken to obtain the transformed synthetic rating of the strategy for attracting FDI for each considered criteria ${}_iu_{rt}^k$ which denotes the transformed fuzzy preference value of evaluator k for assessing strategies for attracting FDI r and t in terms of considered criterion i. This study uses the notation of average value to integrate the judgment values of m evaluators, that is,

$$ {}_iu_{rt} = \frac{1}{m} \cdot \sum_{j=1}^{m} {}_iu_{rt}^k \tag{27} $$

4. Following the normalization of the synthetic fuzzy preference rating of the strategy for attracting FDI for each considered criteria, ${}_i\alpha_{rt}$ is adopted to indicate the normalized rating of the strategies for attracting FDI u and v with respect to considered criterion i, for example,

$$ {}_i\alpha_{rt} = {}_iu_{rt} / \sum_{r=1}^{s} {}_iu_{rt} \tag{28} $$

5. Consequently, ${}_i\overline{\beta}_r$ denotes the average rating of the strategy for attracting FDI r with respect to considered criterion i. The desired rating of each strategy for attracting FDI can be derived for each considered criterion, that is,

$$ {}_i\overline{\beta}_r = \frac{1}{s} \cdot \sum_{t=1}^{s} \alpha_{rt} \tag{29} $$

where s represents the number of the strategy for attracting FDI.

4.2.4 Obtaining the priority weight for selection

A preferred value U_r for developing supporting industries in Vietnam is obtained by multiplying the priority weights of considered criteria by the ratings of the strategy for attracting FDI. That is,

$$U_r = \sum_{i=1}^{n} {}_i\overline{\beta}_r \cdot \varpi_i \mathrm{R_u} = \sum\nolimits_{\mathrm{i}} \bar{\imath}_{\mathrm{u}} * \varpi_{\mathrm{i}} \tag{30}$$

where ϖ_i denotes the aggregated weight of considered criterion i.

5. Results

This study used six supporting industries in Vietnam to serve as examples to demonstrate the efficacy of the theoretical framework proposed in this study. A total of 22 questionnaires were dispatched and effectively returned, with survey candidates including managers from the Vietnamese Local Industry Department and the Vietnamese Foreign Investment Agency, policy-makers, economists, foreign investors, and managers from representatives of the six supporting industries located in Vietnam.

5.1 Weighting calculation of the evaluating criteria

Eight major evaluation criteria are considered as part of the problem of selecting a strategy for attracting FDI considered herein. The pairwise comparisons for these eight criteria are obtained by means of interviews with the assessment representatives involved in this study.

The following examples clarify the computational process used to derive the priority weights using the reciprocal additive consistent fuzzy preference relation approach:

1. Based on the interviews taken with the 22 representatives regarding the relative importance of eight aforementioned evaluation criteria, **Table 3** lists the pairwise comparison matrices for a set of $n - 1$ neighboring criteria $\{a_{12}, a_{23}, \ldots, a_{78}\}$ with their corresponding numbers.

2. The assessment of evaluator 1 (E_1) may serve as an example, and it is listed in **Table 4**. Also listed are the linguistic terms, which are transferrable into corresponding numbers.

3. Eq. (4) was used to transform the elements (listed in **Table 4**) into an interval [0, 1], yielding the following values:

$$p_{12} = (1 + \log_9 9.0000)/2 = 1.0000;\ p_{23} = (1 + \log_9 5.0000)/2 = 0.8662;$$
$$p_{34} = (1 + \log_9 0.2500)/2 = 0.1845;\ p_{45} = (1 + \log_9 7.0000)/2 = 0.8662;$$
$$p_{56} = (1 + \log_9 0.3333)/2 = 0.2500;\ p_{67} = (1 + \log_9 7.0000)/2 = 0.9428;$$
$$p_{78} = (1 + \log_9 3.0000)/2 = 0.7500.$$

The remaining value then can be calculated using Eqs. (3) and (13) with $p_{21}, p_{31}, p_{81}, p_{82}, p_{28}$, etc., being used as examples:

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	E_1	**E_2**	**E_3**	**E_4**	**E_5**	**E_6**	**E_7**	**E_8**	**E_9**	**E_{10}**	**E_{11}**	**E_{12}**	**E_{13}**	**E_{14}**	**E_{15}**	**E_{16}**	**E_{17}**	**E_{18}**	**E_{19}**	**E_{20}**	**E_{21}**	**E_{22}**	
C_1	9	9	7	8	3	9	6	4	9	8	5	7	9	7	5	9	7	8	6	9	5	8	C_2
C_2	5	6	5	6	2	5	4	3	6	5	4	5	7	4	3	7	6	5	4	5	4	5	C_3
C_3	1/4	1/7	1/4	1/6	1/4	1/7	1/1	1/5	1/4	1/6	¼	1/5	1/7	1/5	1/4	1/6	1/5	1/5	1/4	1/6	1/5	1/3	C_4
C_4	5	8	6	7	4	8	5	4	8	7	5	7	8	6	5	7	8	7	5	8	5	6	C_5
C_5	1/3	1/2	1/4	1/3	2	1/3	1	1/2	1	1/2	1	1/3	12	1/2	1/3	1	1/2	2	1/3	1	1/3	½	C_6
C_6	7	8	7	8	5	7	5	6	8	7	6	7	8	6	5	8	8	7	6	7	6	5	C_7
C_7	3	3	1/2	2	1	1/2	1	2	2	1	½	3	2	2	1	1/3	3	1	1/2	2	2	1	C_8

Table 3.
The linguistic terms into corresponding numbers toward eight factors assessed by evaluators.

E_1	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8
C_1	1.0000	9.0000	x	x	x	x	x	x
C_2	x	1.0000	5.0000	x	x	x	x	x
C_3	x	x	1.0000	0.2500	x	x	x	x
C_4	x	x	x	1.0000	5.0000	x	x	x
C_5	x	x	x	x	1.0000	0.3333	x	x
C_6	x	x	x	x	x	1.0000	7.0000	x
C_7	x	x	x	x	x	x	1.0000	3.0000
C_8	x	x	x	x	x	x	x	1.0000

Where x is a variable that can be calculated using Eqs. (3) and (13).

Table 4.
Interval pairwise comparisons of the criteria.

$$p_{21} = 1 - p_{12} = 1 - 1.0000 = 0.0000;$$

$$p_{31} = \frac{3-1+1}{2} - p_{12} - p_{23} = 1.5 - 1.0000 - 0.8662 = -0.3662;$$

$$p_{81} = \frac{8-1+1}{2} - p_{12} - p_{23} - p_{34} - p_{45} - p_{56} - p_{67} - p_{78} = 4 - 1.0000 - 0.8662 - 0.1845 - 0.8662 - 0.2500 - 0.9428 - 0.7500 = -0.8598;$$

$$p_{82} = \frac{8-2+1}{2} - p_{23} - p_{34} - p_{45} - p_{56} - p_{67} - p_{78} = 3.5 - 0.8662 - 0.1845 - 0.8662 - 0.2500 - 0.9428 - 0.7500 = -0.3598;$$

$$p_{28} = 1 - p_{82} = 1 - (-0.3598) = 1.3598;$$

The fuzzy preference relation matrix for the eight evaluation criteria assessed by evaluator 1 is established in **Table 5**.

Table 5 lists $p_{13}, p_{14}, p_{15}, p_{16}, p_{17}, p_{18}, p_{27}, p_{28}, p_{31}, p_{41}, p_{47}, p_{48}, p_{51}, p_{61}, p_{68}, p_{71}, p_{72}, p_{74}, p_{81}, p_{82}, p_{84}$, and p_{86} elements but not in the interval [0, 1]; and thus a linear transformation stated in Eq. (21) is employed to ensure the reciprocity and additive transitivity for the preference relation matrix. **Table 6** lists the transformation matrix.

4. Likewise, the above computational procedures can calculate the fuzzy preference relation matrices of the other 21 evaluators; therefore, using Eq. (22), the aggregated pairwise comparison matrix of 22 evaluators can be derived, as listed in **Table 7**.

5. Eq. (23) is applied to normalize the aggregated pairwise comparison matrix. Taking q_{11} as an example:

q_{11} = 0.5000/(0.5000 + 0.3245 + 0.1859 + 0.3324 + 0.1659 + 0.2172 + 0.0434 + 0.0333) = 0.2774.

The priority weight of each evaluation criterion can then be obtained by Eq. (24). The priority weight and rank of each influence is assessed by 22 evaluators as listed in **Table 8**.

The ranks of the evaluation criteria weights thus are substituted as:

$C_1(0.2022) > C_4(0.1551) > C_2(0.1529) > C_6(0.1227) > C_3(0.1139) > C_5(0.1083) > C_7(0.0738) > C_8(0.0710)$.

The results show that the six main assessment attributes are institutions and policies (0.2022), domestic supply capacity (0.1551), human resources (0.1529), technological development and innovation (0.1227), infrastructure facilities

E_1	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8
C_1	0.5000	1.0000	1.3662	1.0508	1.4170	1.1670	1.6098	1.8598
C_2	0.0000	0.5000	0.8662	0.5508	0.9170	0.6670	1.1098	1.3598
C_3	−0.3662	0.1338	0.5000	0.1845	0.5508	0.3008	0.7436	0.9936
C_4	−0.0508	0.4492	0.8155	0.5000	0.8662	0.6162	1.0590	1.3090
C_5	−0.4170	0.0830	0.4492	0.1338	0.5000	0.2500	0.6928	0.9424
C_6	−0.1670	0.3330	0.6992	0.3838	0.7500	0.5000	0.9428	1.1928
C_7	−0.6098	−0.1098	0.2564	−0.0590	0.3072	0.0572	0.5000	0.7500
C_8	−0.8598	−0.3598	0.0064	−0.3090	0.0572	−0.1928	0.2500	0.5000

Table 5.
Consistent fuzzy preference relations matrix of criteria E_1.

E_1	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8
C_1	0.5000	0.6834	0.8185	0.7025	0.8372	0.7453	0.9081	1.0000
C_2	0.3162	0.5000	0.6347	0.5187	0.6533	0.5614	0.7242	0.8162
C_3	0.1815	0.3653	0.5000	0.3840	0.5187	0.4267	0.5896	0.6815
C_4	0.2975	0.4813	0.6160	0.5000	0.6347	0.5427	0.7056	0.7975
C_5	0.1628	0.3467	0.4813	0.3653	0.5000	0.4081	0.5709	0.6628
C_6	0.2547	0.4386	0.5733	0.4573	0.5919	0.5000	0.6628	0.7547
C_7	0.0919	0.2758	0.4104	0.2944	0.4291	0.3372	0.5000	0.5919
C_8	0.0000	0.1838	0.3185	0.2025	0.3372	0.2453	0.4081	0.5000

Table 6.
The transformation matrix of criteria by linear solution.

E	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8
C_1	0.5000	0.6755	0.8141	0.6676	0.8341	0.7828	0.9566	0.9667
C_2	0.3245	0.5000	0.6385	0.4921	0.6586	0.6073	0.7811	0.7911
C_3	0.1859	0.3615	0.5000	0.3536	0.5201	0.4687	0.6425	0.6526
C_4	0.3324	0.5079	0.6464	0.5000	0.6665	0.6151	0.7889	0.7990
C_5	0.1659	0.3414	0.4799	0.3335	0.5000	0.4487	0.6225	0.6326
C_6	0.2172	0.3927	0.5313	0.3849	0.5513	0.5000	0.6738	0.6839
C_7	0.0434	0.2189	0.3575	0.2111	0.3775	0.3262	0.5000	0.5101
C_8	0.0333	0.2089	0.3474	0.2010	0.3674	0.3161	0.4899	0.5000
Total	1.8026	3.2068	4.3151	3.1438	4.4756	4.0649	5.4553	5.5360

Table 7.
Aggregated pairwise comparison matrices of the 22 evaluators.

E	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	Total	Weight	Ranking
C_1	0.2774	0.2107	0.1887	0.2124	0.1864	0.1926	0.1754	0.1746	1.6180	0.2022	1
C_2	0.1800	0.1559	0.1480	0.1565	0.1472	0.1494	0.1432	0.1429	1.2231	0.1529	3
C_3	0.1032	0.1127	0.1159	0.1125	0.1162	0.1153	0.1178	0.1179	0.9114	0.1139	5
C_4	0.1844	0.1584	0.1498	0.1590	0.1489	0.1513	0.1446	0.1443	1.2408	0.1551	2
C_5	0.0920	0.1065	0.1112	0.1061	0.1117	0.1104	0.1141	0.1143	0.8663	0.1083	6
C_6	0.1205	0.1225	0.1231	0.1224	0.1232	0.1230	0.1235	0.1235	0.9818	0.1227	4
C_7	0.0241	0.0683	0.0828	0.0671	0.0844	0.0802	0.0917	0.0921	0.5907	0.0738	7
C_8	0.0185	0.0651	0.0805	0.0639	0.0821	0.0778	0.0898	0.0903	0.5680	0.0710	8
Total	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	8.0000	1.0000	

Table 8.
Normalized matrix of priority weight and rank of influential factors.

(0.1139), and market size of supporting industries (0.1083). Meanwhile, the two least important attributes are international cooperation and competition (0.0738) and other criteria (0.0710).

5.2 Calculation of the weights for a strategy attracting FDI with respect to evaluation criteria

To determine the priority weight matrix for a strategy to attract FDI with respect to each evaluation criterion, **Table 2** lists the linguistic variables for evaluators. The priority weights of the three attractive FDI strategies are calculated as follows:

1. This study examines the implementation of this strategy for attracting FDI for developing supporting industries; the 22 evaluators are interviewed to assess which path is more likely to occur according to each evaluation criteria. **Table 9** lists the opinions of these 22 evaluators regarding their preference intensities related to the strategy for attracting FDI with respect to each evaluation criterion, and the linguistic term is assigned into the corresponding numbers.

2. The study uses this function, $p_{ij} = \frac{1}{2}\left(1 + \log_5 a_{ij}\right)$, to transform the values in the scale $\left[\frac{1}{5}, 5\right]$ into the interval [0, 1]. **Table 10** lists the transformed preference data.

3. Using Eq. (27), and taking ${}_1u_{rt}$ as an example, the synthetic rating of a strategy for attracting FDI can be obtained (as listed in **Table 11**), where ${}_1u_{rt}$ represented the transformed fuzzy preference value of 22 evaluators for assessing strategies for r and t for attracting FDI in terms of evaluating criteria 1. Eqs. (28) and (29) can then be employed to normalize and synthesize the fuzzy preference rating of 3 attracting FDI strategies based on eight evaluation criteria. **Table 12** lists the normalized values and priority weights, while **Table 13** lists the normalized values and priority weights of all of the criteria.

5.3 Weighting the selection priorities

Using Eq. (30), the priority weights of the eight evaluation criteria and the priority ratings of three strategies for attracting FDI are given, in addition to the preference weightings of the candidates. They are listed in **Table 13**. The preferred weights for the strategy for attracting FDI are calculated as follows:

$$\begin{aligned} A_1 &= 0.2022 * 0.4405 + 0.1529 * 0.4396 + 0.1139 * 0.4378 + 0.1551 * 0.4427 \\ &\quad + 0.1083 * 0.4290 + 0.1227 * 0.4318 + 0.0738 * 0.4366 + 0.0710 * 0.4354 \\ &= 0.4374 \end{aligned}$$

$$\begin{aligned} A_2 &= 0.2022 * 0.2441 + 0.1529 * 0.2333 + 0.1139 * 0.2292 + 0.1551 * 0.2238 \\ &\quad + 0.1083 * 0.2367 + 0.1227 * 0.2236 + 0.0738 * 0.2321 + 0.0710 * 0.2247 \\ &= 0.2320 \end{aligned}$$

$$\begin{aligned} A_3 &= 0.2022 * 0.3155 + 0.1529 * 0.3271 + 0.1139 * 0.3330 + 0.1551 * 0.3335 \\ &\quad + 0.1083 * 0.3343 + 0.1227 * 0.3446 + 0.0738 * 0.3312 + 0.0710 * 0.3399 \\ &= 0.3306 \end{aligned}$$

From **Table 13**, the ranking of alternative solutions is obtained as follows: Alternative A_1 (0.4374) > alternative A_3 (0.3306) > alternative A_2 (0.2320). Evaluators clearly believe that the best policy for creating and implementing a strategy to

		E_1	E_2	E_3	E_4	E_5	E_6	E_7	E_8	E_9	E_{10}	E_{11}	E_{12}	E_{13}	E_{14}	E_{15}	E_{16}	E_{17}	E_{18}	E_{19}	E_{20}	E_{21}	E_{22}	
C_1	A_1	2.0000	3.0000	2.0000	4.0000	2.0000	5.0000	3.0000	4.0000	3.0000	3.0000	4.0000	2.0000	4.0000	1.0000	2.0000	3.0000	3.0000	1.0000	3.0000	4.0000	0.5000	4.0000	A_2
	A_2	0.5000	1.0000	0.2500	2.0000	0.3333	0.5000	1.0000	2.0000	0.5000	2.0000	0.5000	1.0000	1.0000	2.0000	1.0000	0.5000	1.0000	0.5000	0.3333	0.5000	1.0000	0.3333	A_3
C_2	A_1	3.0000	4.0000	2.0000	3.0000	1.0000	3.0000	4.0000	0.5000	4.0000	2.0000	3.0000	2.0000	3.0000	5.0000	3.0000	2.0000	4.0000	2.0000	5.0000	3.0000	4.0000	3.0000	A_2
	A_2	1.0000	0.5000	1.0000	1.0000	0.5000	0.3333	0.5000	1.0000	0.3333	0.5000	1.0000	0.2500	0.5000	2.0000	1.0000	0.2500	2.0000	0.3333	0.5000	1.0000	2.0000	0.5000	A_3
C_3	A_1	4.0000	2.0000	5.0000	3.0000	4.0000	3.0000	3.0000	4.0000	2.0000	5.0000	3.0000	3.0000	5.0000	2.0000	1.0000	3.0000	4.0000	0.5000	4.0000	2.0000	3.0000	2.0000	A_2
	A_2	2.0000	0.3333	0.5000	1.0000	2.0000	0.5000	2.0000	0.5000	1.0000	3.0000	0.3333	0.5000	0.5000	0.2500	0.5000	0.3333	0.5000	1.0000	0.3333	0.5000	1.0000	0.2500	A_3
C_4	A_1	2.0000	5.0000	2.0000	4.0000	2.0000	5.0000	3.0000	4.0000	3.0000	3.0000	4.0000	2.0000	2.0000	5.0000	3.0000	4.0000	0.5000	4.0000	2.0000	3.0000	2.0000	4.0000	A_2
	A_2	0.3333	0.5000	0.2500	2.0000	0.3333	0.5000	1.0000	2.0000	0.5000	2.0000	0.5000	1.0000	0.3333	0.5000	0.3300	0.5000	1.0000	0.3333	0.5000	1.0000	0.2500	2.0000	A_3
C_5	A_1	5.0000	2.0000	2.0000	3.0000	2.0000	4.0000	2.0000	5.0000	3.0000	4.0000	3.0000	3.0000	3.0000	1.0000	1.0000	3.0000	4.0000	1.0000	4.0000	2.0000	3.0000	2.0000	A_2
	A_2	2.0000	0.3333	0.5000	1.0000	0.2500	2.0000	0.3333	0.5000	1.0000	2.0000	0.5000	2.0000	1.0000	0.5000	0.5000	0.3333	0.5000	1.0000	0.3333	0.5000	1.0000	0.2500	A_3
C_6	A_1	4.0000	3.0000	3.0000	4.0000	1.0000	3.0000	4.0000	0.5000	4.0000	2.0000	3.0000	2.0000	2.0000	5.0000	4.0000	2.0000	3.0000	2.0000	4.0000	2.0000	5.0000	3.0000	A_2
	A_2	2.0000	0.5000	2.0000	0.5000	0.5000	0.3300	0.5000	1.0000	0.3333	0.5000	1.0000	0.2500	0.3333	0.5000	0.3333	0.5000	1.0000	0.2500	2.0000	0.3333	0.5000	1.0000	A_3
C_7	A_1	4.0000	3.0000	3.0000	1.0000	3.0000	4.0000	0.5000	4.0000	2.0000	3.0000	2.0000	3.0000	2.0000	3.0000	2.0000	4.0000	2.0000	5.0000	3.0000	4.0000	3.0000	3.0000	A_2
	A_2	0.5000	0.5000	1.0000	0.5000	0.3333	0.5000	1.0000	0.3333	0.5000	1.0000	0.2500	1.0000	0.5000	1.0000	0.2500	2.0000	0.3333	0.5000	1.0000	2.0000	0.5000	2.0000	A_3
C_8	A_1	3.0000	4.0000	0.5000	4.0000	2.0000	3.0000	2.0000	4.0000	2.0000	5.0000	3.0000	4.0000	3.0000	4.0000	2.0000	4.0000	2.0000	5.0000	3.0000	3.0000	3.0000	1.0000	A_2
	A_2	0.3333	0.5000	1.0000	0.3300	0.5000	1.0000	0.2500	2.0000	0.3333	0.5000	1.0000	2.0000	0.3333	0.5000	0.2500	2.0000	0.3333	0.5000	1.0000	0.5000	1.0000	0.5000	A_3

Table 9.
The linguistic term with its corresponding number to the priority weight of three attractive FDI strategies.

		E_1	E_2	E_3	E_4	E_5	E_6	E_7	E_8	E_9	E_{10}	E_{11}	E_{12}	E_{13}	E_{14}	E_{15}	E_{16}	E_{17}	E_{18}	E_{19}	E_{20}	E_{21}	E_{22}	
C_1	A_1	0.7153	0.8413	0.7153	0.9307	0.7153	1.0000	0.8413	0.9307	0.8413	0.8413	0.9307	0.7153	0.9307	0.5000	0.7153	0.8413	0.8413	0.5000	0.8413	0.9307	0.2847	0.9307	A_2
	A_2	0.2847	0.5000	0.0693	0.7153	0.1587	0.2847	0.5000	0.7153	0.2847	0.7153	0.2847	0.5000	0.5000	0.7153	0.5000	0.2847	0.5000	0.2847	0.1587	0.2847	0.5000	0.1587	A_3
C_2	A_1	0.8413	0.9307	0.7153	0.8413	0.5000	0.8413	0.9307	0.2847	0.9307	0.7153	0.8413	0.7153	0.8413	1.0000	0.8413	0.7153	0.9307	0.7153	1.0000	0.8413	0.9307	0.8413	A_2
	A_2	0.5000	0.2847	0.5000	0.5000	0.2847	0.1587	0.2847	0.5000	0.1587	0.2847	0.5000	0.0693	0.2847	0.7153	0.5000	0.0693	0.7153	0.1587	0.2847	0.5000	0.7153	0.2847	A_3
C_3	A_1	0.9307	0.7153	1.0000	0.8413	0.9307	0.8413	0.8413	0.9307	0.7153	1.0000	0.8413	0.8413	1.0000	0.7153	0.5000	0.8413	0.9307	0.2847	0.9307	0.7153	0.8413	0.7153	A_2
	A_2	0.7153	0.1587	0.2847	0.5000	0.7153	0.2847	0.7153	0.2847	0.5000	0.8413	0.1587	0.2847	0.2847	0.0693	0.2847	0.1587	0.2847	0.5000	0.1587	0.2847	0.5000	0.0693	A_3
C_4	A_1	0.7153	1.0000	0.7153	0.9307	0.7153	1.0000	0.8413	0.9307	0.8413	0.8413	0.9307	0.7153	0.7153	1.0000	0.8413	0.9307	0.2847	0.9307	0.7153	0.8413	0.7153	0.9307	A_2
	A_2	0.1587	0.2847	0.0693	0.7153	0.1587	0.2847	0.5000	0.7153	0.2847	0.7153	0.2847	0.5000	0.1587	0.2847	0.1556	0.2847	0.5000	0.1587	0.2847	0.5000	0.0693	0.7153	A_3
C_5	A_1	1.0000	0.7153	0.7153	0.8413	0.7153	0.9307	0.7153	1.0000	0.8413	0.9307	0.8413	0.8413	0.8413	0.5000	0.5000	0.8413	0.9307	0.5000	0.9307	0.7153	0.8413	0.7153	A_2
	A_2	0.7153	0.1587	0.2847	0.5000	0.0693	0.7153	0.1587	0.2847	0.5000	0.7153	0.2847	0.7153	0.5000	0.2847	0.2847	0.1587	0.2847	0.5000	0.1587	0.2847	0.5000	0.0693	A_3
C_6	A_1	0.9307	0.8413	0.8413	0.9307	0.5000	0.8413	0.9307	0.2847	0.9307	0.7153	0.8413	0.7153	0.7153	1.0000	0.9307	0.7153	0.8413	0.7153	0.9307	0.7153	1.0000	0.8413	A_2
	A_2	0.7153	0.2847	0.7153	0.2847	0.2847	0.1556	0.2847	0.5000	0.1587	0.2847	0.5000	0.0693	0.1587	0.2847	0.1587	0.2847	0.5000	0.0693	0.7153	0.1587	0.2847	0.5000	A_3
C_7	A_1	0.9307	0.8413	0.8413	0.5000	0.8413	0.9307	0.2847	0.9307	0.7153	0.8413	0.7153	0.8413	0.7153	0.8413	0.7153	0.9307	0.7153	1.0000	0.8413	0.9307	0.8413	0.8413	A_2
	A_2	0.2847	0.2847	0.5000	0.2847	0.1587	0.2847	0.5000	0.1587	0.2847	0.5000	0.0693	0.5000	0.2847	0.5000	0.0693	0.7153	0.1587	0.2847	0.5000	0.7153	0.2847	0.7153	A_3
C_8	A_1	0.8413	0.9307	0.2847	0.9307	0.7153	0.8413	0.7153	0.9307	0.7153	1.0000	0.8413	0.9307	0.8413	0.9307	0.7153	0.9307	0.7153	1.0000	0.8413	0.8413	0.8413	0.5000	A_2
	A_2	0.0693	0.7153	0.1587	0.2847	0.5000	0.2847	0.5000	0.2847	0.1587	0.2847	0.5000	0.1556	0.2847	0.5000	0.0693	0.7153	0.1587	0.2847	0.5000	0.7153	0.5000	0.2847	A_3

Table 10.
The transformed fuzzy preference value of three attractive FDI strategies.

C_1	A_1	A_2	A_3
A_1	0.5000	0.7775	0.6766
A_2	0.2225	0.5000	0.3991
A_3	0.3234	0.6009	0.5000
Total	1.0459	1.8784	1.5757

Table 11.
Aggregated pairwise comparison matrices 22 evaluator of C_1.

C_1	A_1	A_2	A_3	Total	Average
A_1	0.4781	0.4139	0.4294	1.3214	0.4405
A_2	0.2127	0.2662	0.2533	0.7322	0.2441
A_3	0.3092	0.3199	0.3173	0.9464	0.3155
Total				3.0000	1.0000

Table 12.
Normalized matrix of priority weight of C_1.

	Weight	Priority			Weighted rate		
		A_1	A_2	A_3	A_1	A_2	A_3
C_1	0.2022	0.4405	0.2441	0.3155	0.0891	0.0494	0.0638
C_2	0.1529	0.4396	0.2333	0.3271	0.0672	0.0357	0.0500
C_3	0.1139	0.4378	0.2292	0.3330	0.0499	0.0261	0.0379
C_4	0.1551	0.4427	0.2238	0.3335	0.0687	0.0347	0.0517
C_5	0.1083	0.4290	0.2367	0.3343	0.0465	0.0256	0.0362
C_6	0.1227	0.4318	0.2336	0.3446	0.0530	0.0274	0.0423
C_7	0.0738	0.4366	0.2321	0.3112	0.0322	0.0171	0.0245
C_8	0.0710	0.4354	0.2347	0.3399	0.0309	0.0160	0.0241
Total	1.0000				0.4374	0.2320	0.3306

Table 13.
Normalized matrix of priority weight of all criteria and preference rate of candidates.

attract FDI for developing supporting industries is one that motivates Vietnam's economy's sustainable growth.

6. Conclusions

This study interviewed approximately 22 policy-makers, economists, and managers to identify their individual prioritization of the goals and assessment criteria discussed above. Based on the opinions of all survey respondents, the following findings were obtained:

"Institutions and policies" is the most important criterion considered by supporting industries in attracting potential FDI. Because Vietnam has joined the AFTA, the WTO, and the CPTPP, the Vietnamese government must now concentrate on building special policies for the promotion of supporting industries, which

will involve legal, institutional, and policy-driven changes and improvements consistent with membership in such global trade organizations.

Domestic supply capacity, human resources, technological development and innovation, infrastructure facilities, and market size of the supporting industries have also received heavier weightings in selecting a strategy for attracting FDI. Notably, international cooperation and competition, along with other outstanding criteria, are not presently taken in terms of seriousness, which will undoubtedly lead to diminished levels of future FDI.

All survey evaluators agreed that "attracting FDI for developing supporting industries, which motivates the economy's sustainable growth," is the best strategy to pursue for attracting FDI related to the development of Vietnam's supporting industries. This is followed by "attracting FDI for developing supporting industries, which stimulates the national technological development." The statement that ranked last was "attracting FDI for developing supporting industries, which increases national competitiveness."

The multi-criteria decision-making model for selecting a strategy attractive to FDI presented here is clearly applicable to the evaluation process. The proposed strategy also reveals the concerns and preferences of all supporting industries and main industries. The results of this study provide a valuable reference for the Vietnamese government and policy-makers useful to improve institutions and policies, domestic supply capacity, human resources, technological development and innovation, infrastructure facilities, and assistance to improve the environment for investment. The overall purpose is to better attract FDI that will lead to the development of supporting industries and to select the best strategy for attracting future FDI that will also develop the all-important, requisite supporting industries of Vietnam.

Together, based on these available results, we are continuing to produce future research via a large-scale survey in an effort to select a strategy for better developing supporting industries in Vietnam.

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Conflicts of interest

The author declares no conflict of interest.

Author contributions

Nguyen Xuan Huynh designed the research and methodology. Nguyen Xuan Huynh and Hoang Dinh Phi collected and analyzed the data. Nguyen Xuan Huynh and Hoang Dinh Phi wrote and revised the paper and corrected the final manuscript.

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