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A Survey Investigation of Airports as Distribution Centers: A Strategic Advantage Perspective

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Abstract

An airport is a functional area. Airport Distribution Center would effectively integrate transporting, storekeeping, manufacturing, processing and other industry-related functions into one concentrated and high-efficient logistics environment. Firstly, we divide international logistics into two stages (with four modes) from the viewpoint of value-added services and acquire the competitive indices of the transshipment location mode. Then the evaluation criteria of transshipment mode are established. Furthermore, by combining fuzzy set theory and AHP, the competitive hierarchical structure (transshipment) in Taiwan's Chiang Kai Shek Airport, Hong Kong International Airport and Singapore's Changi International Airport is established. As a result we find Hong Kong Airport and Singapore's Changi International Airport are highly suitable for development of the transshipment mode.

Keywords: Airport Distribution Center; Location mode; AHP

1. Introduction

Owing to the development of globalization and deregulation throughout the corporate world, many companies view the entire world as a single marketplace. Certain factors such as the globalization of corporate purchasing, the division of labor and production, and the marketing involved in the process of the global exchange of cargo have created an urgent need for international logistics. In order to cope with high value-added distributing services and to manage an effort to accumulate sufficient commodities, many owners of international factory operations have set up a handful of strategic bases of operation to stockpile their cargo. As a result, many nations have set up logistics centers, foreign trade zones, and export processing zones in the harbor districts and the surrounding areas. This is done in an effort to strengthen national economic activity and to increase the profit of harbor and airport districts. Different stages and modes of logistics activities in development must be considered in location-to-location factors. Moreover, all locations have different modes of international logistics that are appropriate in the development of a competitive edge. From the perspective of public organizations it is vital to set up an international logistics system, appropriate to the local environment, by providing corporations that deal with international commodities with value-added services such as shipping, distribution, storage, assembly and reprocessing. The development of global logistics is becoming an important aspect of policy-making.

Different modes of international distribution were classified into categories which were determined by the different origins and destinations of conventional import-export cargo. These categories are: (1) transshipment mode, in which cargo is imported from abroad and after being processed in a Distribution Center (DC) are then dispersed to other foreign countries, (2) import mode, in which cargo is imported from abroad and processed in a DC and then dispersed

within the country, and (3) export mode, in which cargo is supplied domestically, processed in logistics centers, and then dispersed to foreign markets. Fundamentally logistics activity can be described as the process of increasing the value of cargo, from the raw material stage to the finished product.

The above mentioned categories are merely an approximation based on the flow and on the integration of logistics and management, thus they cannot adequately evaluate levels of increased value of logistics activity. We try to induce two stages with four modes from the value-added viewpoint and to acquire the competitive indices of the transshipment location mode. Finally, this paper establishes the competitive hierarchical structure of transshipment mode and analyzes the airport location mode.

2. The functions of international logistics system

2.1 The characteristics of international logistics

The term “international logistics” refers to the exchange of cargo between two or more countries. Like domestic distribution, international distribution can be divided into two major parts, physical supply and physical distribution. The former refers to the process of providing cargo from the raw materials industries to the manufacturing industries. The latter refers to the process in which the manufacturing industry delivers the finished product into the hands of the consumer. In recent years, due to the varied and fast changing needs of the consumer, “low volume”, “high frequency” and other diverse modes of delivery services have become necessary. As a result the actual process of dispersing cargo has become one of the major challenges faced in the development of the international distribution of cargo. The international logistics activity environment depicts in Figure 1.

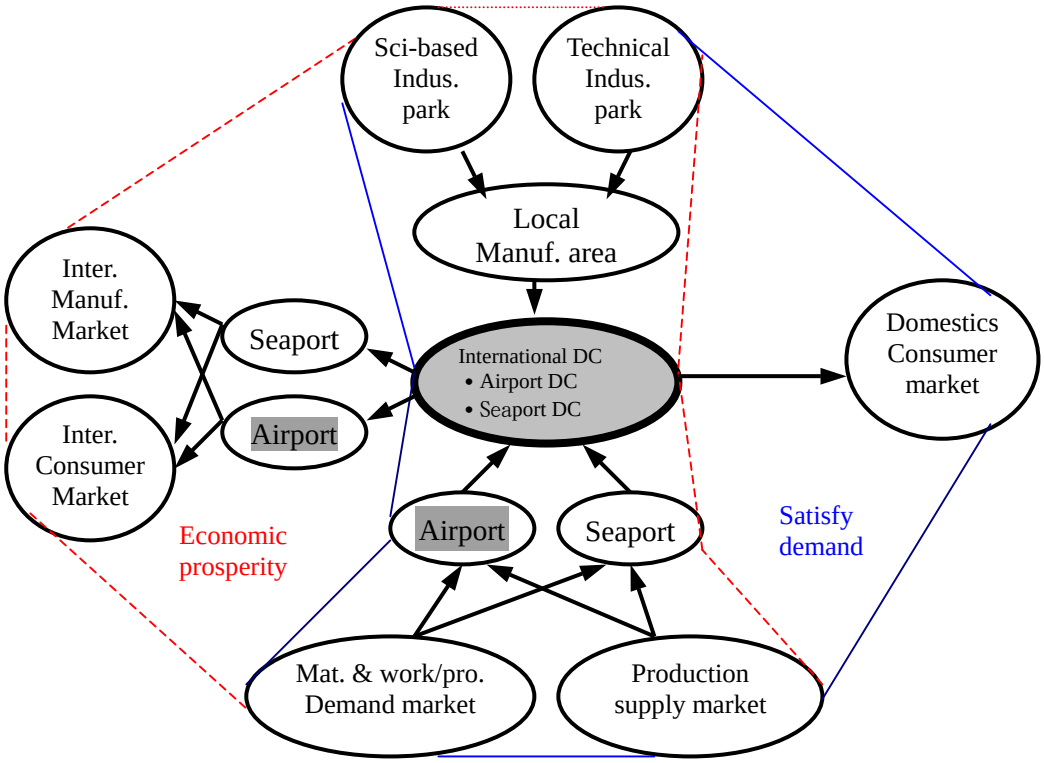

Figure1. The activity environment of international logistics

Resource: Huang, 2002.

The characteristics of international logistics are stated in the following:

(1) The market of international raw materials, semi-finished product and the commodities

In analyzing distribution it is important to consider the origin of commodities, the raw materials and semi-finished product that stimulate the international distribution market. At DC many semi-finished products go through additional fabricating and processing, and then become finished products. These finished products are then either dispersed to the international consumer market or sent to international commercial DC, which acts as a transfer point for the dispersal of cargo. It is apparent that the geographical location of raw material markets, commodities markets, and International Distribution Centers (IDC) is a key factor in the ability of cargo to reach other DCs in a timely fashion. Thus international corporations stress geographic considerations when choosing a location to establish an IDC.

(2) Harbor conditions

Harbors, both seaports and airports, are key hub locations in the transfer and dispersal of cargo in the international marketplace. Thus environmental-geographical factors, such as the frequencies of ships and flights, the level of efficiency of an operating environment and the cost of transshipment are very influential factors. These factors may determine many important things: for example, whether or not the prime cost of the transshipment of cargo of a given distribution center is competitive, or the ability of given DC to satisfy consumers by dispersing cargo in a timely manner. Therefore the conditions of a harbor, excellent or otherwise, are vital factors in the development of IDC.

(3) Local manufacturing.

An important function of DC is the additional fabricating, processing, packaging of semi-finished products, and other such activities which increase the value of cargo. Therefore the characteristics of regional manufacturing industries located near a given DC (which may include science-based industrial parks capable of providing high-level support in increasing the deep value of cargo, and traditional industrial parks which also increase value at a more basic level) contribute to the DC's efforts to increase the overall value of cargo. Product design and flexible manufacturing techniques are examples of such positive contributions. Local manufacturing areas are a key factor in the success of IDC.

(4) International consumer market.

The ultimate goal of international commodities distribution is to satisfy the needs of customers in the international consumer market. Thus, due to the needs for small volume, varied and timely dispersal of cargo for international consumer markets, selection of prime locations to establish DCs has become a major consideration for corporations.

(5) Local consumer markets.

International commerce makes use of international distribution in an effort to satisfy the needs of local consumers. This is also one of the major goals of the development of an international logistics system. Therefore, discovering how to view the geographical considerations of a local consumer market and the production capacity of a given region is an important step in developing an IDC.

2.2 The Modes of International Logistics Activity

According to relevant references the competitiveness can be measured by the creation of value (Porter, 1980, 1985, 1990). From this point of view logistics systems may be viewed as value chain systems measured by the creation of a

value. According to Toffler's third wave theory (agricultural era, industrial era, information era) (1980), and Hope (1997) "Competing in the 3rd Wave," production can be divided into three layered stages in the development of the three waves of increasing value: production capacity, prime cost, and the direction of value added. They believe that production capacity should pursue an increase in the value of cargo. Considering the above mentioned perspective, this paper analyzes the role of intensive labor, intensive technology and intensive services in purchasing, shipping, storage, production, fabrication, examination, selling, information and research of international cargo and establishes a value chain system. By designating the two stages—transportation value-added, production value-added, and four modes—import/export, transshipment, re-processing import, re-processing export, we analyze and construct the model modes of regional development (see further explanation below in Figure 2).

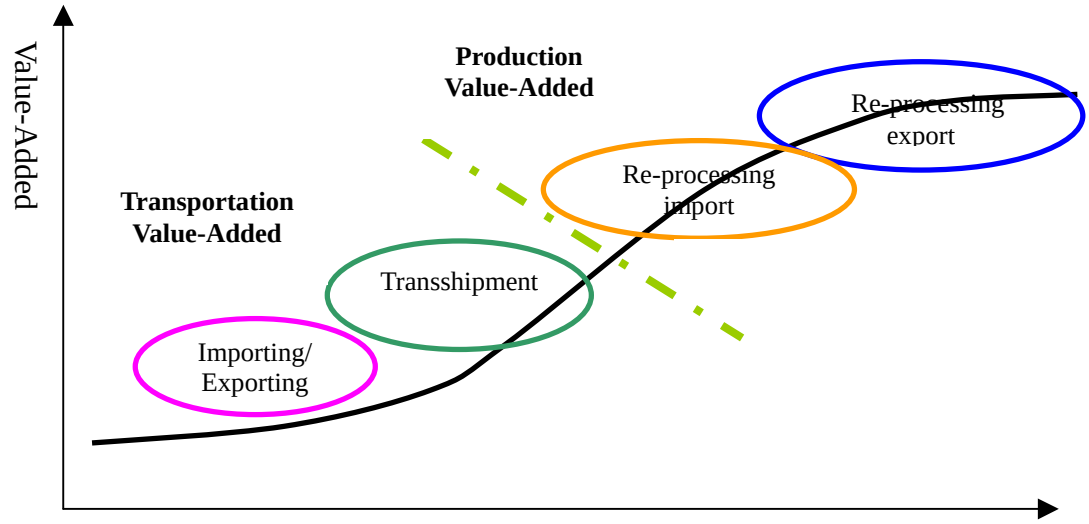

Figure2. The concept of two-stages and four-modes of international logistics

Stage 1: Transportation value-added

Through the integration of harbors, airports and outside transportation systems the main function of this stage is to provide for transportation, warehousing and stocking function. This stage includes the following modes:

・Mode 1: import / export

At the harbor, value-added services encompass only transportation and loading and discharging operations. For example, this form of distribution may deal with the import of daily consumer items and the export of electronic cargo.

・Mode 2: Transshipment

Harbors with excellent geographic positioning, located on major ocean shipping lines, need less time to ship cargo to other ports. Thus these harbors have an opportunity to gradually become Transshipment Centers connecting different regions, and for shipping companies to deal with a distant regions' cargo to a hub port.

Stage 2: Production value-added

Through the integration of advanced and initial manufacturing industries the main function of this stage is to provide reprocessing, examination, labeling, and other services that increase the value of cargo. This stage includes the following two modes:

・Mode 3: reprocessing import

In recent years Japan has reacted to the need for a high volume of import commodities and has worked to ensure that key technology remains within the country. Thus, in many regions the proximity to harbors, Foreign Access Zones (FAZ) has been established to process semi-finished products imported from abroad.

・Mode 4: reprocessing export

In response to the rapid development of international logistics, international harbors have been transformed from the ports specializing in the transshipment of cargo into ports that integrate the DC of cargo. In addition to providing basic storage, the loading and discharging of cargo and Multiple Countries Consolidation (MCC) services, this mode of activity also includes the simple processing of cargo, packaging, labeling, and dispersal and information management.

3. The analysis of transshipment location mode indices of airport distribution center

The logistics ability (competition ability) measure can be divided into outcome-based and behavior-based capabilities /competencies (Shang Kuo-Chung, 2002). The Outcome-based: focus on the outcome of logistics (e.g. Fawcett et al., 1996, 2000; Morash, 1996a, 1996b). Researchers often consider these indices as manufacturing strategies (Frohlich and Dixon, 2001) and employ these items as performance indices (e.g. Scannell et al., 2000). Here the outcome-based capabilities / competencies are used to measure the performance, and the related cultural of indices are shown in Table 1.

Table1. Outcome-based typology of logistics competencies

Author(s)	Dimension Competencies	Sub-dimension of Competencies
Garvin (1987), Schonberger (1990), Stalk (1988), Gerwin (1987), Slack (1987)	Quality	Performance, features, reliability, conformance, technical durability, serviceability, aesthetics, perceived quality, humanity, value
	time	Manufacturing lead time, rate of production introduction, deliver lead time, due-date performance, frequency of delivery
	cost	Manufacturing cost, value added, selling price, running cost, service cost
	flexibility	Material quality, output quality, new product, modify product, deliverability, volume, mix, resource mix
Dornier (1998),	Cost	Initial cost and lifecycle cost
	Quality	Design quality and conformance quality
	Service	delivery speed and delivery reliability
	Flexibility	New-product flexibility, customization, and product mix flexibility
Fawcett, Calantone and Roath (2000)	Quality	Logistics quality Manufacturing quality
	Cost	Logistics cost Manufacturing cost

3.1 Indices Acquisition

According to the related culture of measuring the logistics competition ability based on outcome, four competition dimensions are acquired. They are cost, time, quality and flexibility. To satisfy the users' (airline) demands and to suit

the business management scenario of international logistics, the four dimensions stated as above are utilized to develop the performance measure criteria. The different performance measure situations ought to have different scenario considerations (Andy, Mike and Ken, 1995). Herein, combining the function concept existing in "Competing in the 3rd Wave" and the classification standpoint of international logistics activity, the performance measure indices suitable for transshipment mode of international business practices can be obtained. The converted indices are shown in Table 2.

Table2. Transportation valued-added —The index of transshipment mode conversion form

Performance Dimension	Cost	Time	Quality	Elasticity
Performance Sub-dimension	• Initial cost • Lifecycle cost • Running cost • Service cost	• Supply chain time • Delivery lead time • Delivery speed	• Humanity • Responsiveness to target market (s) • Widespread distribution coverage • Selective distribution coverage • Delivery reliability	• Deliverability • Frequency of delivery Convenient
Demand-Criteria (Airline)	• Transport cost • Airplane in the airport cost • Goods transport cost • Empty goods of air transport the cost • Airline management cost	• The inbound transport time • The outbound transport time • Air terminal transport efficiency	• Humanity • Provide the service quality to source market • Transport operation stability	• Air terminal convenience • Goods clearance convenience • Outside conveyance of transportation system • The information handle the convenient • Air terminal operation liberalism degree
Supply-Criteria (Airport)	• International consumption market • International manufacturing market • Air terminal fee rate • Tax rate • Import /export volume • Transshipment volume	• International consumption market • International manufacturing market • Clearance efficiency	• Political stability • Economic stability • Social stability • Information ability	• Information ability • Clearance efficiency • Management system

4. Research methods

In this section, some research methods used in this paper are briefly introduced.

4.1 Analytic Hierarchy Process

The Analytic Hierarchy Process (AHP) was initially presented by Saaty in 1980 for use in solving multiple criteria decision problems. Using a systematic hierarchy structure, complex estimation criteria can be represented clearly and

definitely. Ratio scales are utilized to make reciprocal comparisons for each element and each layer. After completing the reciprocal matrix, one can obtain comparative weights for each element. Let's consider the criteria $C_1,\ldots,C_i,\ldots,C_j,\ldots,C_n$, existing in some one level in hierarchy. One wishes to find their weights of importance, $w_1,\ldots,w_i,\ldots,w_j,\ldots,w_n$, on some elements in the next level. Allow a_{ij}, i, j =1, 2,…, *n*, to be the importance strength of C_i when compared with C_j. The matrix of these numbers a_{ij} is denoted by *A*, or

$$A=\left(a_{ij}\right)_{n\times n} \tag{1}$$

where $a_{ji}=1/a_{ij}$, that is, *A* is reciprocal. If one's judgment is perfect in all comparisons, then $a_{ik}=a_{ij}\times a_{jk}$ for all *i, j, k* and one calls the matrix *A* consistent (Saaty, 1980). An obvious case is

$$a_{ij}=w_i/w_j,\ i,j=1,2,\ldots,\ n \tag{2}$$

Thus, when matrix *A* is multiplied by the vector formed by each weighting $w=\left(w_1,w_2,\ldots,w_n\right)^T$, one gets:

$$Aw=nw. \tag{3}$$

Because a_{ij} is the subjective rating given by the decision-maker, there must be a distance between it and the actual values w_i/w_j. Thus, *Aw* = *nw* can not be calculated directly. Therefore, Saaty suggested using the maximum eigenvalue, $\lambda_{\max}$, of the solution of matrix *A* to replace *n*, then

$$Aw=\lambda_{\max}w \tag{4}$$

By this method, one can obtain the characteristic vector, referred to as the priority vector.

Obtaining an exact priority vector is complex, so we use the Normalization of Row Average（NRA）(Saaty, 1982) method to replace the more complex operation. This method sums up each element of a row and standardizes it by summing all elements of the matrix. That is

$$w_i=\frac{\sum_{j=1}^{n}a_{ij}}{\sum_{i=1}^{n}\sum_{j=1}^{n}a_{ij}},\ i=1,2,\ldots,n. \tag{5}$$

The consistency test is an important issue for using equation (5) to find the priority vector and contains two layers. One is to check whether the pair wise comparative matrix which is answered by decision makers is a consistency matrix or not. Another is to check the consistency of hierarchy structure. The ratio to estimate the consistency is Consistency Ratio (C.R.).

$$\text{C.R.} = \frac{\text{C.I.}}{\text{R.I.}} \tag{6}$$

Where C.I. is a consistency index and R.I. is a random index, which can be obtained from Table 3. When the value of C.R. is less than or equal to 0.1, consistency will be guaranteed.

Table3. Random index

n	**1**	**2**	**3**	**4**	**5**	**6**	**7**
R.I.	0.00	0.00	0.58	0.90	1.12	1.24	1.32

4.2 Fuzzy set theory

Fuzzy set theory was introduced by Zadeh (1965) to deal with problems involving the absence of sharply defined criteria. Subsequently, Dubois and Prade (1978) presented the improvement and application of fuzzy number.

4.2.1 Triangular fuzzy numbers

In a universe of discourse of *X*, a fuzzy subset *A* of *X* is characterized by a membership function f_A, which maps each element *x* in *X* to a real number in the interval $[0,1]$. The function value represents the grade of membership of *x* in *A*. A fuzzy number *A* (Dubois and Prade, 1978) in $\Re$ (real line) is a triangular fuzzy number if its membership function $f_A : \Re \to [0,1]$ is

$$f_A(x) = \begin{cases} \dfrac{x-c}{a-c} & , \quad c \le x \le a \\ \dfrac{d-x}{d-a} & , \quad a \le x \le d \\ 0 & , \quad otherwise \end{cases} \tag{7}$$

with $-\infty < c \le a \le d < \infty$, the triangular fuzzy number *A* can be represented by (*c*, *a*, *d*)

By the extension principle (Zadeh,1965) the extended algebraic operations of any two triangular fuzzy numbers $A_1 = (c_1, a_1, d_1)$ ， $A_2 = (c_2, a_2, d_2)$ can be expressed as:

(1) Addition $\oplus$

$$A_1 \oplus A_2 = (c_1 + c_2, a_1 + a_2, d_1 + d_2) \tag{8}$$

(2) Multiplication $\otimes$

$$k \otimes A_1 = (kc_1, ka_1, kd_1), k \in R, \quad k \geq 0. \tag{9}$$

4.2.2 Linguistic value

The concept of linguistic variable (Zadeh, 1975, 1976) is useful in describing situations that are complex or poorly defined by quantitative expressions. Linguistic value can be represented by the approximate reasoning of fuzzy set theory. Define the linguistic values set S= $\{\mathrm{VG}, \mathrm{G}, \mathrm{M}, \mathrm{B}, \mathrm{VB}\}$, where VG=Very Good, G=Good, M=Medium, B=Bad, and VB=Very Bad. In here, the linguistic values in sets S are used by the decision-makers to evaluate the suitability of alternative versus various criteria above the alternative level. The membership functions of those linguistic values are shown in Figure 3.

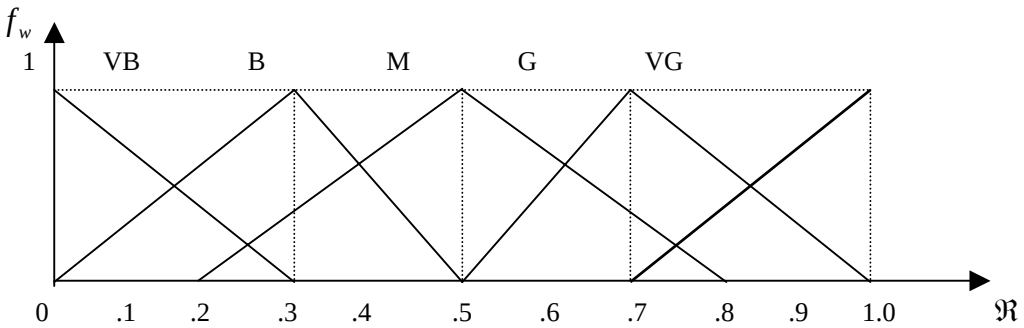

Figure3. Linguistic value membership function, VB= (0, 0, 0.3), B= (0, 0.3, 0.5) M= (0.2, 0.5, 0.8), G= (0.5, 0.7, 1), VG= (0.7, 1, 1)

4.2.3 The representation value of triangular fuzzy numbers

To effectively and easily represent the superiority ratings of all alternatives under each criterion above the alternative level and the aggregation superiority ratings of all alternatives, the graded mean integration representation method (Chen, and Hsieh, 1999) is used to determine the representation value of superiority ratings characterized by triangular fuzzy number. That is, if SR=(*c*, *a*, *d*) denotes the fuzzy superiority ratings, then the graded mean integration representation value of SR will be $\frac{c + 4a + d}{6}$.

5. The transshipment competitive mode of airport distribution enter—In case of Taiwan CKS, Hong Kong, and Singapore Changi International Airport

In this section a systematic fuzzy MCDM model for the optimal location mode of international logistics on Airport competition evaluation is proposed. The steps can be summarized as follows:

Step 1: Form a committee of decision-makers selecting the evaluation criteria.

Step 2: Develop a hierarchical structure of transshipment mode.

Step 3: Use AHP method to obtain the weight for each level.

Step 4: Utilize the weights obtained by Step 3 to determine the integrated weight of all sub-criteria presented above the alternative level.

Step 5: Tabulate the linguistic evaluation values assigned to the alternatives by the decision-makers, and then poll them to obtain the aggregated fuzzy ratings of all alternatives under each criterion above the alternative level.

Step 6: Use the graded mean integration representation method and find the representation values of the aggregated fuzzy ratings of all alternatives.

Step 7: Find the normalized superiority ratings of all alternatives versus various sub-criteria and obtain the position in this competition.

5.1 Develop a hierarchical structure of transshipment mode

To concentrate on similar criteria and facilitate the implementation of weights evaluation and superiority ratings of alternatives, those criteria shown in Table 2 are integrated anew. The transshipment hierarchical structure is shown in Figure 4.

5.2 Use AHP method to obtain the criteria weight for each level

To understand the major considerations the private sector takes into account when evaluating the location of the DC. This study conducts a survey on the core competitive factors of airport locations. This questionnaire (see Appendix A) has been created based on the design and survey principles to analyze the differences between the concerns of various airline managers. A total of 32 questionnaires were mailed to experts and airlines. Returned questionnaires totaled 10 (four academic experts and six airline managers), for a response rate of 31.3%.

Through questionnaires and surveys the subjects use the comparative important scale to assign comparative importance of evaluation criteria based on their professional judgment. Then the AHP method is used to solve the weights of all criteria. Due to space limitation one lists only the results of weights obtained by the AHP method, as shown in Table 4.

5.3 Find normalized superiority ratings of all alternatives versus various sub-criteria

The subjects utilize the linguistic rating set S=$\{VG, G, M, B, VB\}$ to evaluate the superiority of all alternatives under each of the sub-criteria above the alternative level. Then, the Graded mean integration representation method is utilized to pool the subjects' opinions and find the normalized superiority rating of all alternatives versus various sub-criteria. The results are shown in Table 5.

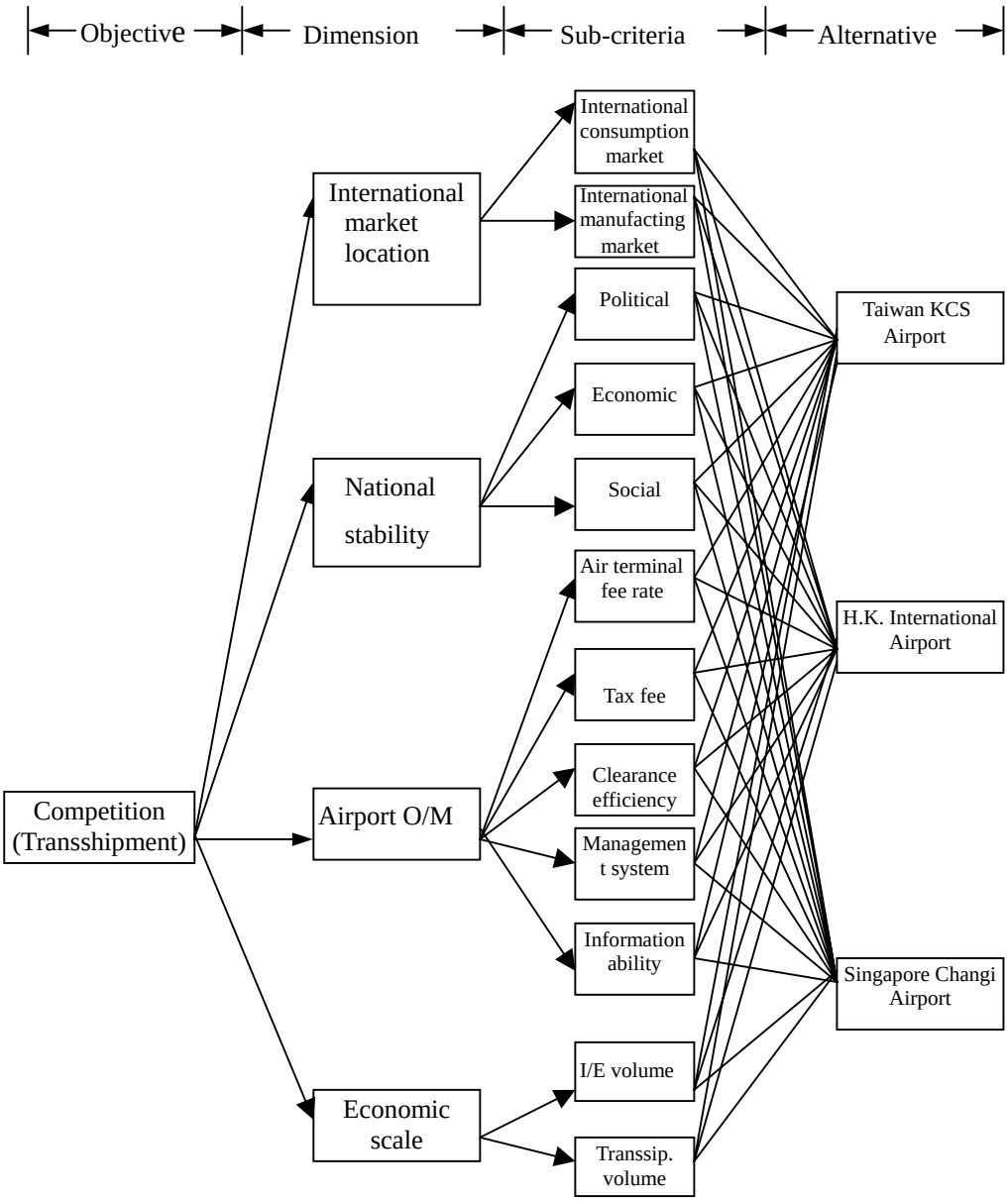

Figure4. The hierarchical structure of the transshipment *mode* of international logistics

Table4. Criteria weights of the transshipment mode

Transshipment			
Dimension	Weight	Sub-criteria	Weight
International market location	0.3507	International consumption market	0.2519
		International manufacturing market	0.0961
National stability	0.2426	Political	0.1060
		Economic	0.0994
		social	0.0340
Airport operation and		Air terminal fee rate	0.0473
		Tax rate	0.0624

management	0.2117	Clearance efficiency	0.0352
		Management Information	0.0241
		Information ability	0.0409
Economical scale	0.1949	I/E volume	0.0354
		Transship volume	0.1672

Table5. Normalized superiority ratings of alternatives under various sub-criteria of Transshipment location mode

Dimension	Sub-criteria	Defuzziness		
		Taiwan CKS Airport	Hong Kong International Airport	Singapore Changi Airport
International market location	International consumption market	0.056907	0.070183	0.070183
	International manufacturing market	0.024153	0.024333	0.024333
National stability	Political	0.011165	0.018567	0.018567
	Economic	0.008311	0.015682	0.015682
	Social	0.004124	0.004721	0.004721
Airport operation and management	Air terminal fee rate	0.004282	0.005719	0.005719
	Tax rate	0.007563	0.010495	0.010495
	Clearance efficiency	0.003726	0.00534	0.00534
	Management Information	0.002182	0.003684	0.003684
	Information ability	0.004957	0.007552	0.007552
Economical scale	I/E volume	0.00395	0.004444	0.004444
	Transship volume	0.013936	0.025889	0.025889

5.4 Analyses of the competition advantage found in transshipment location mode

Analysis is done on the results of survey reports. Based on the anticipated fuzziness (as shown in Table5), in the area of transshipment, Taiwan's CKS Airport has the advantage in the international manufacturing markets, while Hong Kong International Airport has the advantage in the international consumer markets, economic stability, tax rates, information ability, import-export volume, and transshipment volume. Singapore's Changi Airport shows a distinct advantage in the areas of political stability, social stability, airport rates, tax rates, clearance efficiency, and management system.

Based on the above calculated results, the anticipated value of each location mode gathered by the study show the comparison between the developments of various location modes for the airport transshipment center (as shown in Table 6). Through the results of the FAHP calculations, the top two location modes with the highest anticipated values have been chosen as the modes suitable for development. In terms of rankings, both Hong Kong International Airport and Singapore's Changi Airport are highly suitable for developing in the transshipment mode.

Table6. The comparison of location mode of the airport DC

Mode / Location	Transshipment Total Score	The Optimal location mode
Taiwan CKS Airport	0.14526	none
Hong Kong International Airport	0.19661	Transshipment
Singapore Changi Airport	0.18588	Transshipment

6. Conclusions

As more corporations become global and liberal, they have come to view the world as one big marketplace. They establish production bases in different areas, buy raw materials from suppliers based in different countries, and then sell to markets all over the world. However, whether the corporate entity makes global purchases, breaks down production, or does international marketing involving transnational logistics, it must have an airport distribution center at the airport or in a nearby area in order to have its products concentrated in one place. This results in enhancing the nation's economic activities as well as raises the value-added of the airport. Consequently, the main focus of developing a global shipping center is how to develop an optimal location mode for the Airport Distribution Center, which can provide corporations with services for shipping, allocating, warehousing, assembling, logistical processing of goods as well as other value-added mechanisms. Different factors are considered based on the different stages and modes of logistics value-added points and can prove suitable for the implementation of specific logistic functions.

Based on the analysis above, the study has come to the following conclusion:

Because each airport is different in terms of the optimal form of development, the study has chosen Taiwan's CKS Airport, Hong Kong International Airport, and Singapore's Changi Airport as examples. Through the results of the FMCDM calculations, the top two location modes with the highest anticipated values have been chosen as the modes suitable for development. In terms of rankings, Hong Kong International Airport is suitable for development as the transshipment mode; Singapore's Changi Airport is also suitable for the transshipment mode.

Our primary purpose was to identify the suitable location mode for developing international logistics in airports in terms of its external competitive status in the area of transshipment. However, we have not fully explored the competitive strategy. Consequently, future research may focus on this area.

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Appendix A: Survey Questionnaire

The evaluation of Airport Location mode

1. Questionnaire example

This questionnaire uses pairwise comparisons and computes the weighting factors and evaluation. With the multifactor evaluation process, we start by listing the factors and their relative importance on a scale 1 to 9. Using the scale, if you think “International market location” is moderately preferred to “Airport operation and management”. Thus, representing moderately preferred is 3:1. Next, suppose the “International market location” is strongly preferred to “Economical scale”. This represents 5:1. Please write down the answer on the right item and see Table 1.

Table1 the example for pairwise comparisons

Dimension 1	9:1	8:1	7:1	6:1	5:1	4:1	3:1	2:1	1:1	1:2	1:3	1:4	1:5	1:6	1:7	1:8	1:9	Dimension 2
International market location											✓							National stability
International market location							✓											Airport operation and management
International market location					✓													Economical scale
National stability					✓													Airport operation and management
National stability			✓															Economical scale
Airport operation and management							✓											Economical scale

1:1—Equally Preferred

2:1—Equally to Moderately Preferred

3:1—Moderately Preferred

4:1--Moderately to Strongly Preferred

5:1--Strongly Preferred

6:1--Strongly to Very Strongly Preferred

7:1--Very Strongly Preferred

8:1--Very to Extremely Strongly Preferred

9:1—Extremely Preferred

2. Survey for Criteria weights of the transshipment mode

2.1 Comparative importance scale of Dimension

Please focus on the “International market location”, “National stability”, “Airport operation” and “Economical scale” dimensions. And evaluate the degree of pairwise comparisons importance of each dimension item.

Dimension 1	9:1	8:1	7:1	6:1	5:1	4:1	3:1	2:1	1:1	1:2	1:3	1:4	1:5	1:6	1:7	1:8	1:9	Dimension 2
International market location																		National stability
International market location																		Airport operation and management
International market location																		Economical scale
National stability																		Airport operation and management
National stability																		Economical scale
Airport operation and management																		Economical scale

2.2 Comparative importance scale of criteria

(1) Comparative importance scale of "International market location"

Criteria 1	9:1	8:1	7:1	6:1	5:1	4:1	3:1	2:1	1:1	1:2	1:3	1:4	1:5	1:6	1:7	1:8	1:9	Criteria 2
International consumption market																		International Manufacturing market

(2) Comparative importance scale of "National stability"

Criteria 1	9:1	8:1	7:1	6:1	5:1	4:1	3:1	2:1	1:1	1:2	1:3	1:4	1:5	1:6	1:7	1:8	1:9	Criteria 2
Political stability																		Economic stability
Political stability																		Social stability
Economic stability																		Social stability

(3) Comparative importance scale of "Airport operation and management"

Criteria 1	9:1	8:1	7:1	6:1	5:1	4:1	3:1	2:1	1:1	1:2	1:3	1:4	1:5	1:6	1:7	1:8	1:9	Criteria 2
Air terminal fee rate																		Tax rate
Air terminal fee rate																		Clearance efficiency
Air terminal fee rate																		Management system
Air terminal fee rate																		Information ability
Tax rate																		Clearance efficiency

Tax rate																	Management system
Tax rate																	Information ability
Clearance efficiency																	Management system
Clearance efficiency																	Information ability
Management system																	Information ability

（4）Comparative importance scale of “ Economical scale”

Criteria 1	9:1	8:1	7:1	6:1	5:1	4:1	3:1	2:1	1:1	1:2	1:3	1:4	1:5	1:6	1:7	1:8	1:9	Criteria 2
Import /Export volume																		Transship volume

3. Find the performance value of all alternatives versus various sub-criteria

This study has chosen Taiwan’s CKS Airport, Hong Kong International Airport, and Singapore’s Changi Airport as examples. To evaluate each alternative’s performance value of its external competitive status in the area of transshipment.

Please kindly evaluate the degree of relative importance of each alternative of the following criteria. The assessment is based on a scale from 1 to 5. The more important the item is, the higher point the item has.

The factor evaluations for Transshipment mode

Criteria	Alternative Ⅰ Taiwan's CKS Airport					Alternative Ⅱ Hong Kong International Airport					Alternative Ⅲ Singapore's Changi Airport				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
International consumption market															
International manufacturing market															
Political															
Economic															
Social															
Air terminal fee rate															
Tax rate															
Clearance efficiency															
Management Information															
Information ability															
I/E volume															
Transship volume															

Note:

1: very bad

2: bad

3: middle

4: good

5: very good