AN ANALYSIS FOR EVALUATING URBAN COMPETITIVENESS IN ASIAN COUNTRIES

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1. INTRODUCTION

As the transportation and communication technology have been developed dramatically, the world economy has been globalized. Each country in the world has also made an effort to reinforce their urban competitiveness as the core. In a liberalized trade and financial situation, the cities have become cores for innovation, investment, communication, production and consumption. In particular, the competition among cities with dynamic growth in Asia will be keen. The modernization of region in Asia has been developed actively as a late starter. The aspects of development in Asia have appeared in contrast with the region of Europe or North America. In Europe or North America, the levels between the cities of development within the region have appeared homogeneously. The region of Asia, however, has presented contrastively. Therefore, the differences for competitiveness among cities will be expected to expand further. The growth of cities in some region of Asia was attributable to dynamic growth of cities in the region. Cities with various resources have adopted different competitive strategies to get the opportunity for achieving successful globalization. It has also trying to acquire a favorable position on the global economy. Cities have responded to the globalization of economy, but the level of urban competitiveness will be expanded by corresponding level or setting the direction for globalization.

Because Incheon is the venue of 2014 Asian Game, it causes great concern for the city of Incheon among Asian cities. Therefore, the research for cities in the region of Asia and urban indicators is essential to consider the relationship of competition or cooperation between regional cities in Asia.

This research has performed the competitive index of development and evaluation on trial basis to assess the competitiveness of cities in Asia. Statistical indicators used in this research are based on the data in 2005. Chinese Academy of Social Sciences (2008) has listed a ranking distribution of each continent of the 500 cities as shown in Table 1.

Table 1 Regional ranking distribution of the 500 cities

Regions	Upper Ranking(1~150)		Lower Ranking(351~500)	
	Number of Cities	*Rates of Region (%)*	*Number of Cities*	*Rates of Region (%)*
Europe	52	36.4	46	32.2
North America	59	84.3	0	0
Asia	27	14.9	62	34.3
Latin America	6	10.3	11	19.0
Oceania	6	50	1	8.3
Africa	0	0	30	83.3

Chinese Academy of Social Sciences (2008), Global Urban Competitiveness Report

Among the 500 cities of upper ranking (1~150), 126 cities were in the developed countries such as Europe, America, Oceania and etc. The number of cities in newly industrializing or developing countries was only 24. The urban competitiveness of international metropolis in developed countries, was located in Europe, North America and Oceania, has presented highly. Next, the competitiveness of industrial nations and the emerging industrial region in Asia were relatively high. The urban competitiveness in region of Latin America and Africa has been weak.

2. MODEL OF URBAN COMPETITIVENESS

2.1 Structuring of hierarchy

Since the competitiveness of city is originated from various sources and outcomes derived from competitiveness show every area of competitive city urbanness, a single indicator alone is not sufficient enough to capture the attributes of urban competitiveness. As far as this issue is concerned, multiple indicators are usually selected to evaluate the urban competitiveness. This research has argued that economic prosperity, spatial attraction power, international connectivity have to be taken into consideration in the assessment of urban global competitiveness. Good economic performance does not necessarily guarantee high quality of life. A globally competitive

city must be doing well economically with good social facility and structure, as well as good quality of environment. The quality of life and the sustainability of environment are recently becoming more important.

At Level I, there are three competitiveness components such as economic prosperity (EP), spatial attraction power (SP), and international connectivity (IC). These three components are further broken down at Level II 10 subgroups such as resource input factor, cost conditions, innovation competitiveness, liberalization level of market and economy, quality of the economic life, quality of the social and cultural life, ecological sustainability, global infra-structure, international connectivity level, international prestige. We selected 31 indicators affect urban competitiveness at Level III. Table 2 represents the hierarchical structure to evaluate the urban competitiveness in Asian countries. 31 explanatory and performance indicators are organized into different subgroups according to their nature.

2.2. Key performance indicators

We used 31 key performance indicators to evaluate urban competitiveness as follows: (1) Labor force: labor workers and labor productivity, (2) Capital strength: real interest rate, (3) Regulation level regarding business: treatments of business establishment, license and cessation, (4) Cost conditions: available business areas, price of water and electricity, (5) Innovation performance: international patent rights, (6) Innovation infra-structure: R&D centers, high-quality workers including IT and banking, colleges and universities, (7) Liberalization level of economy: liberalization level of economy, (8) Intellectual property rights: protection level of intellectual property rights, (9) Income level: gross regional domestic products per capita, (10) Price level: price level index, (11) Housing supply: owned housing per capita, (12) Medical service : average life span, (13) Air quality: emissions of sulfurous gas, (14) Openness to foreigner: percentage of residential foreigners to population, (15) Tourist attractions: number of the international tourist hotel, (16) Foreign cities linked with direct line service : relative distance index between the foreign cities, (17) Airport: airport passengers and freight treatments, (18) Port: the depth of water near port and container freight treatments, (19) Visiting foreigners: percentage of visiting foreigners to population, (20) International conference holding : number of international conference holding, (21) Foreign investments: number of the head and branch offices of multi-national corporation.

2.3. Weighting method

31 explanatory indicators in 10 different subgroups are used to measure the urban competitiveness of a city. How to weight various indicators to derive a comprehensive index of urban competitiveness is key issue in this research. Objective weighting methods such as Equal Weighting, Principal Component Analysis and Weighting based

on Standard Deviation are often used to weight various indicators. This research is used weight base on AHP method (see appendix.). Used weights are shown on Table 2.

Table 2. The hierarchical structure and weight for urban competitiveness evaluation

1. Economic prosperity level(0.329)	
1.1 Resource input factor (0.073)	
1.1.1 Labor force (0.020)	
1.1.2 Capital strength (0.028)	
1.1.3 Regulation level regarding business (0.025)	
1.2 Cost conditions (0.044)	
1.2.1 Cost conditions (0.044)	
1.3 Innovation competitiveness (0.126)	*2*
1.3.1 Innovation performance (0.046)	
1.3.2 Innovation infra-structure (0.080)	
1.4 Liberalization level of market and economy (0.086)	
1.4.1 Liberalization level of economy (0.054)	
1.4.2 Intellectual property rights (0.032)	
2. Spatial attraction power(0.411)	
2.1 Quality of the economic life (0.126)	*2*
2.1.1 Income level (0.084)	
2.1.2 Price level (0.042)	
2.2 Quality of the social and cultural life (0.163)	*1*
2.2.1 Housing supply (0.070)	
2.2.2 Medical service (0.094)	
2.3 Ecological sustainability (0.122)	*4*
2.3.1 Air quality (0.122)	
3. International connectivity (0.260)	
3.1 Global infra-structure (0.090)	*6*
3.1.1 Openness to foreigner (0.054)	
3.1.2 Tourist attractions (0.036)	
3.2 International connectivity level (0.091)	*5*
3.2.1 Foreign cities linked with direct line service (0.049)	
3.2.2 Airport (0.027)	
3.2.3 Port (0.015)	
3.3 International prestige (0.079)	
3.3.1 Visiting foreigners (0.017)	
3.3.2 International conference holding (0.018)	
3.3.3 Foreign investment (0.044)	

2.4. Selection of Comparison target cities

Kang (2007, 2008) has analyzed the urban competitiveness under the assumption that the competitive cities of Incheon were located in Northeast Asia region. Meanwhile, Incheon Development Institute (2008) has selected the comparable cities on the research to be made Incheon as a luxury city: America (New York, Vancouver, and Phoenix), Europe (Dublin, Milan, Brussels, and Amsterdam), Asia (Shanghai, Sydney, Yokohama). In addition, Tianjin and Qingdao were selected as the objective city for monitoring.

This research has based on the selected cities in Incheon Development Institute (2008). It has also considered adding more cities into the target cities by the advices of experts for urban competitiveness. The experts recommended several benchmarking cities as the gateway city of specific region were located in the city: San Diego and Philadelphia in Americas, Hamburg and Rotterdam in Europe, Sydney in Australia, Dubai, Shanghai, and Yokohama in Asia.

When the cities were selected, the criteria were applied as follow: (1) the capital city of country or the city in higher economic power in Asia, (2) Experts has recommended the city that was shown as the similar level with Incheon for urban competitiveness, (3) the best top 10 cities were presented in the research investigated by prominent research institutions for urban competitiveness[1], (4) the best top 10 cities investigated by prominent research institutions for the global competitiveness[2].

Table 3 presents the selected cities through comprehensive consideration for the above reviews.

Table 3. Selected Cities for assessment of urban competitiveness

Region	Country	City	Criteria				CASS[3](2008) Ranking		
			(1)	(2)	(3)	(4)	500 cities	Comparison target	East Asia
East Asia (25)	Japan (5)	*Tokyo*	O		O	O	3	3	1
		Osaka		O			67	25	10
		Yokohama		O			57	21	7
		Nagoya		O			56	20	6
		Kobe		O			137	30	13
	Korea (4)	*Seoul*	O		O		12	7	3
		Busan		O			242	37	20

[1] The Global Financial Centres Index, Worldwide Centers of Commerce Index, Chinese Academy of Social Sciences, etc.

[2] World Economic Forum, International Institute for Management Development, etc.

[3] Chinese Academy of Social Sciences (CASS)

		Incheon		O			221	33	16
		Ulsan		O			162	32	15
	China (8)	*Beijing*	O			O	66	24	9
		Shanghai			O	O	41	18	5
		Guangzhou		O			130	29	12
		Dalian		O			231	36	19
		Qingdao		O			252	38	21
		Chongqing		O			292	39	22
		Tianjin		O			223	34	17
		Shenzhen		O			64	22	8
	Hong Kong	*Hong Kong*	O		O	O	26	11	4
	Singapore	*Singapore*	O		O	O	8	5	2
	Taiwan (3)	*Taipei*	O				112	28	11
		Kaohsiung		O			227	35	18
		Hsinchu		O			299	40	23
	Thailand	*Bangkok*	O				155	31	14
	Vietnam	*Ho Chi Minh*	O				318	41	24
	Philippines	*Manila*	O				323	42	25
Oceania	Australia (2)	*Sydney*	O	O	O		31	14	
		Melbourne		O			22	10	
Middle East	UAE	*Dubai*		O			39	16	
America (7)	USA	*New York*			O	O	1	1	
		Chicago			O	O	10	6	
		Los Angeles			O	O	6	4	
		San Diego		O			14	8	
		Philadelphia		O			19	9	
		Phoenix					65	23	
	Canada	*Vancouver*		O			47	19	
Europe (7)	UK	*London*			O	O	2	2	
	Ireland	*Dublin*					27	12	
	Netherlands	*Amsterdam*				O	35	15	
		Rotterdam		O			81	27	
	Germany	*Hamburg*					40	17	
	Belgium	*Brussels*		O			69	26	
	Italy	*Milan*		O			29	13	

The cities have selected 42 cities as follows: 7 cities of 2 countries in America, 7 cities of 6 countries in Europe, 1 city in the Middle East, 2 cities in Australia, 25 cities of 8 countries in Asia.

3. RESULTS

3.1. Evaluating result: comparision of previous study

New York has been evaluated as the top on the entire ranking, and also presented as the top ranking in the component of economic prosperity and international connectivity.

Top 10 cities for urban competitiveness are as follow: New York, London, Chicago, Tokyo, Los Angeles, San Diego, Philadelphia, Sydney, Rotterdam, and Dublin.

All cities except Tokyo are non-Asian cities. The most cities, which have evaluated higher than 21th ranking (Milan), have belonged to America and Europe. The 5 cities in the Asia have only belonged to the upper ranking as follow: Tokyo (4), Osaka (13), Singapore (14), Hong Kong (19), Kobe (20).

According to CASS (2008), Singapore and Hong Kong were presented as rank 5 (8 among 500 cities), rank 11 (26 among 500 cities). In contrast, the result of this research has evaluated slightly lower as Singapore(14), Hong Kong (19). Because the component of spatial attraction power(20, 22) was evaluated lower than other components. In the components of spatial attraction power, the leading competitive asian cities could be less evaluated than America, Europe and other developed cities.

The results of between this research and CASS has compared in detail as follows. The 7 cities ranking of the top 21 cities are big rank gap(above ± 5): Sydney + 6, Rotterdam +18, Phoenix +12, Osaka +12, Brussels +8, Kobe +10. Because these cities have higher ranking in the component of spatial attraction power: Sydney 1, Rotterdam 6, Phoenix 12, Osaka 9, Kobe 16.

The most Asian cities have been ranked below rank 22. The major cities or the capital city were between rank 22 and rank 30. The ranking in order of the cities of Asian has been presented as follow: Nagoya, Dubai, Shanghai, Yokohama, Seoul, Beijing, Ulsan, Taipei, and Bangkok.

Seoul have rank 11 in component of economic prosperity, lower spatial attraction power(36), so the entire top 26. Seoul is ranked lower than Nagoya, Yokohama, Shanghai. The rank 22~30 group asian cities have a lower ranks in component of spatial attraction than other components. These cities have to increase dgree of spatial attraction to catch up to the non-asian developed cities.

Incheon’s comprehensive competitiveness ranking is 31(economic prosperity 22, international connectivity 27, spatial attraction power 38). Below rank 32 cities have lowest ranking all three components. This group cities have face to competition with many other cities around the capital of domestic or foreign countries. These cities have to consider all three components.

Table 4. Evaluating result: *comparison of previous study*

City	Overall Region						Region of East Asian		
	Evaluated Ranking				CASS (B)	Difference of Ranking (A)-(B)	Evaluated Ranking (C)	CASS (D)	Difference of Ranking (C)-(D)
	1. Economic Prosperity	2. Spatial attraction Power	3. International Connectivity	Total Competi-tiveness (A)					
New York	1	5	1	1	1	0			
London	3	4	2	2	2	0			
Chicago	4	15	3	3	6	-3			
Tokyo	2	10	13	4	3	1	1	1	0
Los Angeles	9	8	5	5	4	1			
San Diego	5	7	15	6	8	-2			
Philadelphia	6	13	10	7	9	-2			
Sydney	16	1	19	8	14	-6			
Rotterdam	14	6	8	9	27	-18			
Dublin	13	14	9	10	12	-2			
Phoenix	10	12	16	11	23	-12			
Melbourne	17	2	20	12	10	2			
Osaka	7	9	22	13	25	-12	2	10	-8
Singapore	8	20	7	14	5	9	3	2	1
Vancouver	26	3	18	15	19	-4			
Amsterdam	12	21	4	16	15	1			
Hamburg	25	11	12	17	17	0			
Brussels	24	18	6	18	26	-8			
Hong Kong	20	22	11	19	11	8	4	4	
Kobe	18	16	26	20	30	-10	5	13	-8
Milan	31	17	14	21	13	8			
Nagoya	19	23	24	22	20	2	6	6	0
Dubai	41	19	17	23	16	7			
Shanghai	30	24	21	24	18	6	7	5	2
Yokohama	15	27	25	25	21	4	8	7	1
Seoul	11	36	29	26	7	19	9	3	6
Beijing	27	26	30	27	24	3	10	9	1
Ulsan	21	32	38	28	32	-4	11	15	-4
Taipei	29	28	33	29	28	1	12	11	1
Bangkok	28	34	28	30	31	-1	13	14	-1
Incheon	22	38	27	31	33	-2	14	16	-2
Hsinchu	33	29	37	32	40	-8	15	23	-8
Guangzhou	34	33	31	33	29	4	16	12	4
Kaohsiung	37	30	35	34	35	-1	17	18	-1
Pusan	23	41	23	35	37	-2	18	20	-2
Dalian	39	25	41	36	36	0	19	19	0
Tainjin	32	31	39	37	34	3	20	17	3
Ho chi minh	36	35	40	38	41	-3	21	24	-3
Shenzhen	40	39	32	39	22	17	22	8	14
Manila	42	37	34	40	42	-2	23	25	-2
Qingdao	38	40	36	41	38	3	24	21	3
Chongqing	35	42	42	42	39	3	25	22	3

Table 5. Evaluating result by 10 subgroups

City	2.2 Quality of the social and cultural life	2.1 Quality of the economic life	1.3 Innovation competitiveness	2.3 Ecological sustainability	3.2 International connectivity	3.1 Global infra-structure	1.4 Liberalization level of market and economy	3.3 International prestige	1.1 Resource input factor	1.2 Cost conditions
WEIGHT	**0.163**	**0.126**	**0.126**	**0.122**	**0.091**	**0.090**	**0.086**	**0.079**	**0.073**	**0.044**
New York	5	3	2	28	1	2	6	3	3	26
London	3	7	4	25	4	3	12	1	2	42
Chicago	24	6	7	10	5	4	6	7	9	21
Tokyo	13	12	1	16	6	23	18	6	1	36
Los Angeles	19	8	15	1	19	1	6	10	6	30
San Diego	16	5	6	5	29	5	6	20	14	29
Philadelphia	26	4	9	10	8	17	6	24	12	19
Sydney	2	11	25	26	36	10	4	13	29	15
Rotterdam	22	1	19	5	12	13	14	18	4	37
Dublin	11	15	28	20	14	16	3	8	19	27
Phoenix	25	9	22	2	26	6	6	23	15	13
Melbourne	1	13	32	26	39	12	4	21	30	12
Osaka	8	14	3	18	9	28	18	33	5	34
Singapore	15	22	16	20	3	18	1	4	22	18
Vancouver	4	10	26	10	35	7	16	11	20	33
Amsterdam	42	2	13	9	7	8	13	5	8	39
Hamburg	14	16	8	3	13	15	17	25	35	41
Brussels	28	18	11	20	18	14	15	2	25	40
Hong Kong	18	34	39	5	2	21	2	9	32	24

Kobe	7	21	17	14	17	37	18	28	13	31
Milan	20	17	10	13	27	11	32	12	31	38
Nagoya	9	38	18	14	15	29	18	32	10	32
Dubai	30	19	40	16	32	9	31	14	41	9
Shanghai	6	26	23	30	20	19	33	17	28	10
Yokohama	10	23	14	35	16	32	18	30	7	35
Seoul	23	24	5	38	28	24	23	16	11	28
Beijing	12	28	12	34	38	22	33	15	27	4
Ulsan	29	20	21	37	31	38	23	37	18	11
Taipei	36	37	33	18	30	33	27	22	21	23
Bangkok	41	36	29	5	33	20	30	19	26	8
Incheon	27	32	20	41	11	34	23	41	17	20
Hsinchu	33	39	41	23	34	36	27	27	23	17
Guangzhou	34	25	27	31	21	30	33	29	33	7
Kaohsiung	35	40	42	24	23	40	27	35	37	22
Pusan	37	35	24	40	10	39	23	31	16	25
Dalian	17	30	38	32	41	42	33	39	40	3
Tainjin	21	29	31	33	37	31	33	40	34	1
Ho chi minh	39	42	34	3	40	35	41	36	24	5
Shenzhen	32	27	36	36	22	26	33	34	36	16
Manila	40	41	30	29	25	25	42	26	42	14
Qingdao	31	31	37	39	24	27	33	38	39	6
Chongqing	38	33	35	42	42	41	33	42	38	2

3.2. Evaluating result by 10 subgroups

Except for quality of the social and cultural life(0.163), respondents placed the most importance on innovation competitiveness(0.126) and quality of the economic life(0.126), which were followed by ecological sustainability(0.122) and international connectivity level(0.091), and global infra-structure(0.090). The top four, sixth subgroups contributed 53.7%, 71.8% of overall weight.

1) quality of the social and cultural life

Top 10 cities for urban competitiveness are as follow : Melbourne, Sydney, London, Vanqouver, New York, Shanghai, Kobe, Osaka, Nagoya, Yokohama. Oceania has appeared in most strongly. Asian cities are included in the five cities. Especially Japan cities look strong in this subgroup index.

2) quality of the economic life

Netheraland(rotterdam, amsterdam), Northern America(New York, Philadelphia, San Diego, Chicago, LA, Vancouver, Phoenix) are the strong, the weakest in Asia.

3) innovation competitiveness

Some Asian cities are looking strong: Tokyo 1, Osaka 3, Seoul 5, Bejing 12. Incheon the top 20 is relatively highly valued.

4) ecological sustainability

Mega-cities such as New York, London are not good. Europe's small cities has been a good evaluation. Most of asian cities are bad .

5) international connectivity

Among Asian cities have international airports and seaports, Hongkong (2), Singapore (3), Tokyo (6), Osaka (9), Pusan (10), Incheon (11) are highly rated.

6) global infra-structure

Western cities have a high Openness. Asian cities have not been highly evaluated.

7) other subgroups

The bottom four subgroup factors accounted for only 28.2% of overall weight. Market liberalization of Singapore, Honkong the most highly valued in the entire city, but other Asian countries appear to have the lowest. In terms of Internation prestige and resource input, western developed cities have been highly appreciated. Tianjin, Chongqing, Dalian, and the Asian cities have been highly appreciated in terms of cost conditions.

4. CONCLUSION

This research has performed the competitive index of development and evaluation on trial basis to assess the competitiveness of cities in Asia. This research is used weight base on Analytic Hierarchy Process method. There are three competitiveness components such as economic prosperity(EP), spatial attraction power(SP), and international connectivity(IC). Within the framework of 3 evaluation categories, experts rank "spatial attraction power" category variable as the most important(0.411), followed by economic prosperity level(0.329) and international connectivity(0.260).

These three components are further broken down 10 subgroups such as resource input factor, cost conditions, innovation competitiveness, liberalization level of market and economy, quality of the economic life, quality of the social and cultural life, ecological sustainability, global infra-structure, international connectivity level, international prestige. Except for quality of the social and cultural life(0.163), respondents placed the most importance on innovation competitiveness(0.126) and quality of the economic life (0.126), which were followed by ecological sustainability(0.122) and international connectivity level (0.091), and global infra-structure (0.090). The top four factors contributed 53.7% of overall weight, while the bottom four factors accounted for only 28.2%.

According to evaluation result, Only 5 cities in the Asia have only belonged to the upper ranking as follow: Tokyo (4), Osaka (13), Singapore (14), Hong Kong (19), Kobe (20). The most Asian cities have been ranked below rank 22. The major cities or the capital city were between rank 22 and rank 30(Nagoya, Dubai, Shanghai, Yokohama, Seoul, Beijing, Ulsan, Taipei, and Bangkok). These asian cities have a lower ranks in component of spatial attraction than other components. These cities have to increase dgree of spatial attraction to catch up to the non-asian developed cities.

Below rank 32 cities have lowest ranking all three components. This group cities have face to competition with many other cities around the capital of domestic or foreign countries. These cities have to consider all three components.

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Appendix: Methodology

1. The Analytic Hierarchy Process

The AHP is a flexible, yet structured methodology that enables an individual (or a group of individuals) to formulate complex problems and to analyze relative weights or priority for many criteria or factors of varying degrees of subjectivity (Saaty, 1995; Ramanathan, 2001). Because of its intuitive appeal and flexibility, AHP has been used widely in various fields to make major policy decisions (Saaty, 2000).

AHP has the advantage over multi-attribute utility theory (MAUT) as a method for multiple criteria or factors evaluation by the general population, not experts, because MAUT ask complex questions about risk attitude of respondent and careful considerations of subtle trade-offs prior to a main survey, whereas AHP does not. In addition, AHP is a methodology that encourages respondents to make subtle trade-offs in non-quantifiable attributes (e.g., comfort of the seat and convenience of ticketing reservation, etc), even when the evaluation works include too numerous factors to apply other valuation techniques such as contingent valuation method and conjoint analysis.

AHP was originally developed to enable a single expert to evaluate complex decision-making problems, but has been recently extended to apply AHP to decision-making problems by a group of N people. Duke and Aull-Hyde (2002) identified public preferences for land preservation as applying AHP to survey data from 129 Delaware residents. Sohn et al. (2001) assimilated public opinions in nuclear decision-making using 375 data from the public poll.

Application of AHP to quantitatively assess various factors to evaluate urban competitiveness involves the following five steps:

1. Classify various intermediate level factors to affect urban competitiveness into several higher-level criteria according to their common characteristics and develop a hierarchical structure having different levels. This has been done in order to reduce inconsistencies in judgment of respondent by separating the evaluation problem into several hierarchy levels (Davis and Williams, 1994). And, 42 evaluation cities are included in the lowest level.

2. Make pairwise comparisons for several criteria (factors) in three specific levels through the expert survey and compute the priorities of the corresponding elements using a judgmental matrix (A) from the higher-level through the intermediate levels to the lowest level. Saaty (1980) suggests the use of a 9-point scale to transform the verbal

judgments into numerical quantities representing the values of entries a_{ij} in A, which is explained in Table 1.

Table 1. Fundamental scale for pairwise comparisons used in AHP

Degree of importance	Definition	Description
1	Equal importance	Elements i and j are equally important
3	Moderate importance	Element i is moderately important over j
5	Strong importance	Element i is strongly important over j
7	Very strong importance	Element i is very strongly important over j
9	Extreme importance	Element i is extremely important over j
2,4,6,8	Intermediate	Intermediate values between two adjacent judgments
Note: If element i has the above judgments assigned to it when compared with element j, then element j has the reciprocal value when compared with element i.		

Source: Saaty, 1980.

A judgmental matrix (A) is expressed as equation (1).

$$A=[a_{ij}]=[w_i/w_j] \quad (i,j=1,2,\cdots,K) \tag{1}$$

where w_i and w_j represent weights of elements i and j respectively. The entries a_{ij} are assumed to satisfy the following conditions: $a_{ij}>0$, $a_{ij}=1/a_{ji}$, $a_{ii}=1$ for all i.

3. Having made all the pairwise comparisons, we should aggregate individual expert's judgment for criteria (factor) evaluation of urban competitiveness in 42 countries. The issue of aggregation is a matter of importance not only in the expert judgments for complex decision-making problems, but also in the expert's preferences for criteria (factor) evaluation to affect urban competitiveness. We used the geometric mean of the a_{ij} as a method of aggregating each expert' judgments (Golden et al., 1989; Aczel and Saaty, 1983).

$$a_{ij}^{*}=\sqrt[N]{a_{ij}^{1}\times a_{ij}^{2}\times\cdots\times a_{ij}^{N}} \tag{2}$$

This method is likely to describe expert's preferences for criteria (factor) evaluation and

urban competitiveness evaluation more accurately, because it provides an opportunity for testing consistency of an aggregated judgment that a group of N selected experts stated.

4. The eigenvector method suggested by Saaty (1980) can be used for calculating the priority weight of each element and testing for inconsistency. When a certain degree of inconsistency exists, the following equation $AW = kW$ for a case of perfect consistency is revised as $AW = \lambda_{\max} W$ (Saaty, 1980). Then, the vector of priority weight, $W = (w_1, w_2, \ldots, w_k)^T$, can be approximately computed as equation (3).

$$W = (A^m \cdot e)/(e^T \cdot A^m \cdot e) \tag{3}$$

where e is $K \times 1$ matrix whose all elements are one and m is the iteration number for convergence. Then, the priority weight of each factor or option in the lower level of the hierarchy is easily computed by multiplying the priority weight of each criterion in the higher level by the priority weight of each factor or option within each criterion.

5. Finally, the maximum eigenvalue $\lambda_{\max}$ to check the consistency can be determined by equation (4).

$$\lambda_{\max} = \sum_i \sum_j a_{ij}^* w_i \tag{4}$$

The consistency index (CI) to represent the degree of inconsistency is as follows:

$$CI = (\lambda_{\max} - K)/(K - 1) \tag{5}$$

where K is the matrix size. We can check judgment consistency by taking the consistency ratio (CR) of CI with the random index (RI) representing consistency index for a randomly generated $K \times K$ matrix (see Table 2). In addition, overall judgment consistency for the entire hierarchy is found by multiplying each CI by the priority weight of the corresponding factor or option and adding them together, then the result is divided by RI corresponding to the sizes of judgmental matrix as before (Saaty and Kearns, 1985). The judgment can be accepted as consistent if the value of CR does not exceed 0.10 and vice versa.[4]

Table 2. Random index

Matrix size	1	2	3	4	5	6	7	8	9	10
Random index	0.00	0.00	0.52	0.89	1.11	1.25	1.35	1.40	1.45	1.49

Source: Saaty, 2001.

[4] We used Expert Choice 2000 program to check consistency of expert's judgments.

2. Questionnaire design

Survey questionnaire consisted of two parts. The first part was intended to inform experts of information necessary for evaluating criteria and factors to affect urban competitiveness.

The second part contained the AHP questions designed to ask experts to make pairwise comparisons for highest-level category, intermediate-level criteria, and the lower-level factors. Therefore, each expert was provided with 3 pairwise comparisons ($_3C_2$) among three categories and 12 pairwise comparisons ($_4C_2+_3C_2+_3C_2$) among criteria within categories, and 14 pairwise comparisons ($3\times_3C_2+5\times_2C_2$) among factors within criteria. All necessary pairwise combinations for comparison and the order in the pairs of categories, criteria, and factors were exactly the same for all respondents. Before main survey, a pre-test was conducted to correct the questionnaire.

3. Sample selection and survey method

To accurately evaluate urban competitiveness in Asian countries, the study area of this research covers Asian and non-Asian countries. Considering the characteristics of the survey, the survey was administered to domestic and foreign experts who have experienced similar research projects. The survey was conducted by mail because of budget and time constraints.

4. AHP results by the aggregated data

As stated above, we aggregated individual 406 (14×29) usable pairwise comparisons were with 29 pairwise comparisons by a representative of expert group. Expert Choice 2000 program was used for analyzing an aggregated judgment matrix and checking the inconsistency of responses. AHP results by the aggregated data are provided in Table 2. Within the framework of 3 evaluation categories, experts rank “spatial attraction power” category variable as the most important (0.411), followed by economic prosperity level (0.329) and international connectivity (0.260). As the consistency ratio (CR) at the highest-level is 0.01, the judgment on category variables for evaluating urban competitiveness can be accepted as consistent.

A fuller picture emerges, however, from the results on the relative importance of the various criteria for evaluating urban competitiveness. As stated above, we can obtain an overall priority weight for each criterion at the intermediate-level by multiplying the weight of each criterion at the highest-level by the weights of criteria within categories. The consistency ratios (CR_s) at the intermediate-level were 0.01 for resource input factor, 0.01 for international connectivity level, 0.00 for international prestige, respectively. Except for quality of the social and cultural life (0.163), respondents placed the most importance on

innovation competitiveness (0.126) and quality of the economic life (0.126), which were followed by ecological sustainability (0.122) and international connectivity level (0.091), and global infra-structure (0.090). The top four factors contributed 53.7% of overall weight, while the bottom four factors accounted for only 28.2%.

Also, the relative importance of the various 21 factors for evaluating urban competitiveness can be obtained by multiplying the weight of each factor at the lowest-level by overall weights of criteria at the intermediate-level (see Table 2).