

## Using Analytic Hierarchy Process (AHP) for discussing key success factors in the sustainable development of healthy cities

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### Abstract

The coexistence of human beings and environmental sustainability becomes individually and even globally concerned issue. In addition to environment issues, people also encounter negative issues of infectious diseases, gap between rich and poor, violence in society, uneven resource distribution, people's health decline, and population structure aging, which would affect the sustainable development of cities. When taking sustainable development from the world to cities, it appears sustainable cities. The goal of a healthy city is to pursue the sustainability of a city. Aiming at residents in Shanghai, total 360 copies of questionnaire are distributed, and 277 valid copies are retrieved, with the retrieval rate 77%. The research results conclude that 1. "safety" is the most emphasized dimension, followed by "convenience & prosperity", "sustainable ecology", "vitality & health", and "culture friendly" and 2. security, Internet city, pollution control, space use, and inheritance education are top five indicators, among 15 evaluation indicators. According to the results, suggestions are proposed to provide the government with correct, objective, and simply understandable healthy city indicators and sustainable development indicators for the appropriate planning and review of the administration objectives to enhance the public awareness of healthy city and the participation. It would stop the worsening of environment and promote residents' health and the sustainable development of cities to have the city and the public moving towards healthy development.

Keywords: healthy city, sustainable development, environmental sustainability, key success factor

### 1. Introduction

In the 18<sup>th</sup> and 19<sup>th</sup> century, Industrial Revolution drove the city development and technological advancement in Europe. In order to acquire more resources, humans aggressed upon the natural environment and, centered on cities, deprived everything in the nature to harm the environment and ecology. When the destruction of ecology

and species and the abuse of pesticide seriously resulted in environmental pollution, people started to rethink the interaction between human beings and the earth. The emphasis on environment issues was taken by storm in Europe and America. Major environment issues of ozone depletion, global warming, and climate change have been discussed in past years. Such environmental issues are upgraded from regional to global levels. International societies start to perceive the tension and urgency of human existence. The coexistence of human beings and environmental sustainability becomes the individually and even globally concerned issue. It requires huge resources and manpower for supporting a large city system that the population gathers in cities for the convenience. In addition to environment issues, people in the areas encounter negative issues of infectious diseases, gap between rich and poor, violence in society, uneven resource distribution, people's health decline, and population structure aging, which would affect the sustainable development of cities. An ideal city in the 21<sup>st</sup> century would present rational and emotional lifestyles. When environmental quality and economic development are balanced, people living in unhealthy cities would not appear identity and cohesion on the places of residence. The improvement of a city towards "comprehensive health" would attract excellent talents and determine the healthy, free, and pleasant life of people to further lay the foundation of a country. Taking sustainable development from global level to cities would form the so-called sustainable cities. The goal of a healthy city is to pursue the sustainability of the city. For this reason, key success factors in the sustainable development of a healthy city are studied to provide the government with correct, objective, and simply understandable healthy city indicators and sustainable development indicators for the appropriate planning and review of the administration objectives to enhance the public awareness of healthy city and the participation. It would stop the worsening of environment and promote resident health and sustainable development of the city to have both the city and the public develop towards health.

## **2. Literature review**

### **2.1 Healthy city**

Lee et al. (2015) pointed out the formation of a healthy city. A healthy city was started the promotion in 1984 in Toronto, Canada. Pow & Neo (2015) stressed the principles of national health on equity in health, community participation, health promotion, cross-department cooperation, primary health, and international cooperation. It was definitely proposed in The Ottawa Charter for Health Promotion to make healthy public policies, to create supportive environment, to reinforce community action, to develop personal skills, and to adjust health service orientation.

Beal (2015) defined healthy city as a city being able to continuously innovate and improve the physical and social environment, expand the community resources, have the public support each other, practice all living functions, and further develop the maximal potential. Sharifi (2016) indicated that the promotion of healthy city aimed to pursue the sustainable development of a city. In the population explosion era, cities were full of social, health, public health, and environmental pollution problems that healthy city indicators allowed more objective evaluation of the current situation and the implementation result of the city. Lin & Shih (2018) proposed four phases for the promotion of healthy city program. The idea of Health for All was promoted in phase 1 (1987~1992) to establish the new practice structure, expecting to guide organizations and institutions in the cities in the world changing the health promotion directions. The adoption of policies in various cities was accelerated in phase 2 (1993~1997) to reinforce the connection between supporting systems and departments and emphasize action-oriented policies. The integration of health plans were stressed in phase 3 (1998~2002), expecting to fairly maintain social development and various cities presenting systematic monitoring and evaluation methods. The evaluation of effects on health, healthy city plans, and healthy aging were emphasized in phase 4 (2003~2007).

## 2.2 Sustainable development

Lee et al. (2015) proposed that the world would achieve the development limit with the continuous depletion speed of rapid growth of world population, pollution caused by industrialization, food production and natural resources, and energy (e.g. fossil fuel, mineral product, forest and biological resources) to eventually impact human beings and decline industrial development. Such research results triggered a heated debate internationally. Tsolakis & Anthopoulos (2015) mentioned that, since humans were facing major economic, social, and environmental issues, the idea of sustainable development covered economic development, social value, and environmental protection. Jong et al. (2015) indicated that various countries in the world established national sustainable development committees to set sustainable development indicators and precede more systematic classification and integration of such indicators. To prevent the earth from the threatening of warming in the 21<sup>st</sup> century, United Nations called the conference of “United Nations Framework Convention on Climate Change” in Tokyo, Japan, in 1997 and made “Kyoto Protocol” to restrict the greenhouse gas emissions of developed countries and request developed countries to achieve the reduction of greenhouse gas to certain level. The second Earth Summit was held in Johannesburg, South Africa, in 2002, when “Sustainable Development Plan of Implementation” was declared, the schedule and outcome of

sustainable development since 1992 were evaluated, and specific steps and quantified objectives were provided for several issues. Shon & Giffinger (2015) indicated that sustainable development indicators were made according to Agenda 21, aiming to solve contemporary issues of disparity among countries, poverty, hunger, energy deficiency, and worsening ecological systems as well as to prepare for the challenge in the 21<sup>st</sup> century. Wangel et al. (2016) discussed social economy, storage, and management resources to enhance development and reinforce the functions of major groups as well as the implementation tactics. Schulz et al. (2018) mentioned that “protection and enhancement of human health” was included in the social economy in Agenda 21 because of the close relationship between health and development; and, health eventually relied on the ability to successfully deal with the interaction among physical, spiritual, biological, economic/social environment. Seth et al. (2016) considered that there would not have healthy development without healthy population, and human activities would result in environmental burden, while environment would affect human health. Meanwhile, social and economic development would affect health that health and environment were correlated with the improvement of social economy. It was also mentioned that the improvement of health required the cooperation of various departments; besides, it also stressed on the importance of community development and participation as well as the establishment of relevant indicators.

### **3. Research design and method**

#### **3.1 Research method**

Hosseini & Keshavarz (2017) pointed out common ways to confirm key success factors, including (1)Regression Analysis, (2)Factor Analysis, (3)Delphi Method, and (4)Analytic Hierarchy Process (AHP). Maria Garbuzova-Schlifter (2016) explained Analytic Hierarchy Process that, through group discussions, the opinions of scholars, experts, and participants were collected to simplify the elements in complicated problems into a hierarchical evaluation system; then, according to experts' ideas, the contribution or priority of components in various hierarchies corresponding to the components in the upper level was calculated. Through objectively interview with relevant supervisors, Garbuzova-Schlifter & Madlener (2016) explained that objectives and tasks were first confirmed according to management programs, individual key success factors were then proposed according to individual practical experiences and needs, and then key success factors to achieve the objectives were organized after analyses and selection for the sequence so that the corporate resources could be effectively distributed in the key factors; finally, measurement indicators

were established for the practice effectiveness.

In consideration of the problems in traditional Delphi Method, such as mean, decision attribute correlation, and inaccurate group decision making, Fuzzy Delphi Method (FDM) and Analytic Hierarchy Process (AHP) are introduced in the data analysis of experts' questionnaire survey to definitely select key factors in the sustainable development of a healthy city in this study.

- (1) Fuzzy Delphi Method (FDM), first proposed by Murry et al. integrating fuzzy theory into traditional Delphi Method in 1985, applies the value of relative dependent variables to express distinct human semantic. For instance, the weight of semantic in humans' natural languages could be regarded as the variable of language, with the value of "extremely low", "low", "medium", "high", and "extremely high", or other words, which are given different weights for the estimation. Murry et al. explained that the proposal of fuzzy linguistic variables for evaluation aimed to solve the fuzziness in traditional Delphi Method. However, more specific calculations were not proposed. The successive researchers proposed solutions, including range method, fuzzy integral, triangular fuzzy number, and Fuzzy Delphi Method with double triangular fuzzy number.
- (2) Analytic Hierarchy Process: After integrating experts' opinions, the complicated decision-making system is constructed a hierarchy system to clarify problems. With pair comparison, the dual comparison is completed to evaluate the importance of factor weights.

### 3.2 Establishment of evaluation indicator

The questionnaire in this study is emailed to experts in various fields. The first-time feedback is organized for the items considered in the sustainable development of a healthy city. The factors with similar properties are classified into a category and sent back to the experts for opinions. With several runs of inquiry, the major categories are classified. An expert meeting is called for making the applicable principles, economic principles, aesthetic principles, balance principles, and ecological principles of key success factors in the sustainable development of a healthy city. Such key factors are used as the AHP dimensions, and the correspondent categories are regarded as the principles to establish the AHP questionnaire. The following research principles are modified through Delphi Method.

- (1) Safety: resident safety, security, resident complaint.
- (2) Vitality & health: exercise environment, space use, exercise channel.
- (3) Sustainable ecology: living environment, recycle program, pollution control.
- (4) Culture friendly: cultural heritage, inheritance education, cultural tourism.
- (5) Convenience & prosperity: Internet city, transportation system, convenient

environment.

### 3.3 Research object

Aiming at residents in Shanghai, total 360 copies of questionnaire are distributed and 277 valid copies are retrieved, with the retrieval rate 77%.

## 4. Data analysis result

After completing all hierarchy weights, the distribution is based on the relative importance or evaluation indicators in various hierarchies to present the importance of indicators in hierarchies in the entire evaluation system as well as to generate the overall weight of key factors in the sustainable development of a healthy city, Table 1.

Table 1: Overall weights of factors in healthy city sustainable development

dimension	hierarchy 2 weight	hierarchy 2 order	indicator	overall weight	overall order
safety	0.268	1	resident safety	0.075	6
			security	0.109	1
			resident complaint	0.039	14
vitality & health	0.166	4	exercise environment	0.048	12
			space use	0.083	4
			exercise channel	0.033	15
sustainable ecology	0.187	3	living environment	0.065	8
			recycle program	0.050	11
			pollution control	0.093	3
culture friendly	0.152	5	cultural heritage	0.055	10
			inheritance education	0.077	5
			cultural tourism	0.044	13
convenience & prosperity	0.227	2	Internet city	0.101	2
			transportation system	0.072	7
			convenient environment	0.061	9

## 5. Discussion and Conclusion

According to the empirical results and analyses in this study, the following conclusions are summarized.

“Safety”, weighted 0.268, is the most emphasized dimension in hierarchy 2, about 26.8% of the overall weight, followed by “convenience & prosperity” (weighted 0.227), “sustainable ecology” (weighted 0.187), “vitality & health” (weighted 0.166), and “culture friendly” (weighted 0.152). Accordingly, safety is the most emphasized dimension in the sustainable development of a healthy city.

The hierarchy weights of evaluation indicators in hierarchy 3 are sequenced as below.

1. The evaluation indicators under safety are sequenced security, resident safety, and resident complaint.
2. The evaluation indicators under vitality & health are sequenced space use, exercise environment, and exercise channel.
3. The evaluation indicators under sustainable ecology are sequenced pollution control, living environment, and recycle program.
4. The evaluation indicators under culture friendly are sequenced inheritance education, cultural heritage, and cultural tourism.
5. The evaluation indicators under convenience & prosperity are sequenced Internet city, transportation system, and convenient environment.

From the overall weights of evaluation indicators for key success factors in the sustainable development of a healthy city, top five emphasized indicators, among 15 evaluation indicator, are security, Internet city, pollution control, space use, and inheritance education.

## 6. Suggestion

According to the conclusions, following suggestions are proposed in this study, expecting to provide definite guidance and directions for the promotion of the sustainable development of a healthy city.

1. After the establishment of healthy city centers, the government displays the numerical values of indicators in past years and the city related information on the network platform for the inquiry and reference of the public or researchers so as to present the open information of the healthy city. Nevertheless, the indicator data should be more accurate and local data or questionnaire survey should be offered to be closer to local situations.

2. Since the promotion of a healthy city requires community participation, it is suggested that the indicator data could be displayed with administrative areas. In addition to clearer regional resource distribution, contests could be held to promote the competitiveness among regions. Moreover, local healthy city indicators, according to the actual administration, customs, and geographic environment of a city, could be increased.
3. It is suggested that the government could practice health education on resident safety and increase promotional materials to remind citizens of early detection, early treatment. In terms of security, education could be reinforced to reduce criminals. Besides, the patrol of police or community volunteers could stop thieves and criminals. In addition to strengthening publicity and warning signs, crackdown could be enhanced. In regard to pollution control, crackdown on air pollution and waste water discharge should be strict, and green coverage, leisure & sports places, and connection transportation around mass rapid transit systems could be increased.

**Author Contributions:** Yuzhou Luo collected the survey data and summarized related prior literature; Kaijun Yu and Longjie Sun performed empirical analysis and wrote the major parts of the paper; Yi Lian supplemented several parts of the paper and refined the whole.

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