Build Sustainable Cities

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Abstract. It is crucial to make it clear that how to implement smart growth theories effectively into city design around the world. To begin with, six factors are selected from the aspects of economy, social equity and environment. Then we the fingered out the weight vector by using AHP. Based on the ranking vector designed by fuzzy composite operation, the comprehensive evaluation value can be obtained. The testing results indicate that the evaluation results are convincing. Besides, before putting forward reasonable growth plan for Wuzhen and Kabwe, the Shapley values (SV) of the six indexes have been worked out by using the Cooperative Game Theory. The evaluation result indicates that the plan is successful under certain conditions.

Introduction

Many local governments strive to promote economic development while preserving their open spaces and critical environmental habitats, protecting water and air quality, and reducing greenhouse gas (GHG) emissions. Across the United States, many communities are implementing smart growth initiatives in an effort to consider long range, sustainable planning goals. "Smart growth is about helping every town and city become a more economically prosperous, socially equitable, and environmentally sustainable place to live." [1] Smart growth focuses on building cities that embrace the E's of sustainability— Economically prosperous, socially Equitable, and Environmentally Sustainable. It is an urban planning theory that originated in 1990's as a means to curb continued urban sprawl and reduce the loss of farmland surrounding urban centers. This task is more important than ever because the world is rapidly urbanizing. It is projected that by 2050, 66 percent of the world's population will be urban—this will result in a projected 2.5 billion people being added to the urban population. [2] Consequently, urban planning has become increasingly important and necessary to ensure that people have access to equitable and sustainable homes, resources and jobs.

Making cities sustainable is the final goal.

- To begin with, design factors to describe the sustainable degree of a city. And also prove the scientificity of the evaluation system designed.
- Then, select two mid-sized cities on two different continents. Measuring and discussing the current growth plan of each city.
- Finally, developing a growth plan for both cities over the next few decades using smart growth principles.

Evaluation System of the City

Define evaluation factors set:

Suppose the six factors could evaluate the level of sustainability of a city. Those factors as shown below in Fig. 1.
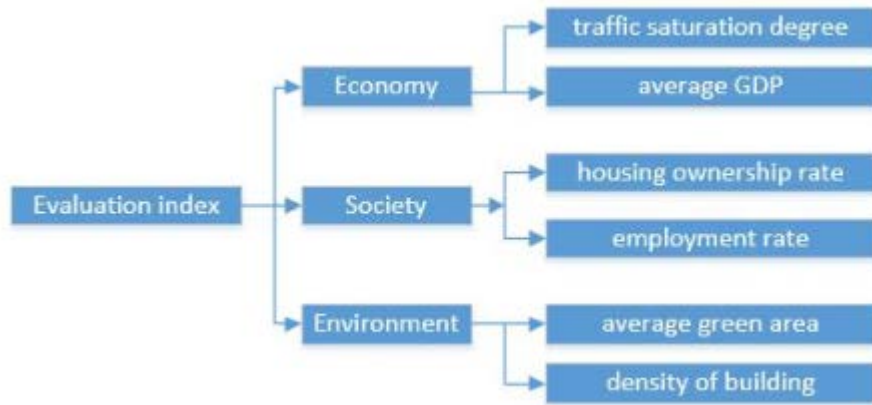
Fig. 1 Evaluation factors

Calculate the single factor weight:

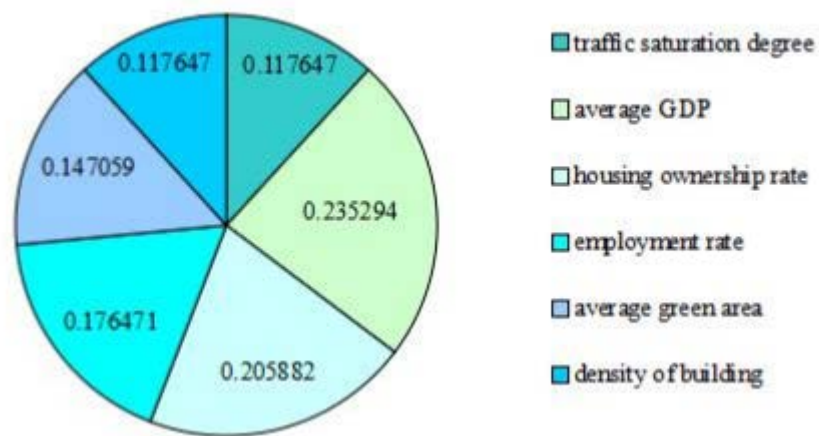Obtaining the weight vector of the six factors by using AHP arithmetic.

Fig. 2 The weight of six factors

Fuzzy composite operation:

Other parameters defined:

B:The evaluation results' subjection degree vector;

R:fuzzy evaluating matrix.

Membership vector can be calculated by using weight matrix A and fuzzy relationship matrix R [3].

$$B = (b_1, b_2, b_3, b_4) = A*R = (a_1, a_2, a_3, a_4)*\begin{bmatrix} r_{11} & r_{12} & r_{13} & r_{14} \\ r_{21} & r_{22} & r_{23} & r_{24} \\ \vdots & & & \vdots \\ r_{71} & r_{72} & \cdots & r_{74} \end{bmatrix}$$

Comprehensive evaluation:

Design rank vector C=$(10, 8, 6, 4)^{\mathrm{T}}$, hence, the final comprehensive evaluation result can be obtained:

$$P=B*C$$

P is a certain value for each city. It can reflect the comprehensive level of a city. The higher the P is, the more sustainable the city is [4].

To ensure the scientificity of the evaluation procedure above, taking Bellevue, Washington as examples to test this evaluation system. Based on the data we have got [5], calculation result is as shown below:

$$B= (0.5247, 0.4753, 0, 0)$$

$$P=9.0494$$

From this result, we come to the conclusion that this city is sustainable, which is accord with the fact. Afterwards, we have the reason to believe that this evaluation procedure is scientific and the evaluation result is convincing.

Develop the Growth Plan

Analysis of Wuzhen and Kabwe.

Wuzhen is famous for its natural scenery with its nice geographic location and pleasant environment, therefore, tourist industry is well-developed and prosperous there. Under the driving of tourist industry, its average GDP and employment rate are much higher than in many other cities. In particular, it is a place which has strong sense of place. However, it has the weak traffic capacity, low growth rate of population and thin building density. The P value of Wuzhen is 7.9424 which is in the range of rank two.

Kabwe is the second largest city of Zambia, and it has the population of 250,000. This is an area that contains large number of lead and copper. Exploiting randomly and managing loosely result in very serious mental pollution. What's worse, even the water and soil have been polluted. The world bank is going to carry a project planning to spend $40,000,000 in teaching local folks how to avoid lead poison. The P value of Kabwe is 7.2812 which is in the range of rank two.

Develop a Growth Plan for Both Cities.
1)Develop a growth plan for Wuzhen

The roads in WuZhen are not wide enough, and the modes of transportation is single. It can make sense that the best way to develop the local economy is establishing a more convenient transportation system to strengthen the communication with the outside.

Under the driving of tourist industry, its average GDP and employment rate are higher than in many other cities. However, in order to further develop local economy, to make full use of the method of mixed soil-exploitation is ideal for an agricultural city like Wuzhen.

Creating walkable neighborhoods can help build population-concentrated communities.

Afterwards, it is convenient to develop democracy and realize social equity.

This city is short of employment opportunity.

According to the facts discussed above, we put forward the growth plan for Wuzhen:
- Expand highway system, develop transportation business, and enrich the transportation mode.
- Change some old buildings into low polluted factories.
- Create a range of housing opportunities.
- Encourage start up business.

2) Develop a growth plan for Kabwe

This is a city engaged in heavy industry with plenty of resources.

The housing problem is serious, which should be solved urgently because of numerous alien workers.

Besides, it has tense population density and high unemployment rate.

In addition, the city suffers problems such as serious pollution and little green area.

According to the facts discussed above, we put forward the growth plan for Kabwe:

- Invest mineral resources
- Build economically affordable housing
- Bring in investment
- Strengthen environment governance

Through analyzing Wuzhen and Kabwe by using the Cooperative Game Theory, we obtain the weight of each index. It is clear that it is important to provide more employment opportunities in Wuzhen. While, in the view of Kabwe, environmental governance is the most potential issue. Based on the weight figured out, we put forward the growth plan for both cities. And we evaluate the success of our smart growth plans by using our metric. Meanwhile, the Shapley value will reflect the rank of the plan. The higher the value, the higher rank it has.

Conclusion

In terms of traffic saturation degree and average GDP, the developmental potential of Wuzhen is far bigger than that of Kabwe. This phenomenon depends on the economic development condition of different cities. For Wuzhen, it has a slow velocity in economic development. In consequence, it is essential to develop a plan involved of economy which is opposite to Kabwe.

As for the average green area, it is the most potential index of Kabwe, however, there is no need for Wuzhen to take it into account. The differences between the two cities are decided by the type of them. Wuzhen is an agricultural city which has a set of complete environmental protection policies. Instead, Kabwe is an industrial city polluted seriously. It is a wise choise for Kabwe to improve its environment.

Building density plan is not carried out in both cities, which has a close relationship with geographical conditions of them. The current building density is tense enough, so it has less potentiality for Kabwe to enlarge building density. Wuzhen has low building density, but it is surrounded by river. Therefore, there is no condition to build more buildings.

Wuzhen and Kabwe are similar in housing own relationship and employment rate. They are not the comprehensive development city either. Thus, it proves that some different factors influence the social equality.

Summary

We research the current growth plan of the selected cities. And then we measure how the current growth plan of each city meets the smart growth principles by figuring out the comprehensive evaluation value for both cities. The result tells us that both cities are not sustainable now. Besides, to put forward reasonable growth plan, we work out the Shapley values (SV) of the six indexes by using the Cooperative Game Theory. Then we put forward four plans for the selected cities respectively. After analyzing the differences between both cities, we reach the conclusion, which is only on the basis of the demographics, growth needs, and geographical conditions of a city can we adhere to the three E's.

References

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