

Smart Level Evaluation Model for Smart City

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Abstract: In this paper, we set up distinct model: Smart Level Evaluation (SLE) model. Moreover, ternary integrated evaluation method is proposed to measure evaluation value, which is our highlight as well. The SLE model is built to evaluate the level of urban smart growth. The level of smart growth is measured with selected 13 indicators by ternary integrated evaluation method, which integrates the merits of AHP, gray correlation and fuzzy comprehensive evaluation. Based on this method, SLE model is applied into two cities- Reykjavik in Iceland and Gulu in Uganda.

1. Introduction

Smart City aims to create a high quality of life. The urbanization of the world's population has become a key issue that needs to be addressed. 25% of the world's population are living in 600 cities.[1] Developing countries in Asia and Africa are urbanizing even more rapidly than other regions of the world. The growing population and maximal use of natural resources in cities cause ecological and environmental problems, and increase public disorder problems.[2] All these challenges and problems force citizens, governments and stakeholders to pay attention to the environment and sustainable development of cities, and to try to implement smart growth theories into city design around the world to reduce these urban problems. This task is more important than ever because the world is rapidly urbanizing. Population growth and urbanization increase rapidly necessitate to cities grow more economical, more social, and retain environmental sustainability. In a word, sustainable cities are needed!

2. Model of SLE

2.1 Selection of Indicators

In this part we will start our analysis with a detailed description of reasons for selecting proper indicators. General principles of choosing indexes are the three E's of sustainability and the 10 principles of smart growth.

Table 1 Three hierarchies in index system

	Hierarchy	Description of index
The first	Integration layer	Coefficient of urban sustainable development
The second	System layer	Coefficient of economy, society and environment
The third	Basis layer	Indexes in basic layer

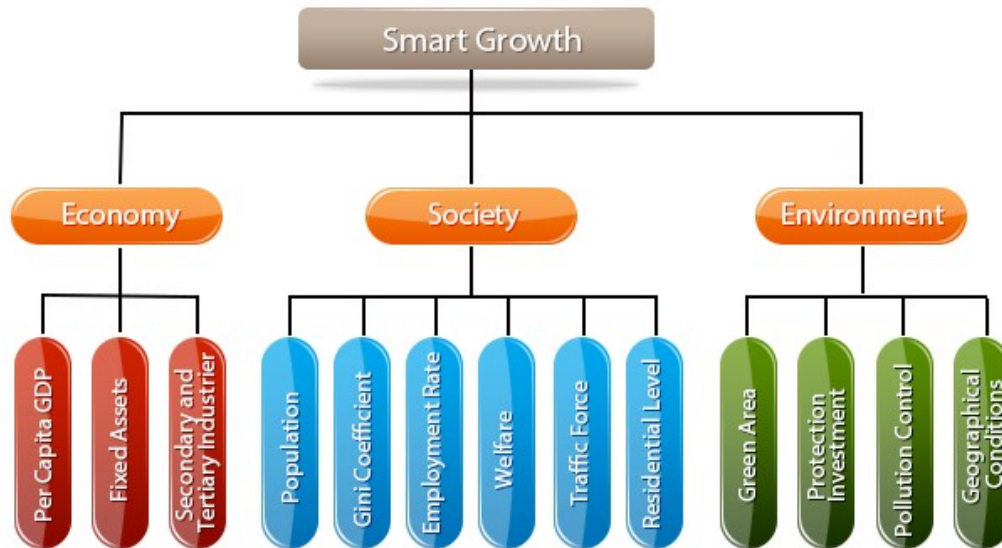


Figure 1 Indicators of SLE

2.2 Smart Level Evaluation (SLE) Model

We develop the ternary integrated method—a combination of success of the above three methods that takes advantage of their strength to offset each other's deficiencies.

The success rate of urban growth can be derived from the comprehensive evaluation value calculated by indicators. At present, there are three kinds of typical evaluation algorithm, namely the Analytic Hierarchy Progress (AHP), the Grey Correlation and Fuzzy Evaluating. However, they have their own drawbacks. AHP is subjective to some degree, and the process of comparison is rough. Grey Correlation method has lower resolution, and it is difficult to analyze the problem more thoroughly. And fuzzy evaluation method is subjective, existing problems of no accurate judgment or the results.

3. Model Application

3.1 Urban Selection

In our statement, with the purpose of making the model analysis more convincing, we selected two cities --Reykjavik and Gulu in two continents of Europe and Africa. In this section, we are going to measure and discuss how the current plan of each city meets the smart growth principles. In the final, we analyze how successful the current plans are.

Reykjavik is the capital of Iceland, with a population of 121.5 thousand. The proportion of tourism and the level of economic development are high. Nowadays many cities have prioritized the provision of bicycle infrastructure, as part of a transition to more sustainable transport. And has aimed to increase the popularity of cycling as a mode of transport.[3]

Gulu, a nation focused on agriculture, is a northern Ugandan city with a population of 170,500.

3.2 Analysis of Current Development Plan

We will measure and discuss the current growth plans of the two typical cities and then get the development evaluation values from 2003 to 2016. After having evaluation values it's easy to analyze the success of the plan according to the growth rate of the city evaluation value.

3.2.1 Urban Evaluation Values

Relevant data for this paper were obtained through some famous websites about Reykjavik and Gulu . These data include 13 indicators of the two cities. Therefore, it is feasible to calculate these data to obtain the evaluating value by means of the ternary integration algorithm model. Evaluation values can represent the degree of sustainable urban development with the value of 0~10. Values between 0-5, 6~8, 9~10 is respectively weak development, medium development and rapid development.

The evaluation value of the growth rate is a reflection of the degree to emphasis on local policy, that is to say, its development plans. The specific evaluation values are revealed in Figure 2 and Figure 3.

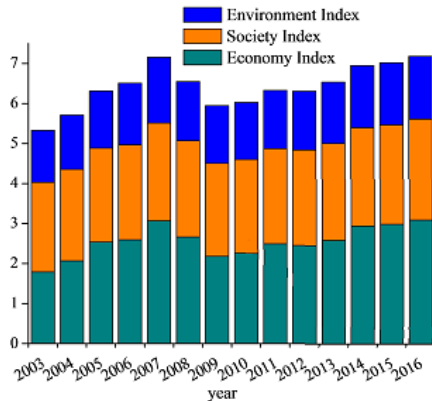


Figure 2 Evaluation values in Reykjavik

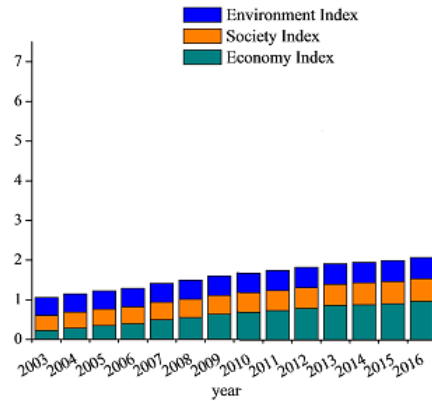


Figure 3 Evaluation values in Gulu

3.2.2 Urban Evaluation Values

The total height of the graph represents the evaluation of its corresponding year. The figure indicates that affected at economic growth the development level has been always high in Reykjavik in recent 13 years. This is due to the highly developed Reykjavik, and social index and environmental index tend to be stable, which decides on the small space of development. Economic crisis in 2008 impacted on Reykjavik, resulting in a sharp decline in economic indicators, and it gradually returned to high levels after 2009. The figure shows the growth plan performs well in Reykjavik.

However, Gulu is an underdeveloped area, whose overall evaluation value is low, and impact of the financial crisis is slight with stable growth rate. But because of the lower index of the three indices, especially the environmental index and the social index, which have been kept at a low level and slow growth. Their growth plans are shown in poor performance.

3.3 Success Evaluation of the Current Plan

3.3.1 Growth Plan Evaluation (GPE) Model

We take account in the following two problems:

- Owing to the different level of development in different regions, the same growth plan in different areas may lead to various results. The degree of success may be the same between the developed regions with high evaluation values and the underdeveloped regions with low evaluation values
- The threshold theory explains that the further development of the city with high development level is difficult. The Marley threshold theory can be introduced into the field of urban research, thus the concept of a city threshold is proposed. In other words, for a city with a high level of development, further development will sustain additional resistance.

Therefore, it is one-sided and infeasible by only considering the evaluation value and the growth rate to measure the success of the development plan. So we will take count in these two aspects comprehensively to determine the degree of success after carrying out the city growth plan.

We have the equation to measure the success of urban growth plan

$$E = \alpha A + \beta r(10 - \alpha) \tag{1}$$

Where A denotes evaluated value and r refers to growth rate. When the evaluation value is big, the coefficient on the front of the growth rate is small, indicating that E is mainly affected by the evaluation value. On the contrary, the proportion of growth rate is larger. This validates our model perfectly.

From the GPE Model, we can get the range of E : 0~10. Table 2 shows different meanings of degree of success plans (we define 3~0 contain extremely slow growth and negative growth).

Table 2 Classification of degree of success plan

Value of E	Implication
10~7	Strong Success
7~3	Medium Success
3~0	Weak Success

After mathematically analyzing, our model would like to present our results, shown in Table 3

Table 3 Evaluation values in two cities

	Evaluation value	Growth rate(%)
Reykjavik	7.180752	2.3
Gulu	2.076932	3.8

4. Conclusions

Reykjavik has a score of 7.2 or so, and the growth plan is more successful. The mainly reason is the social and environmental conditions have reached a high level to continue to develop the economy and promote urban development. This result demonstrates the current growth plan in Reykjavik meets smart growth.

With the score of 2.4, Gulu has a poor growth performance plan. Though urban society, economic and environment is at a low level, Gulu only puts emphasis on economic development rather than the coordinated development of three aspects. That illustrates the poor growth performance.

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