A Model for Judging Whether a City is in a Smart Growth

Xinna Qiao
North China Electric Power University, Baoding, Hebei, China
525871545@qq.com

Keywords: Sustainable city; Smart growth; Economically prosperous; Socially equitable; Environmentally sustainable; Metric

Abstract. With the acceleration of urbanization, the city is also facing the challenges of environmental pollution, traffic congestion, energy shortage, housing shortage, unemployment, disease and so on. In this background, "sustainable city" and "smart growth" become a feasible way to solve urban problems, we develop and optimize the metrics to judge the success rate of urban smart growth and smart growth plan from the economic prosperity, social justice and sustainable environment three aspects, to solve a series of problems brought by the blind expansion of city planning. A comprehensive metric evaluation model can be established through Analytic hierarchy process (AHP), given three E metrics---economically prosperous, socially equitable, and environmentally sustainable and each corresponding influencing factors, we give each metric an evaluation interval as a measure of the standard through literature research and analysis, and a detailed simulation method is formed.

Problem Background

Sustainable city is developed with the concept of sustainable development. The official formulation of a sustainable city for the first time at the second United Nations Conference on human settlements in Turkey, Istanbul, 1996. The study of sustainable city theory originated in the field of city planning. In Europe and the United States continue to explore the development of the theory, the sustainable development of the city is a compact form of view into the mainstream. At the end of 1990s, the United States realized that many problems brought by the development of suburbanization, under the influence of the concept of compact city, in 2000 the Smart Growth America established and put forward the new urbanism, the core concept of smart growth is a basic principle of land use planning in suburban, its fundamental is to prevent the spread of city and suburb of refuge reproduction. “Smart growth is about helping every town and city become a more economically prosperous, socially equitable, and environmentally sustainable place to live.”[1]

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] Nowadays, with the acceleration of urbanization and the increase of urban population, the city is facing the challenges of environmental pollution, traffic congestion, energy shortage, housing shortage, unemployment, disease and so on.[3] In this context, the "sustainable city " and “smart growth” has become a feasible way to solve the urban problems, and is the trend of urban development in the future.

Problem Analysis

I will establish an indicator that is used to measure the success rate of Urban Smart growth. I use a region's economic prosperity, social justice and environmental sustainability as a comprehensive indicator, then use the data and reference values provided by our group for comparison, if the comprehensive metric of the area is less than the reference value, the city's smart growth in the region is not ideal; if the comprehensive metric of the region is greater than or equal to the reference value, it shows that the region is in the stage of urban smart growth.[4]

Hypothesis and Symbol Description

It is assumed that the smart growth of cities is only related to economic prosperity, social equity, and environmental sustainability.

It is supposed that the prosperity of a region is only related to the per capita GDP and the output value of the gross national product per unit area. [5]

It is assumed a certain area of social justice is only related to the gap between the rich and the education expenditure.

It is assumed that the environmental sustainability of a region is only related to water quality, air quality and sound quality.

It is assumed that the gap between rich and poor is entirely dependent on the Gini coefficient; the educational equity of a region is only reflected in the proportion of educational expenditure in the national economy. [6]

It is assumed that the water quality metric is only related to the shortage of water resources and the quality of drinking water, groundwater and surface water.

Model establishment

Factors Affecting the Economic Prosperity: Because a city in line with the smart growth in economic prosperity of the comprehensive indicators is mainly reflected in the per capita GDP and per unit area GDP output value (the gross domestic product (GDP) / the area of the region). The per capita GDP and per unit area GDP output value shall be converted into percentile scores. And the principle of converting the per capita GDP to percentage system: The percentage of the ratio between the per capita GDP and the per capita GDP is multiplied by the value of one hundred as the percentile scores (if the quotient is greater than 1, the scores is 100), then multiplied by an adjustment coefficient λ_1; The principle of converting the per unit area GDP to percentage system: The conversion of the output value of the gross national product per unit area to the principle of: The ratio between the gross domestic product (GDP) and the total area of the region is multiplied by an adjustment coefficient λ_2.[7]

Where:

y_1 is the comprehensive metric of economic prosperity in a region

x_1 means gross domestic product (GDP) in a region.

x_2 indicates the total population of a region.

x_3 stands for the area of the region.

α_1 represents the adjustment coefficient of per capita GDP.

α_2 is adjustment coefficient of per unit area GDP output value.

Then determine the equation:

$$y_1 = \alpha_1 \times \frac{x_1}{x_2} \times \lambda_1 + \alpha_2 \times \frac{x_1}{x_3} \times \lambda_2 \tag{1}$$

Factors Affecting the Social Justice. Because a city in line with the smart growth in social justice of the comprehensive indicators is mainly reflected in the gap between the rich and poor and the expenditure of education. The gap between the rich and the poor and the expenditure on education should be converted into percentile scores. [8] The metric of the gap between the rich and poor is mainly based on the inverse of the Gini coefficient multiplied by an adjustment coefficient λ_3 to give the score of the gap between the rich and poor in the region(the larger the gap between the rich and poor in the region, the greater the Gini coefficient, the lower the score). The metric of education expenditure is mainly based on the proportion of the education expenditure in the gross domestic product, and then multiplied by an adjustment coefficient λ_4.

Where

y_2 is the comprehensive metric of social equity in a region.

x_1 means gross domestic product (GDP) in a region.

x_4 indicates the Gini coefficient of a certain region.

x_5 stands for the educational expenditure .

β_1 represents the adjustment coefficient of the gap between the rich and the poor.

β_2 is the adjustment coefficient of educational expenditure.

Then determine the equation:

$$y_2 = \beta_1 \times \frac{1}{x_4} \times \lambda_3 + \beta_2 \times \frac{x_5}{x_1} \times \lambda_4 \tag{2}$$

Factors affecting the environmental sustainability. Because a city in line with the smart growth in environmental sustainability of the comprehensive indicators is mainly reflected in the water quality indicators, air quality indicators, sound quality indicators, these indicators should be converted into percentile scores. The water quality metric is mainly based on the water shortage and quality of drinking water, groundwater, surface water comprehensive evaluation as percentile scores； The air quality metric is main only determined by the number of days of fine weather; The sound quality metric is mainly converted from decibel to percentile scores. [9]

Where:

y_3 is the comprehensive metric of environmental sustainability in a region.

x_6 stands for the comprehensive metric of water quality in a region.

x_7 means air quality metric in a region.

x_8 indicates sound quality metric in a region.

γ_1 represents the adjustment coefficient of water quality.

γ_2 means the adjustment coefficient of air quality.

γ_3 is the adjustment coefficient of sound quality.

Then determine the equation:

$$y_3 = \gamma_1 \times x_6 + \gamma_2 \times x_7 + \gamma_3 \times x_8 \tag{3}$$

Function Arrangement

The model considers the city smart growth is mainly reflected in the economic prosperity, social justice and environmental sustainability in three aspects, taking into account the scope and extent of the impact of these three aspects of the process of smart growth in a city, our team aims to achieve the goal by adjusting the proportion of the three aspects of smart growth in the city. [10]

Where:

Y is the smart growth comprehensive metric.

ρ_1 indicates the adjustment coefficient of comprehensive metric of economic prosperity in a region.

ρ_2 stands for the adjustment coefficient of comprehensive metric of social equity in a region.

ρ_3 means the adjustment metric of comprehensive metric of environmental sustainability in a region.

ϕ is the reference metric of city smart growth.

Then determine the equation:

$$Y = \rho_1 \times y_1 + \rho_2 \times y_2 + \rho_3 \times y_3 \tag{4}$$

According to the comprehensive indicators Y to determine whether the city is in the stage of smart growth, our team provides a reference value ϕ of the city's smart growth， if the city's smart growth metric is less than the reference value ϕ, the region's city smart growth is not ideal; If the city's smart growth metric is greater than or equal to the reference value, it shows that the region is in the stage of city smart growth. [11]

If $Y < \phi$, shows that the region's smart growth is not ideal.

If $Y \geq \phi$, shows that the region is in the stage of urban intelligent growth.

Summary

Smart growth provides people with a new concept of urban planning, so it is particularly important to determine whether a city is in a smart growth stage. Through the analysis of three E goals and ten principles of smart growth, this model provides people with a way to judge whether a region or a city is in a smart growth stage. For the country, according to whether the model in domestic city smart growth stage and strengthen guidance, and strive to build an economic prosperity, social justice and environmental sustainable society; for the local government, it can be used to determine the city is in the stage of smart growth and help the government of the city planning scheme of smart growth.

References

[1] D.J. Zhu, D.H. Liu: Management of city growth: smart growth theory and the Enlightenment of China [J]. Journal of Tongji University (SOCIAL SCIENCE EDITION), 2006.17 (4). (In Chinese)

[2] L.J. Gao, S.H. Cui, S Y Yu: Understanding of sustainable city research [J]. Progress in geography science, 2010, 29 (10). (In Chinese)

[3] X.L. Tang: A summary of "smart growth" research [J]. city problem, 2009 (8): 98-102.

[4] Duany A, Speck J, Lydon M, et al: The Smart Growth Manual[J]. Smart Growth Manual, 2010, 7(2):89-90.

[5] D.J. Zhu, D.H. Liu: Management of city growth: smart growth theory and the Enlightenment of Chinese [J]. Journal of Tongji University (SOCIAL SCIENCE EDITION), 2006, 17 (4): 22-28. (In Chinese)

[6] Y. Yan, G.L. Wang: Contrast of Six Central Provincial Capitals Development Based on “Smart Growth Theory” [J]. Journal of Shanxi Normal University, 2013.

[7] Grant J L. Theory and Practice in Planning the Suburbs: Challenges to Implementing New Urbanism, Smart Growth, and Sustainability Principles1[J]. Planning Theory & Practice, 2009, 10(1):11-33.

[8] Kenneth Jackson: The Suburbanization of the United States. [J]. NewYork: Oxford University Press, 1985, 4:31-35.

[9] J. Xu, C. Li: Revelation of Smart Growth Theory to the New Urbanization Development[J]. China Ancient City, 2013.

[10] Raparthi K. Assessing Smart-Growth Strategies in Indian Cities: Grounded Theory Approach to Planning Practice[J]. Journal of Urban Planning & Development, 2015, 141(4):05014031.

[11] Panagopoulos T, Barreira A P. Shrinkage Perceptions and Smart Growth Strategies for the Municipalities of Portugal[J]. Built Environment, 2012, 38(2):276-292.