The Research of Smart Growth

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Abstract

With the spread of the city and development of a large amount of land, smart growth has attracted people's attention. We successfully find a new smart growth plan under the background of serious cities' economy and environment, and that is city smart growth evaluation system. Meanwhile, we discuss whether our plan is feasible when the population of each city will increase by an additional 50% by 2050. Frist, after addressing missing data, we develop a model called analytic hierarchy process (AHP) model. The weights of twelve indexes are determined by principle component analysis. Next, to measure and discuss how the current growth plan of each city meets the smart growth principles, we choose two cities, research their current growth plan, score two cities according to AHP model. Then, a grey forecast model is adopted to predict development situation in two cities. We develop a growth plan for both cities over the next few decades. According to city smart growth evaluation model, our plan can make Pittsburgh reach obviously successful in ten years and absolutely successful in twenty years. As well, city Jiayuguan reach unqualified in ten years and qualified in twenty years.And then, we compare two cities from politics, economy and culture. Through data we find shortcomings of cities. Afterwards, rank the individual initiatives combining with twelve indexes. Finally, we calculate population in the year 2050 through the data in five years. By comparing this number with 50%, our plan will adjust the development methods of certain indexes. We simulate the whole city smart growth evaluation system via computer.Also, we analyze the strengths and weaknesses of models and our new smart growth plan. The result indicates that our system has great accuracy and can be applied in many respects.

Keywords

smart growth, grey forecast model, AHP, developmet situation.

1. Introduction

1.1 Statement of the Problem

In the late 1990s, American realized the problemsthat "Suburbanization development" brought. Cities of low density spread disorderly and people flocked to the suburb to build houses. Many people opened up a large amount of farmland which brought about too much energy consumption and long way to work. However, "Compact development" in Europe made many historical towns compact and dense successfully. These towns were generally considered the ideal environment to live and work. Therefore American took method from European and put forward "Smart growth" concept.

The core contents of smart growth are as follows. Make full use of urban space and reduce the blind expansion. Government should strengthen the reconstruction of the existing community. In order to save the cost of infrastructure and public services, those abandoned and polluted industrial land should be redeveloped. Urban construction is relatively concentrated, life and employment unit are relatively in close distance. The costs of the infrastructure and housing construction can be reduced.

These contents will effective when they meet and adapt to special requirements of each community. Therefore, any measure of success should include demographic statistics, growth in demand and geographical condition of a city.

Urban problem is increasingly prominent nowadays and sustainable development of the cityneeds a new theory to guide. Smart growthmeets the needs of the development of the city. The application of smart growth should be focus on all over the world.

1.2 Our Work

We are asked to find out two mid-sized cities in two different continents and develop a model to implement smart growth theory to the construction of cities around the world.

Since the spread of the city and development of a large amount of land bring problems, a good concept arose: smart growth theory. This theory can not only meet development interests but also protect environment. We choose two cities and analysis them.

We firstly use analytic hierarchy process(AHP) model. Then we define twelve indexesto measure the success of smart growth of a city. In order to make results clear, we score two cities and research the current growth plan of two cities.Besides, we make growth plan over the next few decades. We use grey forecast model to evaluate the success of smart growth plans.Then rank each index using the new plan. We discuss whether our plan is feasible when the population of each city will increase by an additional 50% by 2050.

We simulate the whole models via computer. The data indicate that our models have great accuracy. This paper develops an original data-motivated model, which is

feasible even faced with tangled cross-section data and absent time-series data.

1.3 Symbol Description

Symbol	Meaning
B_1	community
B_2	land
B_3	building
B_4	transportation
B_5	development decision
B_6	economy
B_7	population
$\lambda_{\max}$	the largest eigenvector
$W_{m,n}$	weight
C_{11}	Uniqueness of the community
C_{12}	Development of the community
C_{13}	Community and stakeholder participation in development decisions
C_{21}	Land use
C_{22}	Farmland, natural beauty and other open areas
C_{31}	Compactness of the building
C_{32}	Diversity of housing opportunities and choices
C_{41}	Walk able neighborhoods
C_{42}	Transportation choices

C_{51}	Predictability and fairness
C_{61}	GDP
C_{71}	Natural population growth rate
RI	Average random consistency index
CI	Coincidence indicator
CR	Random consistency ratio

1.4 General Assumptions

- Community, land, buildings, transportation, development decisions, economy and population can reflect the development of the city.
- City cannot be affected by force majeure factors and stop developing. Such as wars and natural hazard.
- The data we collect from online databases is accurate, reliable and mutually consistent.Because our data sources are all websites of international organizations, it's reasonable toassume the high quality of their data.
- Criteria factors in the paper all accord with requirements of the hierarchical analysis method of concrete structure.
- There would be no great changes inthe cities that we research about political status, economic status and cultural status in its country in the short term.
- The development of the cities that we research cannot be influenced by other cities around them.

2. Define the Performance Index

2.1 The content of the indicators

The three E's of sustainability are economy, environment and social respectively. They are very important because no powerful international organization is working on the sustainability problem as a whole, which would include all three pillars. As the Great Recession of 2008 demonstrated, weakness in the other pillars can directly weaken the environment pillar. Many nations and states are cutting back or postponing stricter environment laws or investment, since their budgets are running deficits. Many environmental NGOs are seeing their income fall. If the Great Recession grew substantially worse and morphed into another Great Depression, you would expect the environmental pillar would get severely less attention, since eating now is a priority over saving the environment.

The social pillar is critical too. Once a war breaks out environment sustainability has zero priority. If a nation lives in dire poverty, the environment is pillaged with little thought for the future.

Therefore solutions to the sustainability problem must include making all three pillars sustainable.

According to the demographics, growth needs, and geographical conditions of a city, we put forward the evaluation index system of city. This system is divided into three parts: the destination layer, the criterion layer and the index level. As shown in the figure 1.

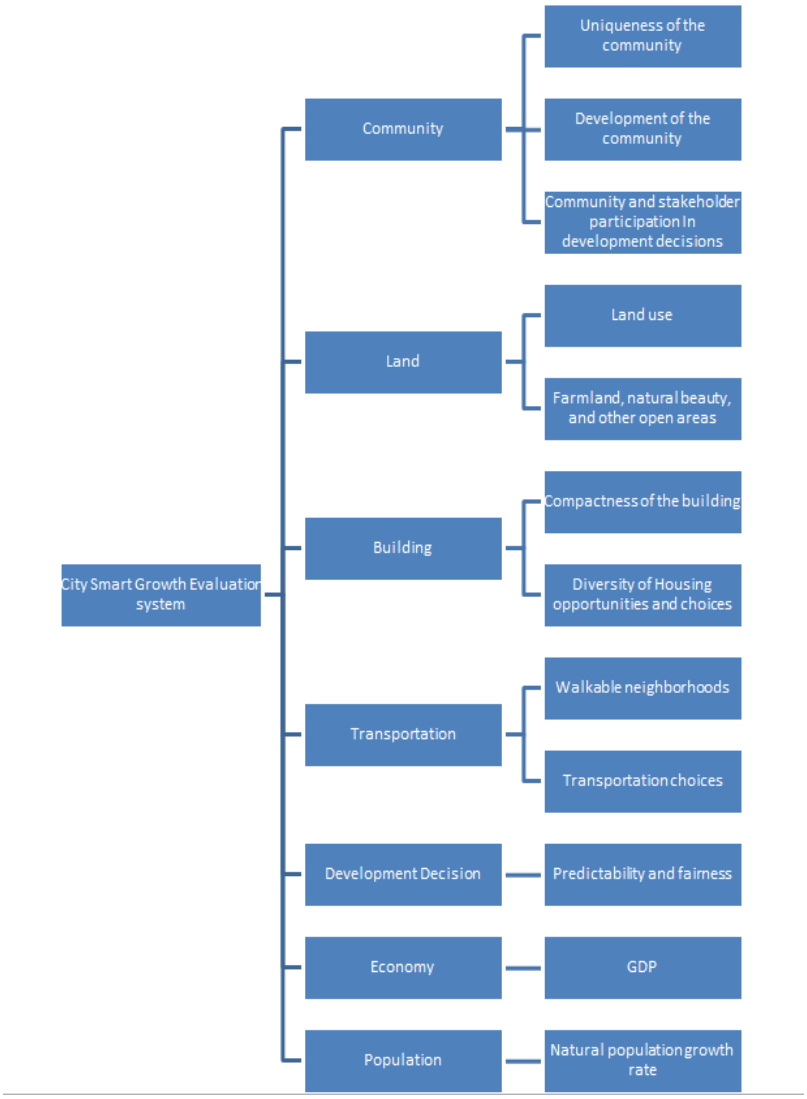


Figure 1

2.2 Weight Allocation

Next we use twelve performance indicators that combine ten principles of smart growth with three legs of sustainability to measure the success of smart growth of a city.

We build analytic hierarchy process (AHP) model.

(1) Structure judgment matrix (B_1)

As usual, we choose 1, 3,⋯,9 and their reciprocal as scale, 2, 4, 6, 8 are mid-value of adjacent judgment above. The implication is in table 1.

Scale Meaning

Scale	Meaning
1	The effect of one factor is as important as that of another one
3	The effect of one factor is slightly more important than that of another one
5	The effect of one factor is more important than that of another one
7	The effect of one factor is obviously more important than that of another one
9	The effect of one factor is absolutely more important than that of another one
2,4,6,8	The effect ratio is between above two adjacent data
$1,\frac{1}{2},\ldots,\frac{1}{9}$	The effect ratio is the reciprocal of above data

We take an example of the weight ofindex layer of C_1, C_2 and C_3.

$$B_1 = \begin{pmatrix} 1 & 5 & 3 \\ \frac{1}{5} & 1 & \frac{1}{3} \\ \frac{1}{3} & 3 & 1 \end{pmatrix}$$

(2) Calculate the maximum characteristic number and eigenvector of each judgment matrix, the procedure are as follows:

- Normalization of column vectors

$$\begin{pmatrix} 0.652 & 0.556 & 0.692 \\ 0.130 & 0.111 & 0.077 \\ 0.217 & 0.333 & 0.231 \end{pmatrix}$$

- Summation of row vectors

$$\begin{pmatrix} 1.900 \\ 0.106 \\ 0.260 \end{pmatrix}$$

- Normalization of line vectors

$$\begin{pmatrix} 0.633 \\ 0.106 \\ 0.260 \end{pmatrix}$$

In this way, we can calculate weigh set of institution building (C_1).

$W_{B_1} = [0.633, 0.106, 0.260]$

Calculate Maximum feature number $\lambda_{\max}$ of judgment matrix

$$\lambda_{\max} = \frac{1}{n}\sum_{i=1}^{n}\frac{(AW_i)}{W_i} = 3.038,$$

(3) Consistency check of weight vector.

RI Value

Order	1	2	3	4	5	6	7	8	9	10
RI	0	0	0.58	0.90	1.12	1.26	1.32	1.41	1.46	1.49

- Coincidence indicator

$$CI = \frac{\lambda_{\max} - n}{n-1} = \frac{3.038-3}{3-1} = 0.019,$$

- Average random consistency index

$RI = 0.58,$

- Random consistency ratio

$$CR = \frac{CI}{RI} = \frac{0.019}{0.58} = 0.0328 < 1.$$

So we consider that matrix has good consistency. The counting process of other matrix is as mentioned above. The result is described in the following.

Table 1: Judge Matrix A and relative right weight

A	B_1	B_2	B_3	B_4	B_5	B_6	B_7	$W_{m,n}$
B_1	1	5	1	3	6	4	2	0.271
B_2	$\frac{1}{5}$	1	$\frac{1}{5}$	$\frac{1}{3}$	2	$\frac{1}{2}$	$\frac{1}{4}$	0.049
B_3	1	5	1	3	7	4	3	0.296
B_4	$\frac{1}{3}$	3	$\frac{1}{3}$	1	4	2	$\frac{1}{2}$	0.113
B_5	$\frac{1}{6}$	$\frac{1}{2}$	$\frac{1}{7}$	$\frac{1}{4}$	1	$\frac{1}{3}$	$\frac{1}{5}$	0.032
B_6	$\frac{1}{4}$	2	$\frac{1}{4}$	$\frac{1}{2}$	3	1	$\frac{1}{3}$	0.074
B_7	$\frac{1}{2}$	4	$\frac{1}{3}$	2	5	3	1	0.165

Table 2: Judge Matrix B_1 and relative right weight

B_1	C_{11}	C_{12}	C_{13}	$W_{m,n}$
C_{11}	1	5	3	0.0633
C_{12}	$\frac{1}{5}$	1	$\frac{1}{3}$	0.106
C_{13}	$\frac{1}{3}$	3	1	0.260

Table 3: Judge Matrix B_2 and relative right weight

B_2	C_{21}	C_{22}	$W_{m,n}$
C_{21}	1	$\frac{1}{5}$	0.167
C_{22}	5	1	0.833

Table 4: Judge Matrix B_3 and relative right weight

B_3	C_{31}	C_{32}	$W_{m,n}$
C_{31}	1	$\frac{1}{6}$	0.143
C_{32}	6	1	0.857

Table 5: Judge Matrix B_4 and relative right weight

B_4	C_{41}	C_{42}	$W_{m,n}$
C_{41}	1	1	0.500
C_{42}	1	1	0.500

Table 6: Calculation results of weights

Target layer	Criterion layer	The weight of criterion layer	Index layer	The weight ofindex layer	Comprehensive weight
The comprehensive index of city smart growth evaluation system	Community (B_1)	0.271	C_{11}	0.063	0.017
			C_{12}	0.106	0.029
			C_{13}	0.260	0.070
	Land (B_2)	0.049	C_{21}	0.167	0.008
			C_{22}	0.833	0.041
	Building(B_3)	0.296	C_{31}	0.143	0.042
			C_{32}	0.857	0.254
	Transportation (B_4)	0.113	C_{41}	0.500	0.0565
			C_{42}	0.500	0.0565
	Development decision(B_5)	0.032	C_{51}	1	0.032
	Economy (B_6)	0.074	C_{61}	1	0.074
	Population (B_7)	0.165	C_{71}	1	0.165

3. Evaluate Development Plan of TwoCities

We choose two medium-sized cities which are Pittsburgh in Pennsylvania State and City Jiayuguan in Gansu Province. In order to measure and discusshow the current growth plan of each city meets the smart growth principles. We research their current growth plan first.

Pittsburgh is the capital of steel which is the second largest city in Pennsylvania State. After Second World War, Pittsburgh started a lot of recovery plan. Dealing with environment problems, air pollution problems especially is very important. The adjustment of industrial structure and urban economic center has turned to high-tech industry. The environment and air quality are turning better in recent years. This city is contributed to become ‘Emerald City”. Building areas that meet green environmental protection standard will be 20 million-meter. The ongoing project in Pittsburgh is called Pittsburgh 2030 District. This project planned to transform the downtown area in order to reduce exhaust emission from vehicles. It can also improve indoor air quality.

City Jiayuguan make full use of historical cultural resources and protect the historical and cultural heritage. In order to show the features of the city and improve the quality of the city, City Jiayuguanmakes some plans. The population of city center is 330,000 people. The number will be 550,000 people in the year 2030. Construction land will be increase to 80 square kilometers from 61 square kilometers. Per capita construction land will be controlled in 145 square meters. Beauty spot will be built. The protection of cultivated land is also vital.Protect wetland and promote ecological regulation ability are part of urban planning. The map is as shown in the figure below.

Now we discuss how the plans of both cities meet smart growth principles. Pittsburgh is not only famous for industry, but also for its trees. Its forest coverage is at the top level in America. Current growth plan in Pittsburgh is based on these aspects which is a part of smart growth principles and three E's. City Jiayuguanregards the traditional culture and virescence as the most important task. However, the government doesn't pay enough effort to development of communities. Compared with City Jiayuguan, current growth plan of Pittsburgh meets smart growth principles better.

In order to analysis development situation of two cities, we score twelve indexes of two cities as follows.

Score introductions of city smart growth

Serial Number	Evaluation index	Assignment instructions	Standard for evaluation
C_{11}	Uniqueness of the community	The proportion of foster distinctive and attractive communities with a strong sense of place	X<20%, assignment 0 20%≤X<30%, assignment 1 30%≤X<40%, assignment 2 40%≤X<50%, assignment 3 50%≤X<60%, assignment 4 X≥60%, assignment 5
C_{12}	Development of the community	The proportion of community investment in total investment	X<20%, assignment 0 20%≤X<30%, assignment 1 30%≤X<40%, assignment 2 40%≤X<50%, assignment 3 50%≤X<60%, assignment 4 X≥60%, assignment 5
C_{13}	Community and stakeholder participation in development decisions	The proportion of community and stakeholder collaboration in development decisions	X<20%, assignment 0 20%≤X<30%, assignment 1 30%≤X<40%, assignment 2 40%≤X<50%, assignment 3 50%≤X<60%, assignment 4 X≥60%, assignment 5
C_{21}	Land use	The proportion of multi-functional land	X<10%, assignment 0 10%≤X<20%, assignment 1 20%≤X<30%, assignment 2 30%≤X<40%, assignment 3 40%≤X<50%, assignment 4 X≥50%, assignment 5
C_{22}	Farmland, natural beauty, and other areas	The proportion of being preserved open space, farmland, natural beauty, and critical environmental areas	X<10%, assignment 0 10%≤X<20%, assignment 1 20%≤X<30%, assignment 2

			30%≤X<40%, assignment 3 40%≤X<50%, assignment 4 X≥50%, assignment 5
C_{31}	Compactness of the building	The proportion of the building coverage	X<20%, assignment 0 20%≤X<30%, assignment 1 30%≤X<40%, assignment 2 40%≤X<50%, assignment 3 50%≤X<60%, assignment 4 X≥60%, assignment 5
C_{32}	Diversity of housing opportunities and choices	The proportion of tramps	X<20%, assignment 0 20%≤X<30%, assignment 1 30%≤X<40%, assignment 2 40%≤X<50%, assignment 3 50%≤X<60%, assignment 4 X≥60%, assignment 5
C_{41}	Walkable neighborhoods	Whether the number of pedestrian streets has increased	↑, assignment 5 Or assignment 0
C_{42}	Transportation choices	The number of transportation choices	X≤4 categories, assignment 0 X=5, assignment 1 X=6, assignment 2 X=7, assignment 3 X=8, assignment 4 X>8, assignment 5
C_{51}	Predictability and fairness	The satisfaction and fairness of the development decisions	X<10%, assignment 0 10%≤X<20%, assignment 1 20%≤X<30%, assignment 2 30%≤X<40%, assignment 3 40%≤X<50%, assignment 4 X≥50%, assignment 5
C_{61}	GDP	Gross domestic product	X≤-1%, assignment 0 -1%≤X<1%, assignment 1 1%≤X≤3%, assignment 2 3%≤X<5%, assignment 3 5%≤X<7%, assignment 4 X≥7%, assignment 5
C_{71}	Natural population growth rate	————	X≥4% &X≤-0.5%, assignment 0 -0.5%≤X<0 &3.5%≤X<4%,, assignment 1 0≤X≤0.5%&3%≤X<3.5%,, assignment 2 0.5%≤X<1%&2.5%≤X<3%,, assignment 3 1%≤X<1.5%&2%≤X<2.5%, assignment 4 1.5%≤X<2%,, assignment 5

- The data of Pittsburgh are as follows.

	C_{11}	C_{12}	C_{13}	C_{21}	C_{22}	C_{31}	C_{32}	C_{41}	C_{42}	C_{51}	C_{61}	C_{71}
Actual numerical	**52.01 %**	**53.4 %**	**70 %**	**36.5 %**	**48.26 %**	**23 %**	**99.7 %**	↑	**9**	**28 %**	**8.39 %**	**-1.90 %**
Score	**4**	**4**	**5**	**3**	**4**	**1**	**5**	**5**	**5**	**2**	**5**	**0**

The mathematical deduction is:

$$\sum_{i=1}^{12}(S_i \cdot W_{m,n}) = 4\times0.017+4\times0.\ 029+5\times0.070+3\times0.008+4\times0.041+1\times0.042+5\times0.254+5\times0.0565+5\times0.0565+2\times0.032+5\times0.074+0\times0.165=3.033$$

- The data of City Jiayuguan are as follows.

	C_{11}	C_{12}	C_{13}	C_{21}	C_{22}	C_{31}	C_{32}	C_{41}	C_{42}	C_{51}	C_{61}	C_{71}
Actual numerical	**31.09 %**	**8.56 %**	**20.58 %**	**12.38 %**	**40 %**	**55.67 %**	**89.7 %**	↑	**8**	**97.74 %**	**-22.67 %**	**5.17 %**
Score	**2**	**0**	**1**	**1**	**4**	**4**	**5**	**5**	**4**	**5**	**0**	**0**

The mathematical deduction is:

$$\sum_{i=1}^{12}(S_i \cdot W_{m,n}) = 2\times0.017+0\times0.\ 029+1\times0.070+1\times0.008+4\times0.041+4\times0.042+5\times0.254+5\times0.0565+4\times0.0565+5\times0.032+0\times0.074+0\times0.165=2.3825$$

We divide success into seven levels.

Score	<2.5	2.5-2.7	2.7-2.9	2.9-3.1	3.1-3.3	3.3-3.5	≥3.5
Level	Unqualified	Qualified	Average	Slightly successful	Successful	Obviously successful	Absolutely successful

The score of Pittsburgh is 3.033 points, and the score of City Jiayuguan is 2.3825.Therefore, the development of Pittsburgh is slightly successful and City Jiayuguan is unqualified.

4. ModelAnalyses

The procedure of the theory of grey prediction model (GM(1,1)) are as follows:

Assume the original data sequence $x^{(0)}$:

$X^{(0)}=(x^{(0)}(1), x^{(0)}(2), \ldots x^{(10)}(n))$,

Record $X^{(1)}$ as the generated sequence:

$X^{(1)}=(x^{(1)}(1), x^{(1)}(2), \ldots, x^{(1)}(n))$,

Among this:

$$x^{(1)}(k)=\sum_{i=1}^{k}x^{(0)}(i), k=1,2,\cdots,n,$$

Record $Z^{(t)}$ is close to the average generated sequence as $X^{(1)}$:

$Z^{(t)}=(z^{(1)}(1), z^{(1)}(2), \cdots z^{(1)}(nn))$,

Among this:

$z^{(1)}(k)=0.5x^{(1)}(k)+0.5x^{(1)}(k-1), k=2,\cdots,n.$

Assume the sequence of the change process of $X^{(1)}$ is index curve, therefore we can establish differential equation(gray model):

$$\frac{d(1)X}{dt}+aX^{(1)}=b;$$

The winterization equation is:

$$X^{(0)}(k)+aZ^{(1)}(k)=b;$$

Assume that $B=(a,b)^T$ is parameters of the column, and:

$$Y_N=\begin{pmatrix} X^{(0)}(2) \\ X^{(0)}(3) \\ \vdots \\ X^{(0)}(n) \end{pmatrix}, B=\begin{pmatrix} -Z^{(1)}(2) & 1 \\ -Z^{(1)}(3) & 1 \\ \vdots & \vdots \\ -Z^{(1)}(n) & 1 \\ & \end{pmatrix}$$

Replace differential by finite difference, differential equation can be transformed:

$$\begin{pmatrix} x^{(0)}(2) \\ x^{(0)}(3) \\ \vdots \\ x^{(0)}(n) \end{pmatrix}=\begin{pmatrix} -\frac{1}{2}[x^{(1)}(2)+x^{(1)}(1)] & 1 \\ -\frac{1}{2}[x^{(1)}(3)+x^{(1)}(2) & 1 \\ \vdots & \vdots \\ -\frac{1}{2}[x^{(1)}(n)+x^{(1)}(n-1)] & 1 \\ & \end{pmatrix}\begin{pmatrix} a \\ b \end{pmatrix}$$

A simple expression is :

$$Y_N=XB$$

To solve by the least square method, therefore we can obtain the solution of the equations:

$$B=\left(a\,b\right)^T=\left(X^T\,X\right)^{-1}X^TY_{N,}$$

Plug in the original differential equation, we can get:

$$X^{(t)}(k+1)=[X^{(0)}(1)-b/a]e^{-ak}+b/a,$$

According to this, we can get the sequence of $X^{(1)}$, then accumulate them and get the following formula:

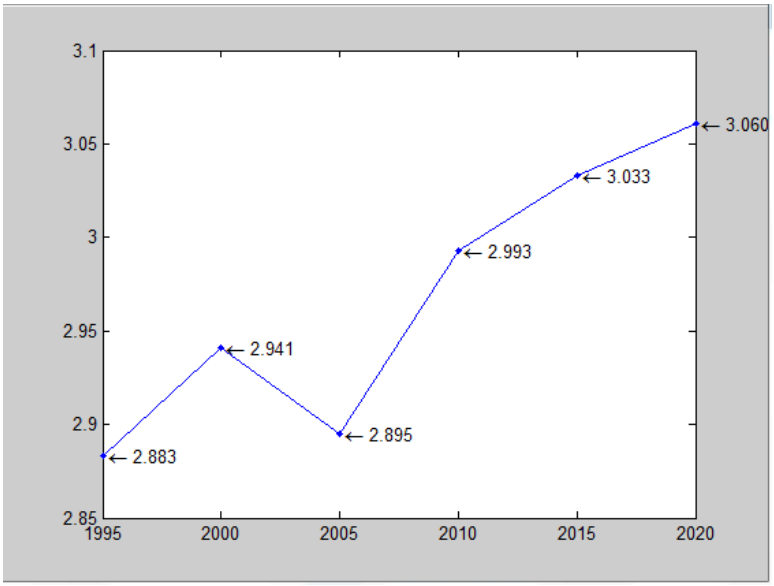
$$X^{(0)}(k)=X^{(1)}(k)-X^{(1)}(k-1)$$

This $X^{(0)}$ sequence is the value of simulation that comes from original data, when k ≥ n, we can obtain predicted value via original data.

We score Pittsburgh according to city smart growth evaluation system and score instructions in the year 1995, 2000, 2005, 2010 and 2015. The synthesis score of Pittsburgh is:

Year	1995	2000	2005	2010	2015
Total points	2.883	2.941	2.895	2.993	3.033

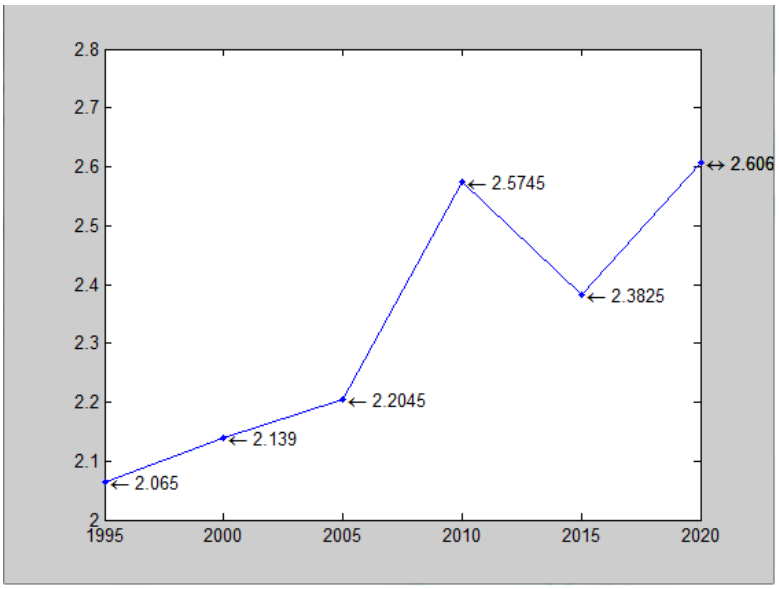
Through grey forecasting model, according to the data above we can forecast the synthesis score of Pittsburgh in the year 2020:



As well, we score City Jiayuguan according to city smart growth evaluation system and score instructions in the year 1995, 2000, 2005, 2010 and 2015. The synthesis score of Jiayuguan is:

Year	1995	2000	2005	2010	2015
Total points	2.065	2.139	2.2045	2.5745	2.3825

Through grey forecasting model, according to the data above we can forecast the synthesis score of City Jiayuguan in the year 2020:



We use grey forecast model to get score of Pittsburgh and City Jiayuguan in the year 2020. According to the trends of line chart, we know the development situation of two cities in next five years.

From the above results, we can know that for Pittsburgh, the compactness of the building is not enough. The smart growth should pay more attention to construct more compact buildings. The satisfaction and fairness of the development decisions in different years have big changes. Natural population growth rate presents the negative growth trend these years. Decline in population is a serious problem. Other aspects such as environment, community development and transportation choices follow urban development planning in general. Therefore, our new smart growth plan maintain these aspects and improve weaknesses. On one hand, government should plan building area in advance. Effect on the compactness of buildings must be considered first. On the other hand, any important development decision had better respect the opinions of the people. Last but not least, it's necessary to improve the medical security system and encourage people to give birth to children.

For City Jiayuguan, the conditions are different more or less. Jiayuguan attach little importance on community development. Natural population growth rate is high. Government should pay more attention to the development of population quality. The proportion of multi-functional land is low. Gross domestic productpresents the negative growth trend. Accelerating the economic development should also be listed in urban development planning. The virescence and vegetation are carried out well in general. The public are satisfied with development decisions widespread. Therefore we keep protect environment and improve shortcomings. First, government need to pay more attention to lead people to participate in community development decisions. In this way, communities would be more and more attractive. There shouldbe more funds invested in communities. Second, it's important for deciders to give much more opportunities to varieties of industries. Third, everybody must obey single-child policy to control the high natural population growth rate.

The growth rate of C_{31}, C_{51} and C_{71} in Pittsburgh in next twenty years as follows.

Year	2020	2025	2030	2035
C_{31}	+8%	+12%	+6%	+3%
C_{51}	+4%	+4%	+5%	+3%
C_{51}	+0.7%	+0.9%	+0.3%	+0.5%
Increased score	0.074	0.207	0.165	0.074

The levels of four years are respectively: Slightly success, Success, Obviously success, obviously success, absolutely success.

The growth rate of C_{11}, C_{12}, C_{13}, C_{21}, C_{61} and C_{71} in City Jiayuguan in next twenty years as follows.

Year	2020	2025	2030	2035
C_{11}	+5%	+8%	+7%	+7%
C_{12}	+7%	+8%	+6%	+8%
C_{13}	+4%	+4%	+5%	+3%
C_{21}	+7%	+7%	+8%	+8%
C_{61}	+3%	+3%	+3%	+3%
C_{71}	-0.5%	-0.5%	-0.5%	-0.5%
Increased score	0	0.054	0.243	0.202

The levels of four years are respectively: Unqualified, Unqualified, Unqualified, Unqualified, And Qualified.

5. Rank Plans

According to city smart growth evaluation system, we rank the individual initiatives within redesigned smart growth plan as the most potential to the least potential. The order of Pittsburgh is planning to build area and provide more housing opportunities and choices, encourage people to participate in development decisions and improve the medical security system and give birth to more children. City Jiayuguaninvests fund in communities, developing economy, giving opportunities to varieties of industries and respecting single-child policy.

Political status, economic status and culture states of Pittsburgh in America are more important than those of City Jiayuguan in China. Pittsburgh has done well in other respects. But there are many tramps in Pittsburgh, it's necessary to solve the housing problems. Natural population growth data of Pittsburgh is negative number, and it will not bring about city's burden. There is no doubt that development decisions should be thought seriously.So we rank the plans of Pittsburgh as above. Chinese don't consider community as a necessary part of life. They ignore the development of communities and they should pay more attention to it. Economy of City Jiayuguan is worth to do

more effort to increase GDP. Because of the huge population, city Jiayuguan need to make the limited land more useful. Last but not least, controlling natural population data cannot be ignored. So we rank the plans of Jiayuguan as above.

6. Conclusion

We collect data of natural population growth rate in Pittsburgh and City Jiayuguan in the recent five years. The data are as follows.

	2011	2012	2013	2014	2015
Pittsburgh	-0.13%	-0.065%	-0.13%	-0.85%	-1.90%
City Jiayuguan	5.58%	5.49%	5.51%	5.72%	5.74%

According to the new smart growth theory, we can calculate the population in Pittsburgh will increase less 50% and in City Jiayuguan will increase over 50%. So we analyze two cities respectively.

For Pittsburgh, the proportion of the building coverage should be increased which will provide more housing opportunities. The proportion of tramps will decrease and more people will enjoy housing conditions. The natural population growth rate will have modest rise. The developed traffic and the number of pedestrian streetscan also encourage the flow of the population.

For City Jiayuguan, the population meets the requirement basically. However, it can also improve in some respects. The community and GDP have room for improvement.

7. Strengths and Weaknesses

7.1 Strengths

AHP:

- A Systematic analysis method

Each factor in each level of this method on the impact of the results are quantified, very clear.

- Calculation is often simple, and the results are simple and clear.
- Do not need too much data to get the results

Grey forecast model:

- Requires less data, gets more accurate prediction and higher precision.
- The distribution of the samples need not be regular, the calculation is simple and the test is convenient.
- Be suitable for medium and long-term prediction.

7.2 Weaknesses

AHP:

- **Cannot provide new solutions for decision-making**

The role of AHP is to select the preferred one from the alternatives.

- **Cannot convince people of the result well**
- **Eigenvalues and eigenvectors are complicated sometimes.**

Grey forecast model:

Regardless of the internal mechanism of the system, sometimes there will be a big mistake.

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