Green University: the Important Influencing Factor of Regional Development

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1. Introduction

Regional Economic Theory focuses on the research of rational distribution and allocation of production resources to get the maximum output in a certain space (area). Production resources are scarce, but the optimized combination of limited resources in a certain area will be able to result in the maximum output. There are two main features of modern regional economic development: one is the gathering on geographic space; the other is the urbanization on the time course.

Regional economic gathering shows a high concentration of population, industries on specific geospatial carrier. And from the economic point of view, regional economic gathering means high concentrated population and high economic density in a certain area. In China, the economic density high value areas are mainly located in the coastal zone, as well as the central region. Among them, there are five top industry gathering areas in the eastern coast: the Bohai Rim, the Yangtze River Delta, Pearl River Delta, the Liaodong Peninsula and the west side of industrial gathering areas. Two major industrial gathering areas are located in the central region: Changzhutan and Wuhan industrial gathering areas. In addition, three major industrial gathering areas are in the western region: Chengyu, Central Shanxi plain and northern slope of Tianshan Mountains industrial gathering areas.

The urbanization of the area is an important symbol to measure a national and regional socio-degree of organization and management level, and to measure a national and regional economic, social, cultural, scientific and technological level. The Urbanization means that a large number of rural population moves into the cities, urban residents’ income level rises continuously, and market expands and attracts more and more investors continuously. With the accelerated pace of industrialization, the level of urbanization in China continues to increase. By the end of 2012, the total urban population of mainland in China has been up to 1,354,040,000, accounting for 52.57% of the country's total population; and the level of urbanization has been 1.3% higher than that in 2011.

China's regional economic development has demonstrated some positive effects such as gathering and urbanization, but the negative effect in the development process can't be ignored either. The serious imbalance of regional economic development in China is mainly shown in four aspects: the economic development gap between coastal and interior areas; the economic development gap among the eastern, central and western areas; the economic development gap among different provinces; the economic development gap between the northern and the southern areas; the
economic development gap between urban and rural areas. It is urgent to study the development direction and driving force of China's regional economic development.

2. Development path and driving force of regional development

2.1 Traditional theory of regional economic development

Generally regional economic development theory has four main theories: External Economic Theory, Gathering Economic Theory, “Center - Periphery” Theory and Growth Pole Theory. First of all, Marshall\(^1\) (1920) from the point of view of the external economics studied the emergency of industrial clusters, Weber\(^2\) (1929) from the perspective of gathering economics concept explained the phenomenon of industrial clusters, Krugman\(^3,4\) (1991,1995) through New Trade Theory studied the the principle of regional economic development. Peru\(^5\) (1945) did the research of industrial clusters in his Growth Pole Theory.

2.1.1 External Economic Theory

Marshall from the point of view of new classical economics through the research of industrial organizations concluded indirectly that enterprises gathering resulted from the pursuit of external scale economy. Marshall also explained the phenomenon of industrial clusters by industrial scale expansion resulting in the increase of knowledge and the dissemination of technical information. Economist Paul Krugman thought the three key elements of Marshall’s industrial clusters theory were labor market sharing, the creation of specialized subsidiary industries and technology spillover. Marshall’s theory does not consider the change of some dynamic factors, such as the enterprise’s business growth in the region and the enterprise’s immigration and emigration among regions.

2.1.2 Gathering Economic Theory

Weber (1929) is the founder of Industrial Location Theory; he was the first scholar to use gathering economy concept, and he clarified that whether enterprises gathered depended on the benefit of gathering and the contrast of the cost. Weber believed that industrial gathering could be divided into two stages: in stage 1, gathering advantage came from the expansion of the enterprises themselves, which is the lower stage of the industry gathering; in stage 2, industrial gathering came from interrelated organization among enterprises, which is the important advanced gathering stage. Webber explored the factors that produced industrial gathering advantages, and quantified the gathering form rules. But Weber’s research ignored all systematical, social, cultural, and historical factors, focused on resources and energy simply. In the actual economic life, to a considerable extent the form of industrial gathering depends on regional social and cultural factors.

Krugman (1991) in his book “Increasing Returns and Economic Geography” applied a simple model to explain that a country or region realized the scale economy through minimized transportation costs, so manufacturing firms tended to make

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4. Paul Krugman, The Indeterminacy of Equilibrium City Formation under Monopolistic Competition and Increasing Retur
location choice in greater demand market. Krugman combined trade theory with location theory, revealed the industrial gathering mechanism in a deep level through rigorous mathematical modeling method, and made up the insufficient view of Marshall and Weber. But Krugman ignored non-material contact (such as information, technical contact) and informal contact (inter personal trust-based contact) emerged in enterprise activities.

French economist Peru first proposed the concept of growth poles when studying the non-equilibrium growth theory in 1950. He thought the enterprises dispersed geographically, and formed forces boundary of their own. According to Peru, the economic space, existing among the factors, being different from geographic space in general sense, focuses on economic ties, the dominant sector and the enterprises of high innovation capacity.

2.2 Driving force of regional economic development

2.2.1 Economy of scope

The development of modern science and technology promotes the high integration of industrialization and information, and makes development space of the scale economy relatively small. The scarcity of natural resources, ecological damage to the environment, policy changed in development mode and the global carbon reduction common action make the improvement of economic quality and efficiency become the inevitable choice for sustainable economic development. It is not difficult to determine, for regional economic development, the era of focusing on economy of scale and pursuing quantity-oriented growth has nearly ended, and the era of pursuing quality or efficiency oriented growth guided by economy of scope has already began. The economy will become one of the driving forces in the future regional economic development.

2.2.2 Knowledge and innovation

In the era of knowledge economy, the economy, taking the high-tech industry as the core, built on the production, distribution, use, and consumption of the knowledge and information will become dominant. After Knowledge becomes a resource even the first resource of the region, regional economic growth mode will change fundamentally. The establishment of a network of high-speed information as well as the large amount of information makes the regional economic regulation built on a timely, accurate, fast, and scientific basis, and makes it change from “periodicity “of the traditional regional economic development to “persistency” of knowledge economy era.

2.2.3 Culture

The regional culture is the important competitiveness of regional development. The Regional Culture is the sum of the factors of a sense of community, value, mental outlook, behavior patterns and management style of the region. On one hand, regional culture constantly changes and is gradually enriched often with the development; on the other hand, the culture is relatively stable, is often handed pass through generations, and always maintains some unique quality which different from the quality in other areas. The resource capital can be got through transactions and circulation in the process of economic globalization, but the spirit literacy, value
pursuit and institutional system can’t be easily displaced and transferred. So the culture has become the regional nonviable source and core competitiveness.

2.2.4 Network urbanization

Information technology, globalization and network not only gives birth to a new paradigm of social and economic development, but also affects the regional economic patterns, and finally makes the urban and regional spatial development model change fundamentally and show a new feature. In the process of urban expansion from the center to the edge, regional ties have been increasing gradually, and regionalization degree has been strengthening. For example, both “Beijing City Master Plan (2004-2020)” and “Tianjin City Master Plan (2005-2020)” have clearly identified city domain space layout structure.

2.2.5 Sustainable development

There are also the reality of population growth, resource scarcity and environmental degradation in regional development. Global environmental problems have posed a great threat to human survival and development. In 1992, the unprecedented scale of the assembly of Heads of the United Nations Environment and Development held in Rio de Janeiro, Brazil, which made sustainable development be as a goal of all the countries all over the world. Under the resource constraints and environmental friendly conditions, the establishment of regional sustainable development index system that meeting the requirements of a new era provides a scientific basis for the regional development policies and countermeasures.

Traditional regional economic development path and its influencing factors can be summarized as follows: the function of location factors in the formation of regional economic pattern; the role of institutional factors in the regional economy structure; regional development differences resulting from policies oblique effect; regional development differences caused by the human resource endowments. With the improvement of the level of economic and social development, human resources conditions will play an increasingly important role in regional economic development. Although under the market-oriented condition, the inter-district flow of resources and elements becomes easier and easier, the higher education in the region has been influencing the regional development greatly and continuously.

3. The relation between driving force of regional development and the green University

In 2006 the report “Leadership Test: the Future of American Higher Education Report” issued by the United States proposed: Today we can claim without exaggeration that higher education has become one of the greatest achievements in the United States. Higher education has been playing an unprecedently important role in the knowledgeable and economic society. It is the main birthplace of human capital and intellectual capital which are necessary for improving labor quality and growth, and it’s the main way to promote social harmony and to promote the rational flow of society.

The main function of university research is personnel training, especially the
training of personnel engaged in scientific research. At the university, a large number of personnel receive specialized training and grasp the new ideas, new theories, new technologies and new processes. With the knowledge they obtained at the university, the personnel above bring energy to the economic society. The staff in the government and the enterprises enters the university for personnel retraining and corporate laboratories are built at the university. The other way round, the demand of the government, the society and the enterprises affects the innovation activities of the university, which drives the reform of the university's internal mechanism and makes the university serve the government, the society and the enterprises more effectively.

After “Earth Summit” in 1992, it’s imperative to build green campus, implement green education and cultivate green talent at the university. U.S. Green Building Council (USGBC) defined green campus as: A higher education community that is improving energy enhancing efficiency, conserving resources, and enhancing environmental quality by educating for sustainability and creating healthy living and learning environments [1].

There are all sorts of contacts between green university construction and regional economic and social development. The development of regional green campus leads and guides regional economic and social development. In this relationship, the development of regional green university is not only the driving force but also the sign of the regional economic and social development. This relationship is built on the condition that both the university construction and the economic and social development have entered a new stage of the times when the university focuses on green campus and the regional development depends on new driving force. In this new stage, the regional economic and social development no longer relies mainly on natural resources or capital, also no longer relies mainly on the general labor force, low-level technical personnel and other primary factors of production, relies mainly on high-quality innovative talents and other external environmental. In the region green university affects regional development in personnel training, scientific and technological innovation and social services.

3.1 Producing knowledge and promoting knowledge spillover directly

Famous American thinker, former Harvard University president Derek Bok thought that the University was designed to perform a special mission- discovering and delivering knowledge [2]. University research has made a significant contribution to the development of treasure house of human knowledge. The exploration of truth, the creativity and the innovation are the basic functions of the University. In addition, a modern society is a learning society in which knowledge and cultural production must rely on the heavy accumulation of the university. University will become the knowledge center in the learning society. Industries in the new century will rely on the production of knowledge more and more [3]. With its own advantages, university stands in the center of society in the provision of new knowledge, the dissemination of new technology and the training of innovative talents and comprehensively promotes the social, political, economic and cultural development.

3.2 Creating innovation directly and indirectly

University produces technological innovation, knowledge innovation, product
innovation, management innovation directly and generates business model innovation, social and economic innovation indirectly. In fact, creativity as an economic form has risen to the level of national policy [4]. University has its unique advantages in innovation. The green technology, green projects, green products in the green university can improve the efficiency and quality of the innovation. The construction of green university will change people's old philosophy, consumption patterns, and lifestyle, generate new business models and new management pattern simultaneously and promote regional to develop toward a new mode and direction.

3.3 Parsing and disseminating culture
The University is always nation-oriented, future-oriented and world-oriented. University creates the ideological and theoretical, scientific and technological achievements and other cultural achievements which play a guiding role in the cultural development of society. University absorbs cultural nutrients from the society and converts the forward-looking and advanced the concept to the society simultaneously. The scientific spirit, the cultural traditions, the sense of innovation and the elegant entertainment form in the university culture radiate and affect the society, lead social and cultural development to a higher level, and add new content and nutrients for the progress and development of the society and culture. The concept of green culture and sustainable development widespread in the construction of green university, which probably change people's lives fundamentally.

3.4 Being important part of the creative economy and urban network
Two main external conditions of creative economy are: close to a comprehensive university; belong to worldwide metropolitan areas [5]. In the post-industrial era, the University is playing an increasingly important role in the growth of the creative economy for the city or region, such as Stanford for Silicon Valley, Harvard and Massachusetts for traditional Route 128 and emerging biotechnology cluster. In these two classical cases, the university's role in regional economic growth is strong and direct. The creative economy is often green economy. Green university strengthens the qualities which makes the innovation and the development more competitive.

3.5 Being exemplary community in the sustainable development of resource constraints and friendly environment
University campus tends to develop to University City. University City has actually turned into a special community which has radiation effects on its surrounding areas in knowledge, culture, technology, environment and lifestyle. Green university will be classical demonstration community in green environmental protection, green management and green economy based on the widespread use of green building technology, and the new generation of energy-saving technologies. The construction of green campus can also provide some reference in solving the unhealthy urban and regional development problems caused by lack of bearing capability and adaptability in resources, environment, economic base, social conditions and many other aspects [6].

4. Force transmission mechanism of green university’s promoting regional development
The construction of green university will affect the driving force of the region to finally affect the regional development. In 1991 Harvard University established the Harvard Committee on the Environment to encourage and coordinate the environment-related activities within the school and academic research. In 2000 Neil Rudenstine, Harvard twenty-sixth Rector supported the establishment of the Harvard Green Campus Agency, provided huge amounts of money, tried to establish an academic union and management institutions under business operations mode, and put additional investment on the agency for several times. MIT’s green building was a little later than Harvard. After 2000, Massachusetts has regarded green campus construction as its own direction of the new century development, and it has made great achievements in green building, green supply chain and green energy-saving technologies. The culture, knowledge, education, technology, innovation of the above university have a major impact on the areas they belong to, on Route 128 region and on emerging biotechnology cluster.

In China, the ongoing green campus construction in some universities also reflects the coordination with regional development. Tongji University and the region where it is located make core development concept together - “Joint Development of Three Areas- university campuses, technology parks and public community”. Siping Road Campus of Tongji University and the region it belongs to build “around Tongji knowledge and economy circle” together.

The university campus is the power source for the development of regional innovation, whose functions are providing innovative entrepreneurial talent, technology, projects and intellectual support for regional economic and social development. Technology park is a key of regional innovation development, a growth pole of regional economic development, an important base for a combination of industries, university and research and a innovation place for university teachers students and researchers. Public community provides public services for the university campus and technology park, and it creates a social and ecological environment suitable for settling down and communication.

4.1 Green education

Green education emphasizes the sustainability of education, and it’s the core content of the concept of green university. Green education penetrates the environmental theme into college lesson plans, provides the students with knowledge, skills which are necessary in sustainable development practice through class teaching, and cultivates the explored spirit, ecological civilization awareness, ecological management awareness, global awareness, and responsibility of human sustainable development. Here, green education will fundamentally change the concept of development through remodeling of knowledge and talent. Its impact mechanism is diffuse, and it influences by the flow of people and knowledge.

4.2 Green campus

Green Campus is to adopt advanced technology and strict scientific management methods, to monitor and control the air, noise, waste water emissions, waste disposal, etc in the campus, and to form clean, beautiful, ecologically virtuous campus environment. The green campus has a high degree of harmonization: the
harm onization between people; the harmonization among people, campus environment, and campus culture; the harmonization between campus environment and natural environment. Green campus influences people and social development path selection by changes and improvement in the environment.

4.3 Green science and technology

Development of green technology is to firmly establish the awareness of green technology, to make the ideas of environmental protection and sustainable development involved in various fields of scientific research and the whole process of each project, to strengthen the scientific and technological research for environmental pollution control and environmental quality improvement (deep green scientific research), to give priority to the development of the technology, processes and equipment (light green research), and to reduce material consumption, energy consumption, and the emission of pollutants. The use of green technology affects innovative ideas, innovative technology paths, enterprise operation and management mode, social business model changes, and thereby the regional development.

4.4 Green culture

The green culture in simply words is the culture of coordinated development between man and nature. Green culture at the campus refers to value orientation and behavior specification forming under the guidance of sustainable development concept, through a long-term cultural heritage. It includes spiritual culture, academic culture, environmental culture, institutional culture, behavior culture and etc. Culture is similar to education in mechanism, but is more far-reaching than culture in impact.

4.5 Green service

Green campus should foster the sustainable development of educational philosophy, and to improve service quality through continuous green innovation. Complete program of green service includes the content of systems, institutions, management, and etc. Study shows that the bottom-up management system performance is better than the top-down type and mixed type [7]. In fact, interactive and full-participated management system is applicable to social and economic filed, and it also promotes the regional development.

4.6 Green consumption

University campus has large occupied land, diverse facilities and densely population, and it consumes large quantity of resources and products in teaching, research, and life. Green consumption in campus can provide the society with standards and experience of low-carbon action plan in energy saving and emission reduction. Green consumption in campus can be replicated for the entire region, and it offers a possible solution for the problems of urbanization.

5. Green campus evaluation index system and evaluation methods

5.1 Content of index system

The green campus service supply contains multiple objectives of education, scientific research, campus construction, social practices and environment. In the evaluation of green campus service performance, a number of factors from the above objectives should be selected according to certain requirements and principle. Based
on the above ideas, learning from the more commonly used green degree evaluation index system, we build the green campus evaluation index system which includes 6 indicators on guideline layer and 24 indicators on index layer, as shown in table 1.

<table>
<thead>
<tr>
<th>Target layer</th>
<th>Guideline layer</th>
<th>Indicator layer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green campus</td>
<td>Green education G1</td>
<td>Curriculum provision G11</td>
</tr>
<tr>
<td>green degree G</td>
<td>Classroom penetration G12</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Special education G13</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Special events G14</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Educational atmosphere G15</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Faculty G16</td>
<td>Educational effects G17</td>
</tr>
<tr>
<td></td>
<td>Ecological landscape G21</td>
<td></td>
</tr>
<tr>
<td>Green campus G2</td>
<td>Green landscaping G22</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Environmental and healthy situation G23</td>
<td>Pollution control measures G24</td>
</tr>
<tr>
<td></td>
<td>Green science and technology G3</td>
<td>Green technology G31</td>
</tr>
<tr>
<td></td>
<td>green project G32</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Green products G33</td>
<td></td>
</tr>
<tr>
<td>Green culture G4</td>
<td>Green education practice G41</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Green social practice G42</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Code of conduct G43</td>
<td>Public participation G44</td>
</tr>
<tr>
<td>Green services G5</td>
<td>Green system G51</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Green institution G52</td>
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<tr>
<td></td>
<td>Green management G53</td>
<td></td>
</tr>
<tr>
<td>Green consumption G6</td>
<td>Energy consumption G61</td>
<td>Resources consumption G62</td>
</tr>
<tr>
<td></td>
<td>Resources occupation G63</td>
<td></td>
</tr>
</tbody>
</table>

### 5.2 Determination of indicators data and weights

Indicators data is primarily from research data of related administration institution and urban environmental quality test report. The dimension of the quantitative and qualitative indicators is different, so the indicators need to be processed.

Quantitative indicators can be determined by index method. For the positive indicators, the bigger the better, its indicator evaluation value is ratio of actual value to reference value. If the evaluation value is greater than 1, take 1; if lower than the minimum standard value, take 0. For the negative indicators, the smaller the better, its indicator evaluation value is ratio of reference value to actual value. If the evaluation value is less than the lower limit value, take 1; of greater than the upper limit value, take 0.
Qualitative indicators can be divided into 5 levels: very satisfied, satisfied, not satisfied, in general, very dissatisfied. For each level evaluation values were 100, 80, 60, 40 and 20. Calculate the weighted average value of public evaluation form, and then use the same calculation method of quantitative evaluation model to get overall index evaluation value.

The determination of the weights is the important step in the comprehensive evaluation. It generally can be divided into subjective weight assignment and information amount weight coefficient assignment. For the former, Delphi method is more commonly used; for the latter, AHP method is more commonly used. Objective equal amount weight assignment or the weighted average method can also be used.

5.3 Evaluation of green degree

For easier calculation, adopt the percentage system weights plus method to calculate campus green degree. Firstly determine the individual indicator weight, use multiple expert survey scoring method to score the individual indicator in percentage-point scale, and get the individual indicators weight by taking the average value(experts include: experts in environmental education theory and methods, landscaping experts, environmental quality evaluation experts, executives in education institutions and departmental management officials, etc.). Then Rate every individual indicator in percentage-point scale by staff in schools and education departments. And finally calculate campus green by multi-objective linear function weighting method. Its formula is as follows:

\[ G = \sum_{i=1}^{m} \sum_{j=1}^{n} W_{ij} G_{ij} \]  

In formula (1), \( m \) refers to the number of indicators in guideline layer; \( n \) refers to the number of indicators of lower layer in every guideline layer; \( W_{ij} \) is the weight of specific indicator in target layer; \( G_{ij} \) is the value of specific indicator in target layer.

A more simple green degree evaluation method is that according to green education, green campus, green technology, green culture, green services and green consumption in guideline layer, propose a number of questions in a questionnaire, survey the school faculty and students with the above questionnaire, in the questionnaire survey each question is given the answer of two or more election, the choice rate (percentage) of non-negative answer is the score for this indicator. Calculated as follows:

\[ G = \sqrt[n]{\prod_{i=1}^{m} \prod_{j=1}^{n} G_{ij}} \]  

\[ G_{ij} = \sqrt[n]{g_1 * g_2 * ... * g_z} \]  

In formula (2) and (3), \( m \) refers to the number of indicators in guideline layer; \( n \) refers to the number of indicators of lower layer in every guideline layer; \( g_z \) is the value of each question for target layer indicators, \( z \) is the question numbers of each indicator.
According to above method, we can calculate the actual total value $G$ of a certain university, i.e. green degree value to evaluate the green campus service performance of this university. The green university grading standard is shown in table 2.

<table>
<thead>
<tr>
<th>Grade</th>
<th>Non-green</th>
<th>Quasi-green</th>
<th>Light green</th>
<th>Green</th>
<th>Dark green</th>
</tr>
</thead>
<tbody>
<tr>
<td>G value</td>
<td>0~20</td>
<td>20~40</td>
<td>40~60</td>
<td>60~80</td>
<td>80~100</td>
</tr>
</tbody>
</table>

### 5.4 Balanced evaluation of green campus service performance evaluation index system

In green campus service performance evaluation index system, in order to measure the balanced development of the indicators in guideline layer and target layer, adopt polygon mapping demonstration method to analyze. Take the guideline layer as an example, constitute a central equilateral hexagon taking out value of the six types of indicators as the radius, as shown in figure 1.

![Polygon radar chart of green campus service performance evaluation](image)

**Figure 1. Polygon radar chart of green campus service performance evaluation**

Extending to the case of the $n$-th indicator, we can constitute a central equilateral $n$-gon by the use of the $n$ indexes. From the $n$-gon, the size of individual indicator, the gap between the maximum value and the minimum value, and the dynamic change over the time can be seen intuitively. We can also calculate the comprehensive index value form the $n(n-1)/2$ triangles. It is as shown in formula (4)

\[
S = \frac{2 \sum_{i>j} S_i \cdot S_j}{n(n-1)}
\]

In formula (4), $\sum_{i>j} S_i \cdot S_j$ is the sum of products of all possible combination of two various indicators; $S$ is comprehensive indicator.

<table>
<thead>
<tr>
<th>Grade</th>
<th>Indicator value</th>
<th>Qualitative evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>&gt;0.75</td>
<td>Excellent balance</td>
</tr>
<tr>
<td>II</td>
<td>0.5~0.75</td>
<td>Better balance</td>
</tr>
</tbody>
</table>
6. Acknowledgment

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References: