Hi-Tech Industrial Cluster Evaluation Model Based on Six-Fold Innovation Index

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Abstract: In current state of regional economic management, there is no comprehensive framework about specialization of the sustainability in high technology industries. This paper focused on the hi-tech clusters evaluation system to consider the influence of some innovative performances affection to the hi-tech cultivation outcome. Through the review of the various concepts based on the cluster objections, we pursue to define industrial clusters by new approaches and also compare the new solutions with other traditional factors in a regional perspective. However, our study is a scan of the current comprise information about innovative performance indicators and also the policy intervention that drive innovativeness to be more beneficial for clusters sustainability. We analyzed and categorized these significant points as six key indicators to provide a index on clustering strategy. The implications of these results are discussed to propose a model including some essential points and also to assess the success in relation to knowledge diffusion and technological spillovers.

1. Introduction

In the new global economy, the hi-tech industrial clusters have become a central issue for economic growth [1] and also they increase the regional sustainable development. [2] The regional economic policies support the innovation [3] due to Innovation represents a key position as to cover and promote many other factors in a hi-tech clusters [4] to sustainable development. [5]

On the other hand many clusters through economy perspectives are not suitable for growth of the national economy but they are evaluable for economy of the region, industry or own economy. [6] In the past decades China by numerous special hi-tech zones has contributed both regional and national economic growth. This mutual success is able to absorb new technologies to China and to adopt modern management systems. [7]

The main purpose of this article is to explore the influence of innovation to hi-tech Industrial clusters and discover the main significant indicators in hi-tech industries in china. The field survey of case study plus some interview, visits, and extensive reviews of many other literatures are adopted as the researching method in hi-tech enterprises in Shanghai Caohejing electronics & IT cluster.

In recent years many researches tried to illustrate the sustainability in high technology industries with specialization of the main actors or indicators evaluation. However, the unclear results are a concern for them. [8] The findings of this study provide a new platform to raise the evaluation in hi-tech industrial cluster by comprehensive analysis of the innovative specification indices.

The reminder of this research is organized as follows: In section 2, literature review is to consider the previous published papers. In section 3, is the methodology. In section 4, the results of case study are discussed. Section 5 is conclusion and after acknowledgement in section 6, finally in section 7 the references are presented.

2. Literature Review

2.1. Background

Key concepts: Much of the current literature on the issue of industrial clusters are about the standard concepts but it is so difficult to make a cluster reference framework due to the clusters’ differences. [9] Industrial cluster as a geographic concentration of the industries [10] also is called “Porterian cluster” because for the first time it was introduced by Michael Porter. [11] He also claims that the productivity, innovation and development are three pillars industrial clusters. [12]

Michael Porter defined a cluster as “geographic concentration of interconnected businesses, suppliers, and associated institutions in a particular field to benefit easier communication, transportation and the deals” [11] After him, Paul Krugman identified that industrial clusters can be set as non-geographic agglomeration.[13] So, today the geographical borders and institutions particular fields are not insisted. [14] Hence, as a new concept we can define hi-tech clusters as “The linked enterprises with the common goal of economic Productivity.” [1] The Cluster is not a conceptual definition but a practical tool, however the economic development policies insist the
concept of industrial clusters to offer positive synergies to the linked enterprises. [15] Even with many differences in level or size. [16]

The national or local policy by a suitable clustering strategy can raise the success elements to result a famous and successful "Regional brand" [17] and also make synergy for local economy [18] and local community benefits. [19] These benefits are based on sharing resources as a reference economy [20] for any kind of clusters as service, agriculture, construction, environment, transportation, the Health and Tourism, IT and the creative Industries. [21]

The Sustainability: The innovation has a lot of influence on the industrial clusters by a large number of industrial specialization [5] to achieve the overall and ultimate goal of cluster development as the sustainability with two main objectives: the socio-economic growth and the value added development. [22]

The industrial development under the concept of clustering are the national economic strategy to grow the social advantages, social networks, social innovative cooperation [23] and also human resource capital. [7] In addition, regional clusters has a high position in value added development by improving functions, studies and new patterns and also investigates the influence on innovative ideas, trends, and industries by effective protection. [24]

Innovation: The innovation is to lead the regional clusters to sustainability [25] and mutually the clusters are to promote the regional innovation. [26] The innovative clusters based on hi-tech industries are the most dynamic feature and force in a local development [7] to lead the economy and industry to top levels of sustainability. [27] The regional clusters lead the investments to the successful regions and in return, the regional economy supports the clusters by innovative infrastructures and development. [26]

Innovation that resources advantages to the environment and not just the technology [28] should happen in all kind of different clusters [29] by governmental supports and regional players. [30] The different industrial clusters, based on different innovation-knowledge based [31] are as a.

a. “Knowledge cluster” needs a high level innovation, b. “Economic cluster” needs a middle level innovation, c. “Historic cluster” well adapted to the traditional industry specific, d. “Agglomerated cluster” just a geographical cluster and e. “High-tech clusters” is a hi-tech oriented, needs a high level innovation and it is well adapted to the knowledge economy, universities and research centers. [12]

The high-tech industries lead regions developing innovation [26] to the most advanced technology available [32] in modern industrial structures. [14] The advanced products often are risky but with the most potential for future growth and offering high profits. [33] Innovation for hi-tech industries is so essential because sometimes technology and market suddenly shift and clusters just by innovation will quick withdraw. [34] To assess the main attributes of a hi-tech cluster we should consider six most significant indicators of innovative industrial approach [9] to concentrate the innovative activities to sustainability potentials. [10]

2.2. Six-Fold Innovation Index

The successful integration of a hi-tech cluster is directly related to some innovative specifications as a mixed type innovation platform [35] to make a stable network between enterprises’ knowledge to share the researches, the competitive necessaries, production, solution and resources [29] and in return achieve the benefits. [36]

a. Relationship: The “connectedness” and “concentration” are two main attributes of clusters. [37] About “connectedness”, the link between privet, public and scientific sectors [19] are called “Triple Helix” that makes a network between financial, executive and scholar players. [38] The clusters also make a positive relationship to decrease the players’ collaboration costs by trust creation in the deals and exchanges. [39] In consequence, network has a positive effect on improving the regional innovation capacity, [36] especially in the central position of a high-tech network to receive public interests and governmental attentions. [40]

b. Knowledge: The common R&D projects in clusters promote the innovative ideas, [41] new technologies and external knowledge. [42] The training and education change rapidly economic environment to a sustainable way. [17] The scientific cooperation in a cluster decreases the cost of knowledge transaction [43] and will enhance the knowledge collaboration culture. The R&D commercialization, knowledge diffusion and technology spillover are as new approach in the hi-tech industrial clusters. [41]

c. Competitiveness: The impact of competitiveness is the lower risk deals on the competitive markets by “concentration” (one of the two main attributes of clusters). In demand market it causes the diversification of products, increasing the quality and decreasing the costs. Also, in supply market will establish the regional “marketing cluster” and expert suppliers hubs to increase the purchasing motivation, to reduce freight costs and to easier sourcing. The small clusters with low innovation capacity rely on the traditional competition advantages, [36] but the hi-tech clusters enhance the overall competitiveness.
to affect the coefficient of environmental protection and market shares to make a competitive environment. [45]

d. Production: The diversification of products and services in clusters will increase the qualification and will decrease the production costs. [13] In hi-tech industries due to changes in technology, products, processes and demands and also to increase the production value added, the production changes should be more quickly by innovation. The hi-tech industries concentrates to the supply diversification to make a demand market but in other industries, it is the market that determine the products diversification. On the other world, the hi-tech industry insists to supply market and in another industries it is the demand market that is insisted.

e. Solutions: In hi-tech clusters the enterprises have more productivity by the accumulation of solutions to face the industrial problems and to economize the costs. [46] Beside the Self-reinforcement in non-commercial activities [47] the common regional cooperation is the base of interaction for building solutions. [48] Our world is going to the large clusters as a global brand value through regional solutions that are made by linking the national clusters. They are patterning some standard and formal templates (e.g. the English language or intl. standards). [49]

f. Resources (specialization): The resource balance as a regional specialization optimizes the accessibility to infrastructures in the resource markets of: a. Financial Resources that investors are interested in specialization, b. Physical Resources that increases the trading compliments, c. human Resources that balance in workforce and wages.

It reduces the training and employment costs due to specialized employees skills and also the emigration from saturated regions to the indigent regions. [11] All clusters are not created equal in terms of employment effects. [50] They will promote the low income societies by expansion of the small entrepreneurship activities. [20]

3. Methodology and measurement

According to relevant literatures, the development is the nature of clusters [51] but the sustainability and progress of development should be analyzed in every cluster life cycle and in every periodical changing process. [36]

So, we should have a weight measuring platform by the success aspects of the hi-tech clusters [19] based on the variable innovative indicators. [29] In our scholar method we used an appropriate framework to evaluate the innovation in hi-tech clusters as our case study by some surveys, interviews and visits.

Regarding many existing literatures, the main aspects and indicators of the hi-tech clusters had categorized (Table 1) and according the fields of this table a questionnaire prepared. We sent our surveys to 20 experts in “Shanghai Caohejing electronics & IT cluster”.

Table 1. Criterion, the main aspects and indicators

<table>
<thead>
<tr>
<th>Ai</th>
<th>Main Aspects</th>
<th>Bi</th>
<th>The Indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>Relationship</td>
<td>B1</td>
<td>with industry companies</td>
</tr>
<tr>
<td></td>
<td></td>
<td>B2</td>
<td>with the research centers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>B3</td>
<td>with the government</td>
</tr>
<tr>
<td>A2</td>
<td>Knowledge</td>
<td>B4</td>
<td>R&amp;D Projects</td>
</tr>
<tr>
<td></td>
<td></td>
<td>B5</td>
<td>innovative ideas</td>
</tr>
<tr>
<td></td>
<td></td>
<td>B6</td>
<td>absorb new technologies</td>
</tr>
<tr>
<td>A3</td>
<td>Competition</td>
<td>B7</td>
<td>lower market Risk</td>
</tr>
<tr>
<td></td>
<td></td>
<td>B8</td>
<td>“Marketing Cluster”</td>
</tr>
<tr>
<td></td>
<td></td>
<td>B9</td>
<td>innovative abilities</td>
</tr>
<tr>
<td>A4</td>
<td>Production</td>
<td>B10</td>
<td>goods diversification</td>
</tr>
<tr>
<td></td>
<td></td>
<td>B11</td>
<td>process diversification</td>
</tr>
<tr>
<td></td>
<td></td>
<td>B12</td>
<td>quality diversification</td>
</tr>
<tr>
<td>A5</td>
<td>Solutions</td>
<td>B13</td>
<td>common infrastructure</td>
</tr>
<tr>
<td></td>
<td></td>
<td>B14</td>
<td>trust</td>
</tr>
<tr>
<td></td>
<td></td>
<td>B15</td>
<td>the cost Economizing</td>
</tr>
<tr>
<td>A6</td>
<td>Resource</td>
<td>B16</td>
<td>Financial Resources</td>
</tr>
<tr>
<td></td>
<td></td>
<td>B17</td>
<td>Physical Resources</td>
</tr>
<tr>
<td></td>
<td></td>
<td>B18</td>
<td>Human Resources</td>
</tr>
</tbody>
</table>

From 20 surveys in total, 11 valid replies analyzed by 5 point Likert-Type scale relative affection to determine the normalized weights of the main aspects as No affect (0), Minor affect (0.5), Neutral (1), Moderate affect (1.5), Major affect (2).

The aspects were normalized (formula 1) by adjusting values measured on different scales to result a notionally common scale when \( \sum W = 1 \): (all weights sum is equal one):

\[
\text{Normalized weights} = \frac{x_i}{\sum X_n} = 1
\]
\[ \bar{x}_n = \frac{\sum x_i}{n} \]

**Table 2. Normalization of the key aspects by standard score method**

<table>
<thead>
<tr>
<th>Relationship</th>
<th>A(i)</th>
<th>( \bar{x} )</th>
<th>Norm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge</td>
<td>A2</td>
<td>1.86</td>
<td>0.180</td>
</tr>
<tr>
<td>Competitiveness</td>
<td>A3</td>
<td>1.68</td>
<td>0.162</td>
</tr>
<tr>
<td>Production</td>
<td>A4</td>
<td>1.59</td>
<td>0.154</td>
</tr>
<tr>
<td>Solution</td>
<td>A5</td>
<td>1.82</td>
<td>0.175</td>
</tr>
<tr>
<td>Resources</td>
<td>A6</td>
<td>1.77</td>
<td>0.171</td>
</tr>
<tr>
<td><strong>Sum:</strong></td>
<td></td>
<td>10.36</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Then, to result the indicators weight, the indicators data were normalized by TOPSIS fuzzy method (squaring), the result should multiply to the aspects weights. Finally, the evaluation matrix of indicators affection weights calculated (formula 2) and consist of m (18) alternatives and n (1) qualification column value.

\[
\text{Normalized weights} = \frac{x_{ij}}{\left( \sum x_{ij}^2 \right)^{0.5}} \quad (2)
\]

**Table 3. Normalization of the indicators**

<table>
<thead>
<tr>
<th>B(i)</th>
<th>( \bar{x} )</th>
<th>( \bar{x}^2 )</th>
<th>A×B</th>
<th>Norm</th>
</tr>
</thead>
<tbody>
<tr>
<td>B1</td>
<td>1.36</td>
<td>1.86</td>
<td>0.35</td>
<td>0.0478</td>
</tr>
<tr>
<td>B2</td>
<td>1.82</td>
<td>3.31</td>
<td>0.46</td>
<td>0.0638</td>
</tr>
<tr>
<td>B3</td>
<td>1.32</td>
<td>1.74</td>
<td>0.33</td>
<td>0.0462</td>
</tr>
<tr>
<td>B4</td>
<td>1.91</td>
<td>3.64</td>
<td>0.55</td>
<td>0.0763</td>
</tr>
<tr>
<td>B5</td>
<td>1.14</td>
<td>1.29</td>
<td>0.33</td>
<td>0.0454</td>
</tr>
<tr>
<td>B6</td>
<td>1.45</td>
<td>2.12</td>
<td>0.42</td>
<td>0.0581</td>
</tr>
<tr>
<td>B7</td>
<td>1.27</td>
<td>1.62</td>
<td>0.33</td>
<td>0.0459</td>
</tr>
<tr>
<td>B8</td>
<td>1.73</td>
<td>2.98</td>
<td>0.45</td>
<td>0.0623</td>
</tr>
<tr>
<td>B9</td>
<td>1.50</td>
<td>2.25</td>
<td>0.39</td>
<td>0.0541</td>
</tr>
<tr>
<td>B10</td>
<td>1.32</td>
<td>1.74</td>
<td>0.32</td>
<td>0.0450</td>
</tr>
<tr>
<td>B11</td>
<td>1.86</td>
<td>3.47</td>
<td>0.46</td>
<td>0.0636</td>
</tr>
<tr>
<td>B12</td>
<td>1.32</td>
<td>1.74</td>
<td>0.32</td>
<td>0.0450</td>
</tr>
<tr>
<td>B13</td>
<td>1.82</td>
<td>3.31</td>
<td>0.51</td>
<td>0.0709</td>
</tr>
<tr>
<td>B14</td>
<td>1.23</td>
<td>1.51</td>
<td>0.35</td>
<td>0.0478</td>
</tr>
<tr>
<td>B15</td>
<td>1.45</td>
<td>2.12</td>
<td>0.41</td>
<td>0.0567</td>
</tr>
<tr>
<td>B16</td>
<td>1.23</td>
<td>1.51</td>
<td>0.34</td>
<td>0.0466</td>
</tr>
<tr>
<td>B17</td>
<td>1.91</td>
<td>3.64</td>
<td>0.52</td>
<td>0.0726</td>
</tr>
<tr>
<td>B18</td>
<td>1.36</td>
<td>1.86</td>
<td>0.37</td>
<td>0.0518</td>
</tr>
<tr>
<td><strong>Sum</strong></td>
<td>41.69</td>
<td>7.223</td>
<td>1.00</td>
<td></td>
</tr>
</tbody>
</table>

\[ \text{Sum}^*0.5 = 6.457 \]

4. Discussion:

The central government policy of China tries to reinforce the Chinese socio-economic sustainability by more advanced hi-tech industries as an innovative fundamental development, this policy made China a world leader in some areas. [52]

China has three metropolitan regions with most significant effect on China regional economy and also high policy supports. The Pearl River delta, Yangtze River delta and Bohai Rim economic circle. The mega city of Shanghai is in Yangtze River Delta Economic Zone (YRD) with a high supply chain surrounding the region encompasses Shanghai, Jiangsu, Anhui and Zhejiang province and involved in finance, banking, property, automobiles, logistics industries, foreign companies, automobile industry, electronics, education, energy, iron and steel industries. [53] Shanghai government supports innovative clusters with favorable policies and specialized infrastructures, [54] due to hi-tech zones in Shanghai has an effective competitive force to speed up the sustainability of region (Yangtze River). [48]

Shanghai is with long-term strategic adjustment, experience, modern equipment and also opportunity of global manufacturing industry transfer [44] Shanghai hi-tech zones and also science and technology parks by innovation made Shanghai technologic industries jumped from comparative advantage to competitive advantage. [55]

“Caohejing electronics & IT cluster” is located in Shanghai Caohejing Hi-tech Park and it is supported by Shanghai Caohejing hi-tech innovation center. This innovation center for over 10 years has supports enterprises and promoting commercialization, industrialization and internationalization of scientific and high technological achievements specializing in electronics & IT.

Regarding our case study after gathering questionnaires from the enterprises, interviews with some experts in the field and also considering the analysis, the results show that the knowledge (A2) is the most important aspect in innovative hi-tech clusters and the interviewees said that the source of technical knowledge is mostly from cross-connections by government supports. The analysis also results that the Production (A4) has the less affection in the aspects class. Some interviewees argued that in hi-tech industry it is the competitiveness that push the product to diversification but another one said “to copy” is the main reason of this low value.
In addition, the most important indicator is “To create the common R&D Projects” (B4) weighted 0.076. The less affective indicators are in aspect of “production” as “To diversify the goods and productions” (B10) and “To diversify in qualification” (B12) with the same weight (0.0450).

The results totally present that in Shanghai Caohengan electronics & IT cluster the enterprises has a suitable impact score in sustainability and affective values in innovative aspects and indicators. We should consider that all values are in a same range without so different levels. In addition, in all questionnaires there is not any item mentioned as not important or not effective, it shows that all the aspects or indicators from their view are the key factors.

About the cooperation culture, the interviewees mentioned that training and educative policy are very important. They confirmed that in high-technology the knowledge diffusion and technological spillovers are the new approach and the main key to further sustainably and competitiveness. As a final point also one of the interviewees said that in China the relationship with government (B3) is very important.

5. Conclusion

The main goal of the current study is to determine a hi-tech industrial cluster evaluation model to assess the progress of sustainability and development. A large and growing body of literatures argue that there are many differences in clusters’ specialization but the most significant specialization of the hi-tech clusters is the significant quota of innovation in overall goal of sustainability. [9] Hence, the hi-tech evaluation should consider by some stable innovative factors in a multi-criteria index and in this research six innovation aspects with some key indicators have been tested. [56]

The findings of our investigation by six-fold innovation index shows the sustainability degree in Shanghai hi-tech clusters especially in knowledge and R&D is in a suitable position. Making the solutions in a hi-tech cluster with many experts and technology talents is a great opportunity of cooperative innovation in Shanghai. But this cooperation and network need to be reinforce due to the low value of the relation with industry enterprises. The hi-tech intellectual cultivation by knowledge diffusion and R&D spillover should be deeply accepted by the enterprises and also the policies should promote this culture.

It is a big problem for the clusters to be adapted with international cluster networks on a higher levels across regions because the differences or some weakness. To face this problem the innovative solution making is necessary, but contrary the public belief the development of global economic activities becomes a great problem for the clusters because make more distance between the clusters level.

The final conclusion is to understand some ultimate factors of sustainability as social progress. After the knowledge resources the human resource for hi-tech industries is very effective and the main part of investment in long-term should concentrate to this part. For another ultimate factors of sustainability as value added, it is advisable that hi-tech industries shift from demand markets to supply markets to make up the production weaknesses and also to accelerate in the competitiveness. The hi-tech clusters should enhance the innovative abilities and ideas by avoidance of just producing by copy.

To make a standard platform for definition or evaluation of the clusters is so difficult due to the clusters’ differences, but it is not a reason to the objective studies. Future research could also be conducted to determine the limitations, risks and treats in a hi-tech industrial cluster.

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7. References:


