Designing and Implementation about Urban Core Competitiveness Decision Support Model Based on Case Based Reasoning

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Abstract. The decision-making of urban core competitiveness is quite subjective and faced with much uncertainty, which makes the existing theoretical strategies of urban core competitiveness lack practicability. The author used case-based reasoning technology to design an urban core competitiveness decision support model, and developed a decision support system based on the model. Finally, some case cities were selected to testify the feasibility of the model. The study built model index system to measure similarities between case cities from intellectual capital perspective. By mining information of the source case cities in the model, we can obtain ample experience knowledge automatically, which may provide guidance for target city's core competitiveness decision-making. As a result, the procedure of urban core competitiveness decision-making will become intelligent.

Introduction

Since the 1990s, economic globalization makes economic resources flow freely and restructuring on a global scale. In order to gather more resources to produce sustainable development capacity, cities around the world are actively committed to enhance their core competitiveness. Up to now, most of researches on the urban core competitiveness decision proposed only theoretical strategies which are often lack practicability. It is mainly because the urban core competitiveness decision is unstructured decision-making issue that is vulnerable to subjective and uncertain factors. For such unstructured decision-making question, there is a perfect solution called Case Based Reasoning (CBR). CBR can guide the current decision-making practice with the past experiences [1]. So it is ideal to be used in core competitiveness decision-making issues which are lack theoretical knowledge but full of practical experiences. Based on this, the study will use CBR technology to design an urban core competitiveness decision support model. And a decision support system will be developed according to the model.

CBR stems from the role of memory in human reasoning. In 1982, Schank studied the case issue in the memory and its role in learning, then proposed a CBR cognitive model in his book "Dynamic Memory"[2]. Today, CBR has become an Artificial Intelligence (AI) reasoning technology [3]. In recent years, scholars around the world carried out a wide range research about CBR. But the research of CBR application in the urban core competitiveness area is uncommon. In this study, CBR will be employed to build an urban core competitiveness decision support model.

The Design of Urban Core Competitiveness Decision Support Model Based on CBR

A. The Overall Framework

In the CBR, the current decision matter is called the target case and the experience stored in the case library is referred to the source case. According to the CBR principle, an urban core competitiveness decision support model is constructed in the study. The operation process of the model is as follows:

(1) Enter the index information of the target city.

(2) Retrieve similar source case city from the case library according to the case retrieval

algorithm, and bring up the corresponding urban core competitiveness strategy and related information.

(3) Decision-makers decide whether to modify the source case scenario, so that it will be suitable for the current target case.

(4) The decision-makers use the (modified) source case city's strategy to make the core competitiveness decision for the target cities, and evaluate the effect of the decision implementation;

(5) Assume that the self-learning threshold of the system is $|\alpha|$. If the similarities between the target city and all source case cities are less than $|\alpha|$, the system absorbs the target city as new case automatically. And its information will be included in the case library. Otherwise the target city will be abandoned.

B. Case Retrieval Policy

For a decision support model based on CBR, case retrieval policy determines the effectiveness of its decision-making. Recent adjacent method is the most widely used technology in the CBR system. It will be adopted in this model.

1) Determination of case retrieval indexes and weights.

With the advent of knowledge economy era, more and more empirical studies show that urban competition in the 21st century will lie fully in the intellectual capital field (Zhi-zhang Wang, 2007) [4]. New Growth Theory (Romer, 1986) [5] believes that "skills and knowledge are the key factors to improve productivity". The urban core competitiveness comes more directly from intellectual capital. So we can build the urban core competitiveness index system from the perspective of intellectual capital, which can be used to measure the similarity between model cases. According to the international mainstream viewpoint, urban core competitiveness will be divided into the following four aspects: (1) Urban human capital—the education level, health status, skills, comprehensive ability of every citizen in the city; (2) Urban innovation capital—input and output of research and invention in order to promote knowledge creation; (3) Urban relationship capital—various relations between the city and relevant interest groups(including cross-regional connection, city cooperation, government support, etc.). (4) Urban process capital—the process and related basic conditions in transportation, communications, and management system [6].

After consulting the indexes proposed by Pasher (1999)[7], Malhotra(2001)[8], Nick Bontis (2004)[9], and Yufen Chen (2006) [10], also after considering the specific situation of China's cities and the availability of data, we build the index system (shown in table 1) to measure similarity among case cities.

Then, the study uses the entropy method to determine the weights of case similarity measurement. Index weights are calculated using information entropy according to the degree of dispersion in the indexes, which will avoid the influence of subjective factors [11].

2) The calculation of similarity between cases

The similarity between the source case and the target case will be calculated as follows:

$$Sim_i = \sum_{j=1}^{27} \omega_j Sim_{ij} \tag{1}$$

Where, Sim_i is total similarity between the target city and source city i in the Case Library. ω_j is the weight of index j. Sim_{ij} is the similarity between index j of the target city (y)and index j of source city i (x). Its computation formula is:

$$Sim_{ij} = \begin{cases} 1 - \dfrac{|x-y|}{100}, & x, y \text{ are percentage variables} \\ 1 - \dfrac{|x-y|}{x+y}, & x, y \text{ are numerical variables} \end{cases} \tag{2}$$

TABLE I. The index system to measure similarity between case cities

Items	Indexes
Urban Human capital	Number of colleges and universities per million people
	Number of full-time teachers of colleges and universities per ten thousand people
	Number of students of colleges and universities per ten thousand people
	Number of doctors per ten thousand people
	Number of hospital beds per ten thousand people
	Number of theaters per million people
	Number of books in public library per hundred people
Urban innovation capital	Expenditure on education per capita
	Expenditure on science per capita
	Number of scientific research, technical services and geological prospecting practitioners per ten thousand people
	Number of information transmission, computer services and software practitioner per ten thousand people
	Number of patent application accepted per ten thousand people
	Number of patents granted per ten thousand people
Urban relationship capital	Contracted foreign investment per capita
	The actual use of foreign capital per capita
	Total import and export commodities per capita
	Total merchandise sales of wholesale and retail trade per capita
	Total retail sales of social consumer goods per capita
	Domestic tourism income per capita
	Tourist foreign exchange income per capita
Urban Process capital	Number of mobile phone users per hundred people
	Number of Internet users per hundred people
	Post and telecommunications business per capita
	Total freight per capita
	Total passenger traffic per capita
	Total investment of environmental pollution control per capita
	Urban environmental construction investment per capita

This model calculates respectively the similarity Sim_i between the target city and each source city in the Case library according to the above formula. After that, the source city with the largest similarity will be retrieved, and its urban core competitiveness policy information will be brought up. Judged and modified by expert, the information will become guidance for the target city's core competitiveness decision-making.

C. The Design of the Model Case Library

To provide guidance for the cities whose core competitiveness is weak, all the initial storage cases in the model case library should have strong core competitiveness. The data in the model case library include urban basic information, urban core competitiveness evaluation index system, and urban core competitiveness strategy information (shown in table Ⅱ~ table Ⅳ) .

Application of the Urban Core Competitiveness Decision Support Model Based on CBR

To test the effectiveness of the decision support model, 287 China' prefecture-level cities in year 2009 are chosen as the research sample. After deleting insufficient data sample and obvious outlier sample, the study determines 216 effective sample cities finally. Sample data are obtained from the "China City Statistical Yearbook 2010"and the statistical data released publicly by national ministries at the same year.

The study uses the entropy method to calculate urban core competitiveness value of each sample city. Then the top 20 cities in value were chosen as the source cases, including shenzhen, Beijing,

Dongguan, Shanghai, Suzhou, Nantong, Shaoxing, Zhuhai, Guangzhou, Ningbo, Changsha, Xiamen, Fuzhou, Hangzhou, Wenzhou, Jiaxing, Wuxi, Tianjin, Qingdao, Nanjing. Then under the environment of Visual Studio 2005 and Access 2003, using C # language, the study develops an urban core competitiveness decision support system according to the model constructed previously. The system consists of five functional menus: case library maintenance, case retrieval, case reuse, user management, and system help. Case library maintenance module is used to enter, add, browse, modify and delete source case cities. Case retrieval module is the main module of the system. Its function is to add the target city data, as well as matching retrieve the source case city. Case reuse module aims to modify and reuse the urban core competitiveness strategy of similar source case. User management module is used to supervise user's extent of authority. System help module aims to accomplish the system maintenance and system knowledge description.

TABLE II. Urban basic information

City No.	City Name	Year	City size	Province	Region
1	……	……	……	……	……
……	……	……	……	……	……
n	……	……	……	……	……

TABLE III. Urban core competitiveness evaluation index system

City No.	City Name	Year	Urban human capital (7 items)			Urban innovation capital (6 items)			Urban relationship capital (7 items)			Urban process capital (7 items)		
			Number of colleges and universities per million people	*Weight*	…	*Expenditure on education per capita*	*Weight*	…	*Contracted foreign investment per capita*	*Weight*	…	*Number of mobile phone users per hundred people*	*Weight*	…
1	…	…	…	…	…	…	…	…	…	…	…	…	…	…
…	…	…	…	…	…	…	…	…	…	…	…	…	…	…
n	…	…	…	…	…	…	…	…	…	…	…	…	…	…

Note：All the indexes are from table Ⅰ. And the index weights are the results of entropy method calculating.

TABLE IV. URBAN CORE COMPETITIVENESS STRATEGY INFORMATION

City No.	City Name	Year	Basic situation of the city	This year's core competitiveness status	New Year's core competitiveness strategy
1	…	…	…	…	…
…	…	…	…	…	…
n	…	…	…	…	…

Note：Table Ⅱ ~ table Ⅳ are connected through City No.

According to the above case retrieval policy, the study designs the algorithm of the similarity comparison between case cities as follows:

```
float Sim = 0, mSim = 0;
float[] sSim = new float[41];
int i,j,m;
for (j = 0; j < dt2.Rows.Count; j++)
{
        for (i = 0; i < dt3.Columns.Count; i++)
        {
                Sim =
 1 - Math.Abs(Convert.ToSingle(dt1.Rows[0][i].ToString()) -
Convert.ToSingle(dt2.Rows[j][i].ToString())) /

(Convert.ToSingle(dt1.Rows[0][i].ToString()) + Convert.ToSingle(dt2.Rows[j][i].ToString()));
                Sim =
Sim * Convert.ToSingle(dt3.Rows[0][i].ToString());
                sSim[j] = sSim[j] + Sim;
            }
        }
        odbc.Close();//to calculate the similarity between each source case and target
city using recent adjacent method.
        mSim = sSim[0];
        for (i = 1; i < sSim.Length; i++)
        {
            if (sSim[i] > mSim)
            {
                mSim = sSim[i];
                m = i+2;
                this.LBCityId.Text = m.ToString();
            }
        }// Find serial number of the source city with largest similarity.
```

Where, the array dt1 is used to store 27 index data of target city; the array dt2 is used to store 27 index data of all source cities; the array dt3 is used to store weights of all indexes.

We enter the data information of 20 source cities in the case library maintained module, then select Jinhua city (one city in Zhejiang province of China) in year 2010 as target case, trying to make Jinhua's core competitiveness decision in year 2011 using the decision support system. After Jinhua's index data in year 2010 had been entered, and the "case retrieval" button had been clicked on, the system run automatically comparison procedure to identify and display the most similar source case. The retrieval result shows that Shaoxing is the most closely matched source city of Jinhua. The similarity between them is 78.1693%. The retrieval result is memorized in the system after "Save" button is clicked on. Then we click the "case reuse" button, the system brings up the basic situation, this year's (year 2009) core competitiveness status and new year's (year 2010) core competitiveness strategies of Shaoxing City. Decision makers modify directly the new year's core competitiveness strategies of Shaoxing city in "case reuse" interface based on the actual situation of Jinhua city. Finally, the modified information is displayed as new year's (year 2011) core competitiveness strategy advice for Jinhua city.

After the output of result, the system will do case self-learning automatically. The self-learning threshold $|\alpha|$ of the system is determined to be 90% after soliciting relevant experts. Because the biggest similarity of this retrieval (78.1693%) is less than 90%, the system absorbs jinhua city as the new source case. And its core competitiveness decision-making information is also stored in the system. As a result, jinhua city becomes the 21st source case city in the case library.

Conclusion

Using CBR technology, this paper constructs an urban core competitiveness decision support model, and develops a corresponding system according to the model. It aims to provide guidance for the goal city to make core competitiveness decision. The rich experience knowledge embedded in the past cases can be obtained through similarity retrieval of the system, which will provide guidance for the target city's core competitiveness decision-making. Accordingly, the shortage of incomplete and uncertain knowledge from experts can be avoided. Secondly, the model has self-learning function. If the similarities between target city and all source cities in the case library are all less than specified threshold, the system will absorb target city into the case library automatically. Therefore, the model has a stronger adaptability and flexibility. In addition, the urban core competitiveness decision support system has graphical interface, which is flexible and easy to use. Decision makers can operate the system after simple learning. Overall, this study applied CBR to the urban core competitiveness area. It offers a new research idea for the application of artificial intelligence technology in the management science.

In this study, the CBR technology is used in the design of the urban core competitiveness decision support model. But it is just an attempt in the area. Many problems need to be solved, such as finding more appropriate representation ways of city case, more accurate method for determining the index system and weights of similarity measurement, etc. These are the difficulties of the study, also the directions of future research.

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