Chapter 86
Innovative Monitoring and Evaluation System of Chinese Cities Based on GIS

Chuanglin Fang, Jing Qin and Xiong Shu

Abstract On the basis of collecting, modifying, storing, and managing the innovative urban indicators data and the GIS data of Chinese prefectural-level cities, this article is proposed to design and develop a system for monitoring and evaluating the innovative level of Chinese cities. This system integrates the technology of DBMS, MIS, and GIS. It can not only manage the indicators data and GIS data of prefectural-level cities but also could fulfill functions of the spatial query analysis and the thematic map rendering based on the secondary development of ArcGIS Engine. The system can help the researchers to manage, analyze, and compare the indicator data of many years and different cites, and provide support for writing assessment report of innovative cities.

Keywords Monitoring and evaluation system · .NET · ArcGIS Engine · GIS

86.1 Introduction

The innovative city is defined as follows: it is a city whose driving force is scientifical and technological progress; foundation is innovation culture; and the guide is independent innovation. It is also an urban morphology whose economic development is driven by innovation factors such as science, technology,

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knowledge, cultural, etc., [1–3]. In the twenty-first century, the competition among countries focused on the innovation ability. The main carrier of the national innovation capacity is urban which agglomerate technological, economic, and cultural. The strength of the city's innovation capacity indicates that the national innovation, so enhancing the national innovation capacity should vigorously raise the city's innovation capability. Establishing the evaluation indicators system is a necessary stage and an indispensable tool in constructing the innovative city. At present, the vast majority theoretical studies of innovation city are concentrated on the composition of the evaluation indicators system of regional innovation capability [4, 5].

In this paper, we developed a system with Visual Basice.NET 2008 and ArcGIS Engine on Windows XP, and the database system was SQL Server. The data connection mode is ADO. The innovation monitoring and evaluation system is an integrated information system which includes data management, data analysis, data visual functions, spatial and attributes query, and thematic map rendering capabilities. The goals of it mainly include: establishing an innovation monitoring indicator database of Chinese prefectural-level cities; implementing the basic functions such as information management, data query, data edit and output; providing better services for the city's innovation capacity analysis and management decisions.

86.2 System Database

In this paper, the SQL Server 2005 database platform is used to build the database. There are two types in the database: spatial data and attribute data. Spatial data is storage as shape file. Spatial data include national boundaries, provincial administrative boundaries, prefecture-level cities boundaries, and the coordination of prefecture-level cities which were considered as points. Attribute data include all levels of innovation indicators of 34 provinces, municipalities and autonomous regions and 287 prefecture-level cities. The data are from the Statistical Yearbook of various regions; provincial and municipal economic and social development communiqués; provincial and municipal Science and Technology Statistics Yearbooks, etc. Figure 86.1 shows the process of the system database establishment.

86.2.1 Attribute Data Organization

The attribute data in this system are management by SQL Server, data stored in the form of tables. Figure 86.2 shows the relationship of data tables in the attribute database. It is composed by the region table (Area), the index system table (Index), the basic data field table (Field), the basic data table (2009, 2010), and analysis

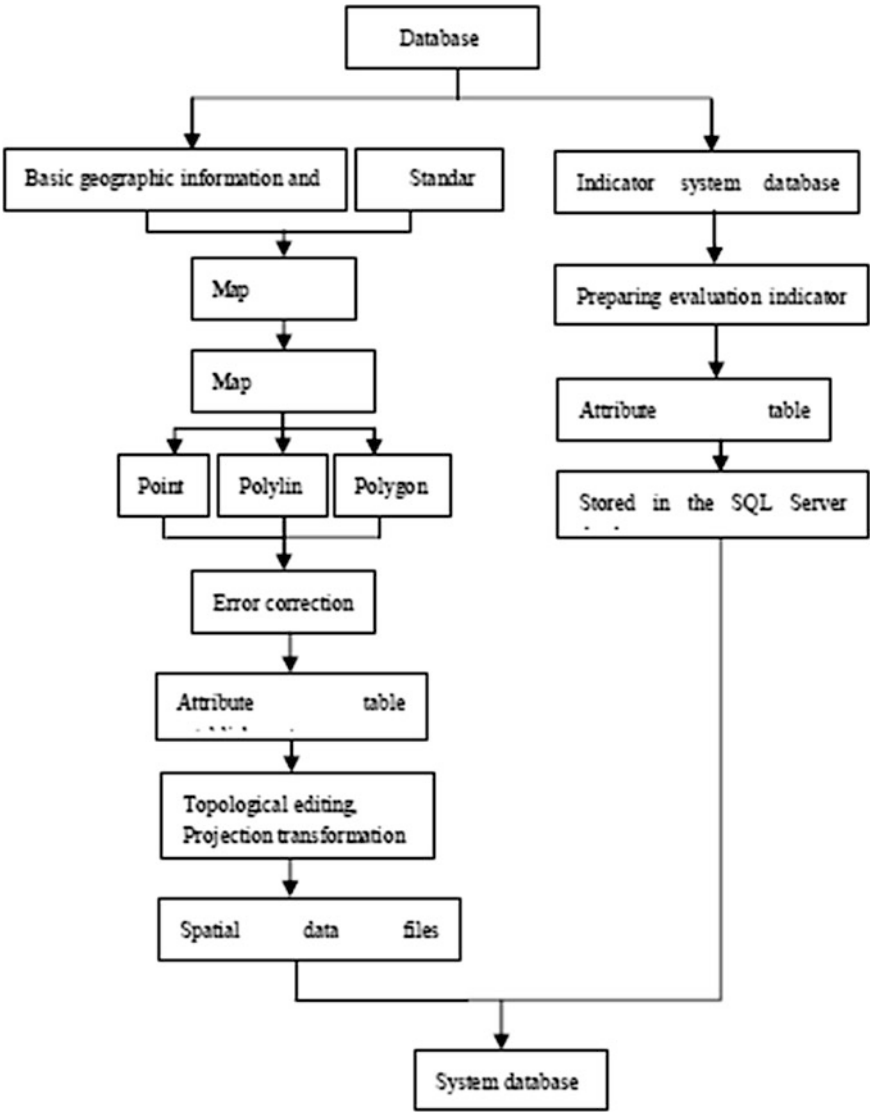

Fig. 86.1 Flowchart of database

result table (Result). The innovation cities information which prepare to evaluate is stored in the Area table. The evaluation indicators, formula, and the relationship between the indices are stored in the Index table. The name of basic data and formula are stored in the Field table. The basic data of different years are stored in the basic data table. The evaluation results are stored in the Result table.

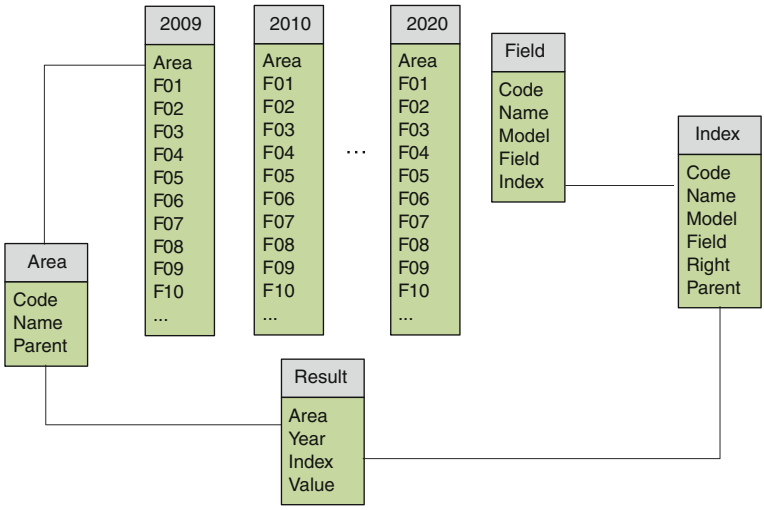

Fig. 86.2 The relationship of data tables in the attribute database

86.2.2 Spatial Data Organization

The spatial data in the system are stored in Shape file (the data format is .shp). It takes 1:500,000 underlying geographic data as data source and builds geographic data files in the form of different layers. Different .shp layers are associated with the corresponding attribute data tables in SQL database, so as to realize the GIS functions of spatial query, spatial analysis query, and thematic rendering.

86.3 System Architecture

The innovation monitoring and evaluation system concludes three layers which are the functional application layer, the logical design layer, and the data management layer (see as Fig. 86.3).

86.3.1 Functional Application Layer

The functional application layer is a client-oriented functional module, it concludes functions of user management, district management, attribute query, spatial query, the indicator query, the indicator weight calculating, statistical graphics drawing, spatial analysis, thematic mapping so that users can query, edit, analysis, modify, and map the spatial data and innovative urban indicator data.

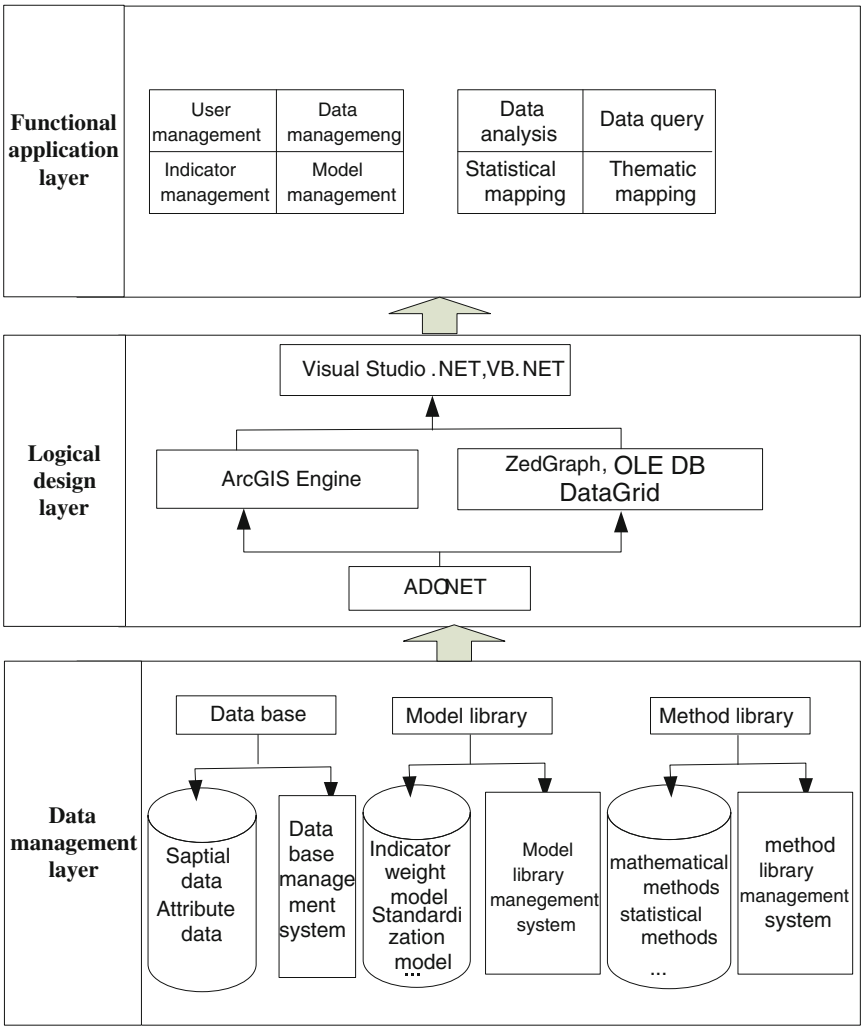

Fig. 86.3 System structure

86.3.2 Logical Design Layer

The logical design layer can supply technical support for the innovation monitoring and evaluation system. The software environment of this system is windows XP, Microsoft Visual Studio 2008 is the system's development platform, and the VB.NET is the developing language of this system. When the system is loaded, the database file (.mdb) is imported by ADO control; database table and the corresponding SHP file layer are associated in order to query the attribute information and location information, or SQL query.

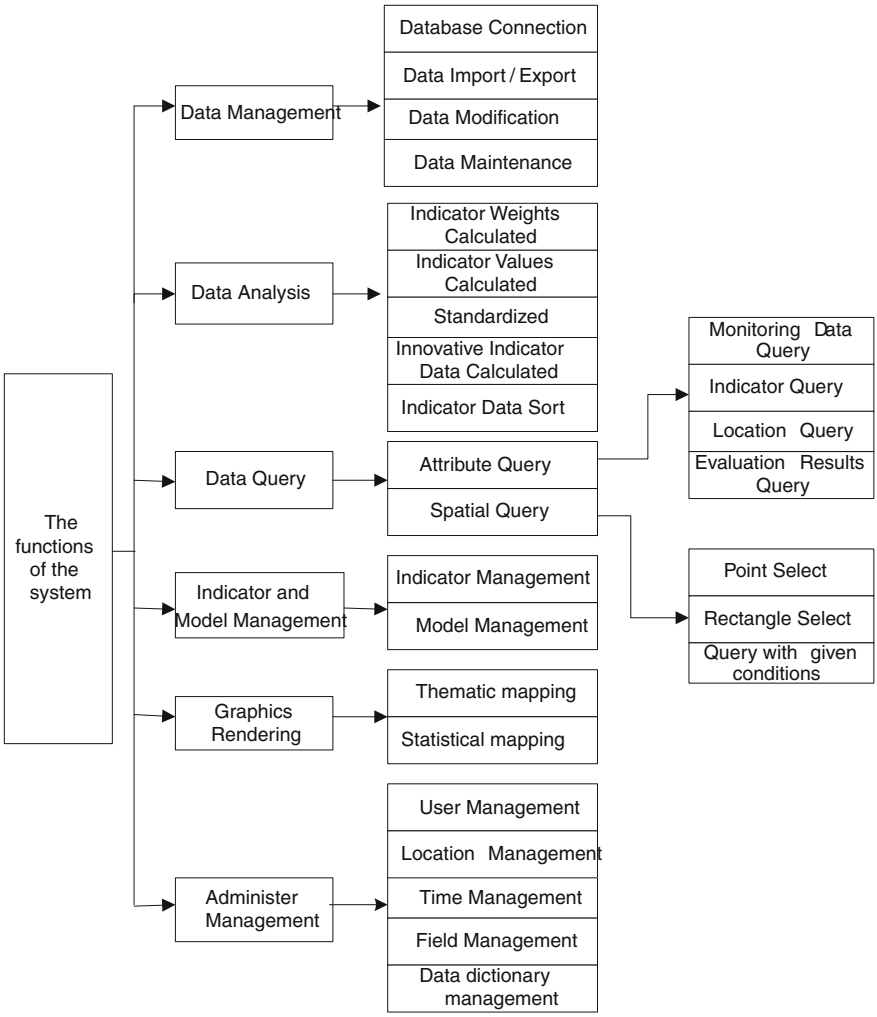

Fig. 86.4 System function

ArcGIS Engine is a collection of GIS components and developer resources that can be embedded, allowing you to add dynamic mapping and GIS capabilities to existing applications or build new custom mapping applications. The software developed with AE could be run on a Runtime environment and the installation of ArcGIS is never necessary. ArcGIS Engine provides GIS developing environment for system, but it just to use its GIS component to achieve spatial query and thematic mapping function in the system development. Others functions, such as innovative urban indicators database operations, statistical graphics rendering, visualization query, report generation are achieved using other components such as

data manipulation components (OLE DB, Data Grid), graphical component (zardgrap), etc.

86.3.3 Data Management Layer

The main purpose of the data management layer is to design and manage the database, model library and method library; it is the core of the whole system. The database is the important part of the system, which mainly consist of the spatial data and innovative urban indicators data. Data in the system are managed by SQL Server which can provide the function of data storage, querying, processing, and maintenance. And it can obtain data from various information resources and convert them to data structures which can meet the computing requirement. The model library is a collection of models which are stored as certain forms of organizational structure in the computer. The method library can be considered as the model library displayed in a smaller granularity level, it mainly store the basic mathematical methods, statistical methods, and other methods, it is responsible for calling the appropriate method to computing based on the needs of human–computer interaction subsystem and model library.

86.4 Main Function of the System

The functional modules of the system are composed by data management, data analysis, data query, indicator and model management, graphics rendering, and

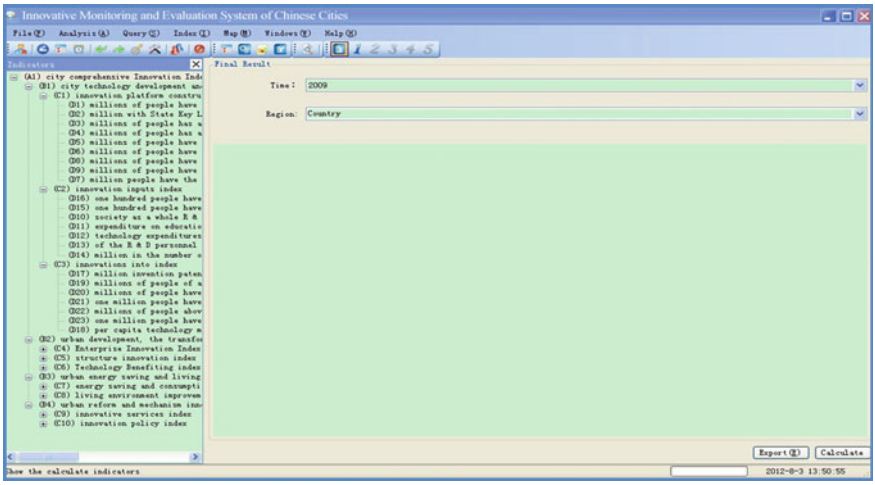

Fig. 86.5 Thematic rendering function

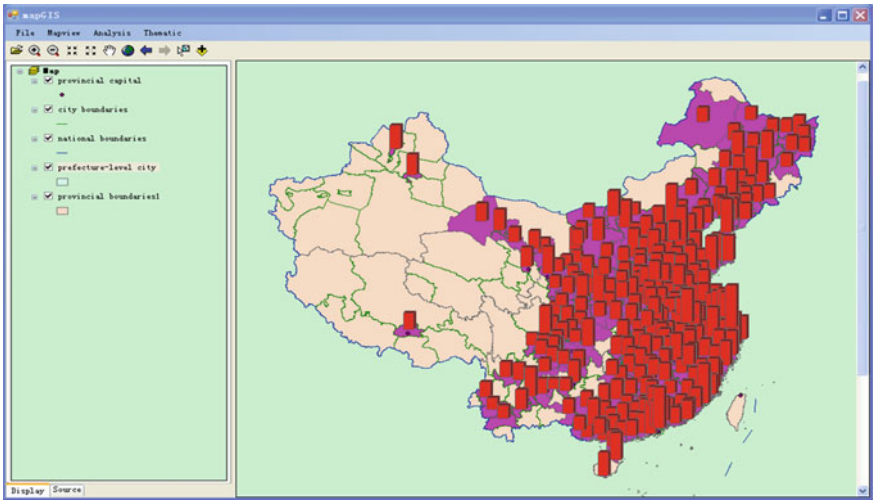

Fig. 86.6 The interface of the system

administer management. The core modules are data management, indicator analysis, indicator and model management, graphics rendering. Figure 86.4 shows the system functions. Figure 86.5 shows the interface of the system, and Fig. 86.6 shows the thematic rendering function. The innovation indicator is representing by the column height.

86.5 Conclusion

In this paper, the monitoring and evaluation system of Chinese innovative cities is developed based on the Visual Studio.NET developing environment with the support of ArcGIS Engine. The monitoring, management, and evaluation of innovative Chinese cities are effectively supported. And the information supporting platform for city planning and developing is provided. Further research should focus on updating system data in time, guaranteeing the reliability and timeliness of the system, and realizing the real time and dynamic monitoring of Chinese innovative cities. How to combine model operation and spatial data, how to integrate approach like artificial intelligence and fuzzy logic and complex mathematical models like multivariate statistical analysis, system dynamics and fuzzy mathematics into the system, and build an intelligent decision support system are also what should be considered in further research.

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