SPATIAL ANALYSIS DECISION MAKING IN GIS APPROACH TO REAL ESTATE SYSTEM

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ABSTRACT:

In the real estate business, it is a common understanding that the value and potential of a property are fundamentally determined by its location. For real estate agencies, the real estate system can be used as an aid to selling and managing properties, for the buyers, the system can function as consultant in their decision making in purchasing properties. This emphasizes the significations of spatial analysis factors in decision making, which offers a prototype of a real estate. A geographical information system (GIS) is undoubtedly available in this decision making. This paper presents the development of a prototype real estate system by the theory of a GIS-MIS-Network (GMN) based system. Spatial Analysis Decision Making (SADM) is a branch of decision making (DM) science. Using spatial analysis decision making (SADM) in the real estate business as assisting decision makers for sellers. The real estate system is a GIS based decision support tool developed on a systematic and automatic basis, which conventionally is based on manual processes in the real estate industry. Methodologies are demonstrated in the paper; therefore some particular problems emerged during the exploitation of the real estate GIS systems are analysed briefly. Moreover, although developed as a generic tool with capabilities to deal with GMN, this prototype can be applied to other fields, which involve spatial analysis decision making.

1. INTRODUCTION

1.1 General Instructions

Different researchers have put forward very different opinions regarding what kinds of spatial analytical functionalities should be linked to Geographic Information System (GIS). For instance, in Godchild's view, an ideal GIS should include at least six classes of spatial analysis (Goodchild 1987). Openshaw (1991) recommends eight spatial analysis techniques that might be regarded as 'GIS appropriate generic'. Haining (1994) identifies three fundamental types of spatial operations for a spatial data analysis module in GISs. Bailey (1994) lists more than ten methods of potentially useful spatial analysis techniques.

However, Spatial analysis techniques have be defined as those "whose results are dependent on the location of the objects or events being analysed " (M. F. Goodchild et al. 2000).

Wise and Haining (1991) identified three types of spatial analysis, which might be of interest to whose working with GIS: map-based analysis, spatial modelling and statistical spatial data analysis (SSDA). SSDA, may be described as the analysis of empirical spatial data using statistical methods. There is a considerable degree of consensus as to the types of techniques that ought to be made available to the GIS community to facilitate SSDA. Two types of SSDA can be identified, although there is some overlap between them. Exploratory spatial data analysis (ESDA) is concerned with detecting spatial patterns in data, identifying unusual or interesting spatial features of the data (such as spatial outliers), formulating hypotheses which alter based on or which are which about the geography of the data and validating spatial models. Confirmatory spatial data analysis (CSDA) is concerned with model building, which normally involves the estimation of parameters (and their errors) and usually includes hypothesis testing as part of the process of model specification (Haining, R., 1994).

The strategies for linking a GIS with statistical analysis are also very different in practice. Following Goodchild (1991), four statistical can be identified: (a) standalone spatial analysis software, (b) loose coupling of existing GIS software with statistical software. (c) close coupling of GIS software, and (d) full integration of statistical spatial analysis in a GIS.

1.2 Optimal Analysis Decision Making(OSDM)

In general the organizations are hence more likely to use more sophisticated analytical approaches to support spatial decision making. One such approach relying on Optimal Spatial Decision Making (OSDM) has been the active area of research and applications in spatial decision analysis. The objective of using OSDM is to help find solution to decision problems characterized by multiple-choice alternatives, which can be evaluated by means of performance characteristics called decision criteria. Because much of modelling done with GIS deals with evaluating location choice alternatives on the basis of optimal criteria considerable attention in the last decade was devoted to integrating OSDM with GIS software. (Thomas Q., 2001).

Optimal spatial decision making (OSDM) is a branch of decision making (DM) science. In general, OSDM involves the analysis of factors and constraints that affect decision making. It requires handing a substantial amount of data, which is often associated with uncertainties, net work, management information system (MIS) and utilizing expert knowledge. Geographical information system (GIS) was specially designed for handling spatial data, which compiled with MIS and Network, is capable of performing these tasks. However despite the long history of decision making theories and its applications, OSDM using GIS only emerged recently. Studies were reported, for example, in pipe circuitry site selection, urban studies, urban planning, locating facilities and real estate etc.

In general, there are two main streams in OSDM. One seeks optimum locations for activities over a network (e.g. the network based location allocation analysis). The other seeks the best location by evaluating specified criteria (site-selection). This paper focuses on the latter with particular interest in real estate (Chen. 2001).

The objective of the study is to develop a methodology and prototype real estate GIS for OSDM in the real estate industry. This is done by incorporating the existing decision making (DM) theories, rule-based system (RBS) and GIS-MIS-Network (GMN) based system within a GIS. The real estate GIS is to serve two applications: (1) For real estate agents, it is used as a tool for assisting property selling and management. (2) For purchasers, it serves as a consultant that locates the initial or potential area, and evaluates available choices by weighting functions according to the customer's preferences.

2. FRAMING THE PROBLEMS

Research and applications of Geographic Information Systems (GIS) in China started in the early 1980s. In the early period, the development of GIS was mainly depended on the progress and applications of remote sensing, aerial photography, as well as computer-aided design (CAD). With the rapid progress of Management Information System (MIS) and Internet technology, GIS has developed vigorously in the country in recent years. Real estate industry provides a booming sector for GIS and MIS as well as for Internet applications. Real estate system is the essential part for a real estate enterprise, it is very important for the decision makers and managers. However, previous office management methods have many faults, it could not meet the requirements of modern society. Nowadays, more and more office software come in force, but they are short of a new methodology for tackling the difficult problems.

A property can be referred to as an unmovable (mostly, if not all) commodity that exists in physical and social space. Its location, as well as price, is the premier factor that affects decision making in property selection. The most two important factors are 'location' and 'the optimum', which implicates the property environment and purchaser's preference. Although these two factors are inherently related, the good location is the dominating factor. Therefore, the location is the focus of the purchasers and the problem that we should faced. In order to find out what are considered 'good locations', the real estate GIS should provide two main function, namely, systematic analysis of the physical and social environment and mapping the potential area, and assessment of environment of the target properties of the purchaser's choices.

Otherwise, there are many databases having geographical information in real estate systems. How to represent the geographic information in an easy way is an important problem. With the investment on the cable systems growing fast in China, the Internet users are increasing greatly; the traditional management methods of the drawing are very difficult to satisfy the development of the real estate systems. In the design of communication systems, the share of the resources, especially the geographic information, is very limited. The real estate GIS system should meet these requirements.

3. METHODOLOGY

3.1 Concepts of GMN

GIS has been an essential tool for enterprise organizations and government to do scientific management and make important decisions. Therefore, the realization of modern real estate system depends on the GIS technology to some degree, and it needs much more technologies, such as the management technologies. The key technologies, for creating the real estate system, mostly including Geographic Information System (GIS), Management Information System (MIS), computer Internet, database management etc.

The new concept of GMN is set force under the situation. GMN is the abbreviation of GIS + MIS + Network. GMN is also called Geographic Management System. It is a leading edge technology in the GIS field recently (Lin, ACRS 2001).

In order to take advantage of GIS, MIS, Network, GMN has its own characteristic. Also, as GMN could be seen as "GIS for MIS", it is a new form for the development of GIS. The key points are:

1. High compatibility makes more applications possible on the GIS and MIS.
2. GMN is so compact and exquisite, but has more and powerful function.
3. GMN connects with MIS seamless.
4. Good customisation takes no more training (Lin, 2001, ICII 2001).

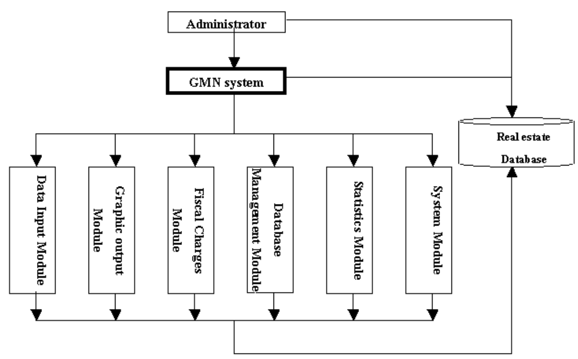

Figure 1. Function modules of GMN in the real estate system

3.2 Location Methodology

The integration of GMN and RBS with GIS offers a great potential for enhancing our ability in OSDM. The multiple-component model has four functionalities, namely, grid modelling, network analysis, information manipulation and random simulation.

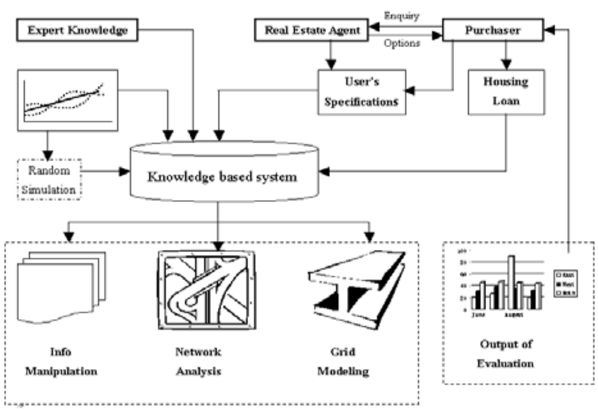

Figure 2. System structure of Real Estate GIS

As the figure 2 shows, the grid modelling functions are tools for analysis physical and social factors to produce potential area maps. Each factor is represented in a data layer in which every location has an attribute value expressed in terms of GIS membership. The network analysis aims to measure the distance between residence and work, shop, school and public transport. The information manipulation is to calculate repayments and compare financial alternatives. The random simulation is used to estimate the future trend in house price.

3.3 Optimal Site Selection

Selection procedure, as described in DM theories, usually involves two stages: in the preliminary stages, candidate site are selected using the random simulation. In the second stage, the selected sites are compared with each other and ranked according to their attractiveness.

Through the selection process, the potential areas are mapped to identify target sites. In this stage, grid modelling is used with fuzzy analysis. Once the candidate sites are selected, the attributes for each site are assessed using the RBS for network analysis, information manipulation, and random simulation. The attribute values are summarized in table form, with recommendation by the rule-based system.

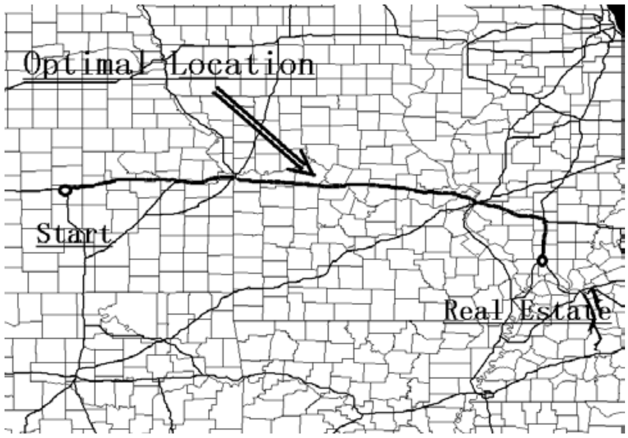

Figure 3. Optimal Site Selection

3.4 Random Simulation

Random simulation is another optional function, conducted using parameters based on empirical analysis. Since this simulation requires in-depth local knowledge and there are too many uncertainties in the future economics, this function can be substituted simply by using the price trend based on statistical data of the transaction. The sales price data may be commercially available and easily obtained.

4. DISCUSSION

Location is a critical factor that affects real estate value. This method provides an assessment of location on a broad scale, and also a way to build a GIS system, thus increasing the awareness of agents and buys of local physical environmental factors， which may influence property values.

Searching for a property to purchase can be a very stressful process; this system can provide a buyer with a map of potential areas that best meet their requirements.

However, GMN system uses GIS for real estate decision making, such as the property valuation GIS, which aims to assist value in retail property valuation by comparing the physical properties of a property (e.g. size, frontage and stories, etc.) with other similar ones and their accessibility.

In order to describe the detailed geometry of a building we must sample some points and create dozens or hundreds of basic surfaces. Those data, especially in the buildings, are usually extracted from the aerial photography or digital camera. There are mass images in order to present the material or texture feature of each surface, so we have specially a proper systematic coding rule, which can ensure efficiency during extracting data, and devised the integrity during creating.

Furthermore, in the optimum spatial analysis, other than the location factor, the property price, which is affected by other socio-economic factors such as composition of population, is another important factor to be considered in decision making. In recent years, Automatic Valuation Models (AVMs) have been rapidly developed and are commercially available. Basically, the AVM is built to analysis and compare property values based on the similarity of property attributes (e.g. number of rooms, house age, selling price, etc.), by using statistical/mathematical methods. AVM answers the question whether a property is a 'good buy' in terms of price, thus it provides a natural extension to real estate GIS for real-world application.

5. CONCLUSION

The real estate system is a GIS-based decision support tool developed on a systematic and automatics basis, which conventionally is based on manual processes in the real estate industry. It has two main advantages. First, this method can handle the uncertainly in defining the selection criteria and boundaries of different factors. Secondly by codifying expert knowledge using a rule-based system, it also mitigates the problem of data starvation, which is common in decision making. As is demonstrated, GMN system is developed and designed especially to manage the real estate and help the operator to sell the houses. The main characteristic of the software is exploiting the 3D coding data, GIS data, CAD data and managing the real estate attribute data including area, price, floors, rooms and so on. Also, the system can be used for the administrators; it is designed to assist administration of enterprises.

Moreover, although developed as a generic tool with capabilities to deal with location, this prototype can be applied to other fields, which involve optimal spatial decision making, By altering the input parameters and by using other available datasets, e.g. census data, this methodology can be applied to a wide range of disciplines, especially in all aspects of the digital earth, such as locating infrastructure, town planning (e.g. for re-zoning), transportation as well as marketing involving site selection. So developed as a generic tool with capabilities to deal with location, this prototype real estate GIS can be applied to other fields, which involves optimal spatial decision making.

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