

GIS Based DSS Model for Business Site Selection

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ABSTRACT

The objective of any issue of site selection is to discover the best place with required circumstances that fulfill predetermined requirements of choice. In such a method, manipulating various criteria spatial data is crucial for decision-making achievement. While acknowledged as helpful decision-making support techniques, conventional geographic data systems (GIS) do not provide the means to manage multiple decision factors. However, a GIS-based scheme properly coupled with the methods of spatial multi-criteria decision analysis (SMCA) may become capable of transforming geographic data into a decision. This research develops and effectively tests an embedded remote sensing and GIS-based methodology by creating an up-to-date digital database. Finally, for the town development officials, a Decision Support System (DSS) is intended. This study's primary goal is to produce a digital database containing data about urban sprawl, accessible land for urban growth, land development rate and land use change, etc. Using information from various sources, the entire database was created. The urban sprawling pattern is recognized and modeled using remotely sensed data. Remote sensing information was categorized based on built-up, transport (road and rail network) and water bodies for land use. The methods of spatial and temporal analysis, such as GIS and Remote Sensing, are used to create a DSS to provide planning officials with equipment to take strategic choices and set rules for new buildings.

Keywords: *Decision Support System, GIS, Spatial Data.*

1. INTRODUCTION

One of modernity's prevalent policies in our times is the use of sophisticated IT. According to many world reports, information technology was the fastest-growing science sector by the end of the 20th century, affecting progress in many of our life's key areas.

As a result, modern IT has discovered its place in commonly understood earth sciences. Modern techniques are particularly essential for the protection of the environment, which is certainly one of the greatest problems today. This task requires a wise, efficient and creative use of the opportunities provided by IT.

The new science discipline called geomatics arose from the mixture of information technology and earth sciences, while GIS incorporates "spatial data acquisition, storage, verification, integration, conversion, evaluation, presentation, transfer, management and dissemination procedures as well as suitable organizational and technical infrastructure and spatial databases serve as a well-known instance of the presence of information technology (including privacy) in environmental studies.

GIS activities are based on spatial data. The need for efficient data processing is the reason why such systems are created. Spatial data analysis, carried out with the assistance of advanced GIS instruments and techniques, is the basis for further growth of our environmental understanding. These instruments provide invaluable assistance for the required decision-making processes and

efficient tracking, resulting in successful preventive actions, decreasing the adverse impacts of antropopression [1].

Hence there is a need to develop a DSS for Site Selection, which will incorporate the criteria involved in development of site including the physical and legal aspects. Decision Supporting System is to be developed in the form of GIS, which will give spatial information so as to enable the general public to have a better understanding of the procedure in buying a site as well to purchase a site/building to their choice.

1.1 GIS AND DECISION MAKING

GIS is a fresh paradigm for data organization and information system design, the vital element of which is the use of the place idea as the basis for information system structuring. The notion of place as a non-spatial data integrator has been suggested [6].

GIS now provides the most efficient means of doing so. The biggest advantage of GIS for preparing database is its potential for data integration. GIS does not create a single integrated database; instead it provides a mechanism for integration to assist in solving whatever problem is in hand. Geographic information system excels at editing, displaying, and plotting networks and related data.

By using GIS with a modeling package, it is possible to extend modeling capabilities and open up new possibilities for developing, using, and maintaining data.

Most of the decisions require the use of spatial data. Decision-maker face difficulties as data obtained are from different sources.

The spatial data must be linked with other spatial data and non-spatial data sets to maximize the use of data in decision making. The applications of GIS are numerous and varied. People and groups involved in decision making come from all walks of life and include citizens as well as from government officials and other organization representatives.

Most decisions involve one or more aspects, which has to be weighed against one another for which GIS is used. The volume of data available is also enormous which make the user to make use of a tool which will help them to relate it to a spatial unit and GIS is only tool available[2].

Capacity of GIS in visualizing the data is very high and visualization of data helps to a great extent in decision making.

1.2 OBJECTIVES OF THE PRESENT WORK

GIS is a modern technological tool and can be used for the management and analysis of a network and also the database of quarries. Keeping this in view, the present work has been undertaken with main objectives as:

1. To prepare maps showing existing place of interests, road and railway networks, waterline network, water bodies and land use in Lucknow city
2. To build a DSS for the prospective buyer, to choose a site/building according to his choice (after analyzing lot of facts in model made in MS Excel sheet)
3. To build an information system on sites suitable for construction
4. To build an information on eligible location of house sites or building which will include:
 - a) Location and type of construction
 - b) Facilities available on site and off site.
5. To build an information system on the aspect to be looked into while buying a site.
6. To build a Land use Information System for selected area.
7. To assist the decision makers in laying the foundation for the growth of the Lucknow Metropolitan area
8. To visualize and analyze all these information using GIS software and model made in MS Excel sheet.

2. STUDY AREA

Study area in this work has been taken Lucknow city in India. As Lucknow city is easily reachable, various information about city that needed for study is easily available on internet, so we have chosen this as our study area.

Lucknow is India's most populous state capital, Uttar Pradesh, and is located in the core of the state about 500 km northeast of New Delhi. The City has a humid subtropical climate from December to February with a cool dry winter and from April to June a warm summer.

The extreme temperature in the summer varies from around 45 degrees Celsius to 3 degrees Celsius in the winter. Between July and September, the City gets about 100 cm of annual rainfall mostly from the southwestern monsoons. The town is located at an average altitude of 110 meters above mean sea level and usually eastward slopes. Lateral slopes lead to the Gomti River, which flows through the core of the town from north-west to south-east, dividing it into the areas of Trans-Gomti and Cis-Gomti.

The city's more densely populated regions are on the southern bank of the Gomti River, and several scheduled housing colonies south of the river have been established. Lucknow's cultural legacy is regarded [5].

3. METHODOLOGY

A. METHODOLOGY ADOPTED FOR DSS

We can describe the methodology taken in the research in the following steps.

1. Lucknow City's map and adjacent regions are digitized. The Cadastral information includes the features of the city's waterway, highway and railway network and infrastructure installations.
2. Map is ready and different data has been allocated to attributes for each site.
3. A DSS with all its characteristics has been developed to obtain data about each site.
4. The entire database is transformed into a supported format and is tailored to provide query services for instant and prepared information extraction through a MS Excel Sheet DSS model.

A DSS model is made in MS Excel Sheet to help us in choosing best location. We adopted the method of assigning weights to a particular facility for different locations and then calculate the total weight of all the

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locations and it gives you an idea of best location for your purpose by seeing the highest weight in sheet.

B. FLOW CHART FOR METHODOLOGY

The flow chart for the methodology adopted is shown in Figure 1 below:

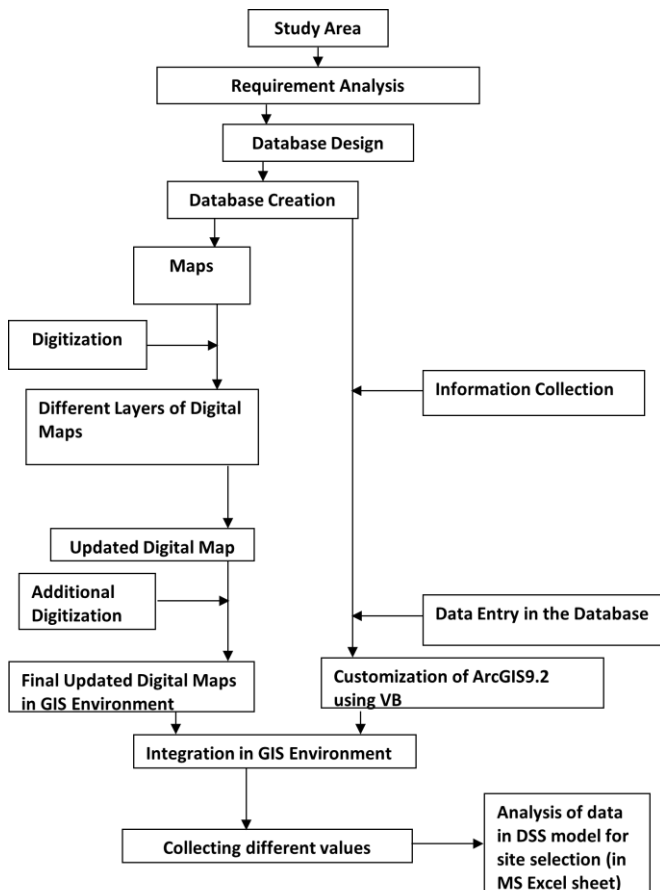


Figure 1: Methodology Flow Chart

C. ASSIGNING OF WEIGHTS FOR DIFFERENT FACILITIES

The criteria for weight assigning with different facilities is shown in Table 1 below:

Table 1: Weight assignment criteria corresponding to facilities

S.No.	Facility	Criteria	Weight Given
1.	Road Distance	<1 Kms	10
		>=1 &<2 Kms	8
		>=2 &<=4 Kms	6

		>4 &<=6 Kms	4
		>6 Kms	1
2.	Railway Distance	<1 Kms	10
		>=1 &<2 Kms	8
		>=2 &<=4 Kms	6
		>4 &<=6 Kms	4
		>6 Kms	1
3.	Water Body Distance	<1 Kms	10
		>=1 &<2 Kms	8
		>=2 &<=4 Kms	6
		>4 &<=6 Kms	4
4.	Land Use	Yes	10
		No	0
5.	Highway Availability	Yes	10
		No	0
6.	Drainage Availability	Yes	10
		No	0

These criteria can be changed according to purpose for site selection.

D. MODEL FOR DSS

The DSS Model in MS Excel Sheet is shown in Figure 2 below:

Criteria	location1	weight1	location2	weight2	location3	weight3	location4	weight4	location5	weight5
road distance(in kms)	10	10	10	10	10	10	10	10	10	10
railway distance(in kms)	10	10	10	10	10	10	10	10	10	10
water body distance(in kms)	10	10	10	10	10	10	10	10	10	10
land use(=1, no=0)	0	0	0	0	0	0	0	0	0	0
highway(=1, no=0)	0	0	0	0	0	0	0	0	0	0
drainage availability(=1, no=0)	0	0	0	0	0	0	0	0	0	0
Total Weight Score	30	30	30	30	30	30	30	30	30	30
DECISION SUGGESTED --			Possible Best Location	Highest Score	Location Name					
			location1	30	0					
Directions for use --	values in	cells should be changed for doing analysis								

Figure 2: DSS Model in MS Excel

In the DSS model shown above, various parameters (in blue cells) have to be entered which is to be collected from ArcInfo with the help of information tool and other customized tools and after entering the data for various locations (represented as location1, location2 etc.) and their corresponding weights (represented as weight1, weight2 etc. and is in pink cells) are calculated automatically according to Table 1.

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After entering all the values for each location this model calculates the total weight for each location (represented in orange cells) and then automatically chooses the location with highest weight and display the name with its weight.

(a) Calculation of Total Weight for Different Locations

$$\text{Total weight for location 1 (W1)} = \sum_{ci=c3}^{c8} Wci,$$

where Wci is the weight corresponding to cell Ci for location 1.

And similarly calculate $W12, W13, W14$ and $W15$ using the formula stated above for their respective cell numbers.

(b) Calculation of Maximum Weight

For calculating maximum weight we used MAX () function of MS Excel as follows:

MAX (W11:W12:W13:W14:W15), this will give the maximum value among these.

4. RESULTS AND DISCUSSIONS

This application has been developed through ArcGIS customization. In ArcGIS an interactive tool was developed, this tool gives the facility to the user to access the all database and geographical view of Lucknow City. GUI has been developed for the person who in general may not have in-depth knowledge of GIS. Using this, users who have basic knowledge of computers can work under GIS environment. This interactive GUI is user friendly; user can access more details of any particular location.

A. DIGITIZED MAP OF STUDY AREA

Digitized map of study area is shown in Figure 3 below:

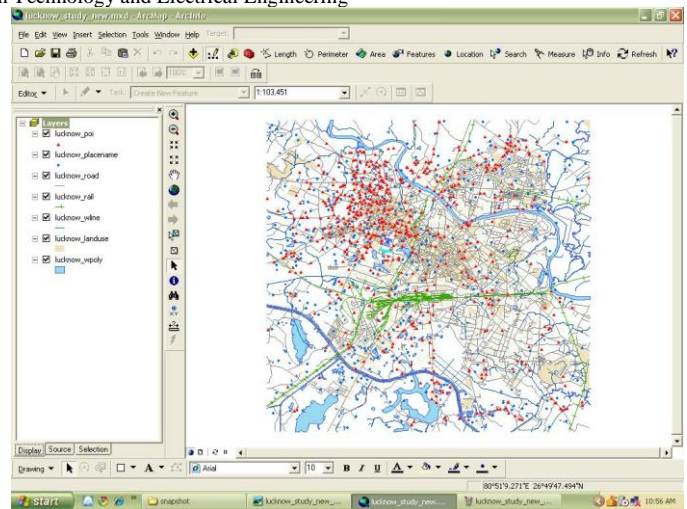


Figure 3: Study Area

B. DATA COLLECTED BY INFO TOOL

This is information tool for giving the various attributes of selected feature. Once we select this tool and it will clicked on a feature it will open a form .In this form, some selected attributes of hazratganj will showing in the Figure 4 shown below:

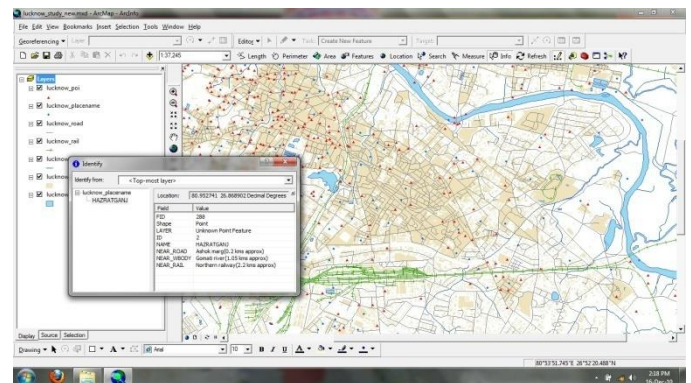


Figure 4: Use of Info Tool

C. ANALYSIS OF DATA IN DSS MODEL

After filling all the values of required parameters of corresponding locations in MS Excel, our DSS model will suggest the best location for business as shown in Figure 5 below:

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Criteria	location1	weight1	location2	weight2	location3	weight3	location4	weight4	location5
Location Name	alambag		chhatbag		aminabad		hazratganj		kesarbag
road distance(in kms)	0	10	3.4	6	1.2	8	2.4	6	2.34
railway distance(in kms)	2	6	5	4	3	1	1.3	8	1.2
water body distance(in kms)	7	1	0.5	10	1.9	8	0.6	10	0.5
land use(yes=1, no=0)	1	10	1	10	1	10	1	10	0
highway(yes=1, no=0)	0	0	0	0	0	0	0	0	0
drainage availability(yes=1, no=0)	1	10	1	10	1	10	1	10	1
Total Weight Score		37		40		37		44	
DECISION SUGGESTED --			Possible Best Location		Highest Score		Location Name		
			location4		44		hazratganj		
Directions for use --	values in		cells should be changed for doing analysis						

Figure 5: Use of DSS Model

As suggested by our DSS model out of five locations ,location4 (hazratganj) is best site for business.

5. CONCLUSIONS

Spatial data plays a significant role in the area of GIS and decision making. The GIS based DSS model developed in this project uses raw stored data and helps in efficient and effective decision making for selecting suitable business site.

This GIS based DSS model proves their worth in numerous ways, such as:

- It is efficient as it does not require collection of data for every calculation, as it uses readily available data for calculation so it takes less time for analysis and producing decision options.
- It is effective as the system considers most of the factors and related relevant data for the study area and produces accurate and quality decision options.
- The study has considered available literature and expert opinion to identify most of the factors responsible for generating decision options. More the identifying factors, more accurate results we get.
- This model is flexible as a user can increase or decrease the factors responsible for producing decision options as well as their weights.
- As it already stored raw data so it is useful for new site selection as well as analysis of older site for future planning.
- In this model dynamic analysis (extraction of new information) is also possible for any site by using customized tools.

For the effective and possibly widespread usage of GIS based DSS model an appropriate approach is needed. That means: appropriate data organization, easy access to data and creating suitable interface. This model fulfills these requirements for a user.

The efficient and suitable use of spatial data should also include methods to supply the information for studies, tourism and common interest purposes as well.

REFERENCES

[1] Biswajit Sarma, Dhanunjaya Y. Reddy and B. Venkat Rao, August 1-6(2004), "GIS Based Decision Support System for Seismic Risk Reduction in Urban

Planning of Guwahati City, India", 13th World Conference on Earthquake Engineering, Vancouver, B.C., Canada, Paper No. 2685.

[2] Srinivasan Santhanam, "Decision Support System for Real Estate", GIS Cell, Chennai Metropolitan Development Authority.

[3] Kai Han, November 30, 2005 "Developing a GIS-based Decision Support System for Transportation System Planning", Paper submitted to AASHTO GIS-T Student Paper Contest.

[4] Leszek Litwin, Marcin Guzik., 23-25 June 2004, "Database Model of GIS as an Element of Spatial Data Infrastructure", 10th EC GI & GIS Workshop, ESDI State of the Art, Warsaw, Poland, pp. 1 – 9.

[5] Feedback Ventures Pvt. Ltd., 2006 "City Development Plan Lucknow", Report prepared by Feedback Ventures Pvt. Ltd. and submitted to Government of Uttar Pradesh.

[6] Burrough P. A., McDonnell R. 1998, "Principles of Geographical Information Systems", Oxford University Press, ISBN: 0198233655.

[7] Hanan Samet, 1994, "The Design and Analysis of Spatial Data Structures", Addison-Wesley Publishing Company, Inc., ISBN: 0201502550.

[8] GIS Development, March 2010 The Global Geospatial monthly magazine on Geographic Information system, Vol. 14 Issue 03, Subscriber's copy.

[9] Internet1: http://training.esri.com/acb2000/showdefl.cfm?DID=6&Product_ID=8, accessed in August-November, 2010

[10] Internet2: <http://www.esri.com/software/arcgis.html>; Introduction of Arc GIS, accessed in August-October, 2010

[11] Internet3: <http://www.lmc.up.nic.in/nfinal.pdf>; Lucknow municipal corporation, accessed in September-December, 2010

[12] Internet4: <http://www.gis.com>; Data types & Data Model, accessed in September-December, 2010.

[13] Zongyao Sha, Minghua Zhang, 2007, Development of Web-Based Decision Support System for Field-Based Crop Management, acm journal.

[14] Perencsik A., Redlands, Calif, 2005, "Building a Geodatabase: ArcGIS 9, ESRI Publication", ISBN: 158948102X

[15] Zieler M., Redlands, Calif, 1999, "Modeling Our World": The ESRI Guide to Geodatabase Design, ESRI Publication, ISBN: 1879102625

[16] Yi Zhang, David Hawkins, Wei Zeng and Menghong Wen, April 25-27, 2003, "The Framework of GIS-based Decision Support Systems (DSS) for Water Resources Management at the Flint River Basin", Georgia Water Resources Conference, held at The University of Georgia, Athens, Georgia.

[17] Xiaosheng Liu, Hengkai Li, Yanpeng Li, May 22-24, 2009, "Real Estate Decision Support System of Market Comparison Approach Based On GIS", ISBN 978-952-5726-00-8 (Print), 978-952-5726-01-5 (CD-ROM), Proceedings of the 2009 International

Symposium on Web Information Systems and Applications (WISA'09) Nanchang, P. R. China, pp. 108-111

- [18] Alan Muhlemann, John Oakland, Keith Lockyer 1998, "Production and Operations Management", Macmillan India Ltd., SBN: 0333930053.

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