



An Intelligent Decision Support System for Establishment of New Organization on Any Geographical Area Using GIS

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Abstract— For establishment of any new organization as industry or school or hospitals etc., on a geographical area, the decision and intelligence of human being are required as, the location has proper habitat factors for living or the location has less-possibilities to get affected by disasters. Some time it may happen that we don't know some probable conditions or some measurements during taking decisions. It may happen that a person by himself is unable to take decision as the less knowledge of affecting factors for that area. And they have to hire some professional. An intelligent decision support system is required in such conditions, to provide a complete guidance. In this paper we are proposing an intelligent system to support making decisions for establishment of new resources on any geographical area. Using GIS we can get the whole information of any geographical area. The GIS and AI techniques are used here with spatial database.

Keywords— Geographical Information System, Artificial Intelligent, Spatial decision support system, Knowledge database.

I. INTRODUCTION

The “Geographical Information System (GIS)” is the most powerful tool to organize complex spatial environment with digital spatial database to develop [1, 2] the imaging satellites, aircrafts, digitization of maps and transactional database. In recent years the research is based on the use of GIS for effective data handling and also for analyzing and geographically transferring the information around the world [1, 2].

A spatial database is a database that is optimized to store and query data that represents objects defined in a geometric space. Most spatial databases allow representing simple geometric objects such as points, lines and polygons. The major goals of spatial database integrated with GIS is to improve the decision making process [31]. A decision support system may present information graphically and may include an expert system and artificial intelligence (AI). [4]

A decision support system (DSS) is a computer-based information system that supports business or organizational decision-making activities. DSSs serve the management, operations, and planning levels of an organization and help to make decisions, which may be rapidly changing and not easily specified in advance. Decision support systems can be either fully computerized, human or a combination of both. DSSs include knowledge-based systems. A properly designed DSS is an interactive software-based system intended to help decision makers compile useful information from a combination of raw data, documents, and personal knowledge, or business models to identify and solve problems and make decisions [32].

A spatial decision support system (SDSS) is an interactive, computer-based system designed to assist in decision making while solving a semi-structured spatial problem. It is designed to assist the spatial planner with guidance in making land use decisions. A system which models decisions could be used to help identify the most effective decision path. An SDSS is sometimes referred to as a policy support system, and comprises a decision support system (DSS) and a geographic information system (GIS). This entails use of: a database management system (DMS), which holds and handles the geographical data; a library of potential models that can be used to forecast the possible outcomes of decisions; and an interface to aid the user's interaction with the computer system and to assist in analysis of outcomes. An SDSS typically uses a variety of spatial and non-spatial information, like data on land use, transportation, water management, demographics, agriculture, climate, epidemiology, resource management or employment. By using two or more known points in history the models can be calibrated and then projections into the future can be made to analyze different spatial policy options. Using these techniques spatial planners can investigate the effects of different scenarios, and provide information to make informed decisions. To allow the user to easily adapt the system to deal with possible intervention possibilities an interface allows for simple modification to be made [33].

As GIS is introduced to new areas and expands its base in existing areas of application, there is an increasing need for specialized software development. Most commercial GIS vendors provide a development environment for their software products that allow for the creation of specialized software tools using GIS functionality and targeted at specific research or operational goals. The intent of such efforts is to provide users a simplified set of tools that allow them to perform their jobs without exposing them to the complications of spatial data management and analysis. The major hurdle to broad and integrated application of GIS in these organizations is a lack of understanding with regard to what GIS is, how

it can be utilized, and what benefit/roll it can play in an organization. A major task lies in the area of demonstrating the utility and cost effectiveness of implementing broadly applied and well integrated systems [3].

In this paper we are proposing an intelligent GIS based system which provides a decision support system to make right decision for the establishment of a new resource on any geographical area. The decision is based on various factors affecting that area.

II. LITERATURE REVIEW

The literature reviewed in the area of GIS-based routing showed that there are many advantages to developing systems that make use of GIS and intelligent software components (e.g., intelligent agents) [5]. Most of the current research in the area of agent-based intelligent support systems deals with intelligent spatial search and information retrieval. In year 1999 a paper is based on rural land use planning was published in ELSEVIER shows the implementation of a spatial decision support system. The works was based on land use planning tools which further evaluates and initializes the result. It makes use of core spatial data structure by using partially mirrored techniques [6]. A one more paper was published in ELSEVIER to show the work flow based spatial decision support system. It was used to agree environmental planning activities. It was centred on dynamically capturing use inter actions with a geographic information system in a real time and documenting them by using scientific work force [7]. In another study, Mangold (2000) described the costs of snowploughing and using road salt, as well as its importance for snow removal [8]. Aridor et al. (2000) described the development of a knowledge agent for the web [9]. Salim and Timmerman (2001) described artificial intelligence-based software techniques for optimizing resource allocation and asset management to improve productivity. The model uses an artificial intelligence-based shell that takes decisions in combination with various asset databases [10]. Rasmussen et al. (2001) developed “weather support to de-icing decision making”: a winter now-casting system. The system uses commercial weather data in the form of Next Generation Radar (NEXRAD) WSR-88D and METAR surface weather reports from Automated Surface Observing System stations and observers. Much recently published research describes web-based intelligent systems and their advantages over non-web-based decision support systems [11]. In 2002, Office of Statewide Health Planning and Development (OSHPD), in California USA, established a powerful system for resource and facility management. In this project, a conceptual model was designed by using the results of need analyses. In the next step, classes, subclasses and available relations and so on were defined in software [12, 13]. In 2002 in Ayuthaya, Thailand, GIS was used for examining effects of different factors on public health, showing disease distribution, performing specific analyses, visualization and providing of information on health care and also helping in different decision making. Data used in that study include: population data, data concerning infectious diseases and their occurrence locations [12,14]. Tsou (2002) described “developing a prototype framework for an agent-based information finding/filtering application by customizing ArcGIS and ArcIMS” [15]. Shahiari and Tao (2002) in their paper, “GIS Applications using Agent Technology,” described special spatial search (SSS), which provided a web-based spatial search engine to search geospatial data [16]. In 2003, Eastern Europe international health organization started to estimate diseases as a result of water pollution by means of GIS to specify pollution resources and direction of occurring diseases. In this research, primary studies determined system requirements for managing and taking care of disease and also factors that cause them. Then, some of disease intensifying factors and data related to them were gathered. Finally, GIS was used as a managing system to store and recover data, display and recognize temporal and spatial association of disease [12, 17]. An example of such research is presented by Mahoney and Myers (2003). They described a winter road MDSS. Their research focused mainly on using weather data to design a DSS for maintaining roads during winters [18]. In a work, Shad et al. (2003) evaluated various route-finding methods for a GIS-based application. A substantial amount of research reviewed utilized weather information for GIS-based systems and other DSS. The literature included systems that use comprehensive weather information to provide decision support and systems that improve the functionality of current systems [19]. Hahne (2004) described the advantages of the integration of GIS and asset management systems by the Chelan Public Utilities Department [20]. Similar work was presented by Pisano, Stern and Mahoney (2004). They demonstrated a winter maintenance DSS that uses complex winter weather prediction data plan snow removal operations [21]. Choi (2004) discussed a web-based prototype SDSS for watershed management [22]. In 2006, a project was accomplished by environmental conservation organization in order to control WN virus, in Pennsylvania, USA. This virus could spread easily and quickly in every environment. In this study, GIS was used for gathering and combining of data from different resources and for creating a central geo-database to provide relation between different data centres. Environmental sampling was accomplished by means of dynamic GIS technology and wireless GIS. In the resulted system, users could determine prevalence direction, extent of spreading and number of affected people [12, 23]. In year 2008 a paper was published to show the geographical information system application in public health as a decision support system [12]. In 2008 a paper was published to show the integrated approach for systematizing the sewer renewal planning process. The approach integrated the three main criteria in the planning process: condition, risk, and cost [24]. In 2009 some research followers identifies the possible organizational, technical, and scientific factors that may form an obstacle for the design and application of a Decision-Support System (DSS) for river-basin management by analyzing the interaction between the different participants in the Elbe DSS project [25]. In 2010 a paper demonstrates the applications of natural language quantifications in spatial decision analysis through selection of the criteria weights and aggregation definitions. The paper presented the fuzzy majority approach using IOWA procedure for GIS-based multicriteria decision-making and its implementation in the ArcGIS environment [26]. In 2011an study reviews environmental applications of MCDA paper was published. In this review paper over 300 papers published between 2000 and 2009 reporting papers were classified by their environmental application area,

decision or intervention type. In addition, the papers were also classified by the MCDA methods used in the analysis (analytic hierarchy process, multi-attribute utility theory, and outranking). The results suggest that there is a significant growth in environmental applications of MCDA over the last decade across all environmental application areas. Multiple MCDA tools have been successfully used for environmental applications [27]. In 2011 a paper was based on decision support system aimed at offering the users (e.g., government or municipal agencies) a flexible and user-friendly environment to provide decision aid in urban infrastructure planning. The visualization of available alternatives on maps provides a value-added for decision support processes in urban infrastructure evaluation problems [28]. In 2012 the major focus was on disease detection using GIS and DSS systems. A paper was presented to characterize the malaria risk by spatial variability, manifested by clustered patterns of malaria cases. The effective management of malaria requires a spatial perspective and the inclusion of a geographical component to any malariae limination information system. Maps provide effective monitoring, evaluation and surveillance tools to overcome the complexities associated with the spatial variability of malaria. Modern advancements in GIS and location-based data collection technology create opportunities to establish geospatial components into information systems, thereby strengthening the ability of the systems to support the scaled-up operational priorities of malaria elimination [29]. In some recent works the scientific basis of the soil has been shown. A USLE/RUSLE-based model approach is founded on multiple flow algorithms and the unit contributing area concept with an extremely precise and high-resolution digital terrain model ($2 \text{ m} \times 2 \text{ m}$ grid) using GIS allows for a realistic assessment of the potential soil erosion risk, on single plots, i.e. uniform and comprehensive for the agricultural area [30].

III. METHODOLOGY

In this work we are using spatial database integrated with GIS for an intelligence decision support system. A decision support system has four major components: Data Management System, Model Management System, Knowledge based system, User Interface system.

The data management system works as spatial database, which includes POSTGIS queries to create and manipulate the database objects. PostGIS adds spatial functions such as distance, area, union, intersection, and specialty geometry data types to the database.

The model management is used to generate new models on a geographical area, as buildings, malls, etc. In this work, we are searching the type of organization suitable for the specified geographical area. So, the model management is less efficient here. After deciding the type of organization, we can use this module.

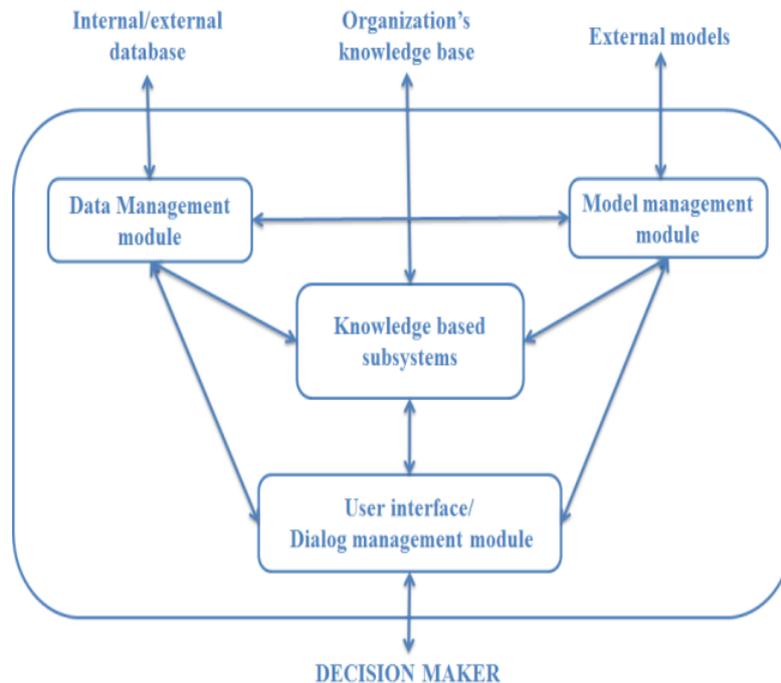


Figure1. Decision Support System

The knowledge based sub-system is the core part of any decision support system. It contains the overall logical part for supporting to take a decision. The knowledge database is connected with spatial database, model management system and user interface. The user interface provides the result to user. Functioning of various modules in our work is in following manner.

A. Spatial Database

The database contains overall surrounding of that particular geographical area as boundary, railway track, roads, drainage system, ground water level, slope, villages, geomorphology and lithology. Numerous queries are required to find the right result, from the databases created for storing the information of all the objects of that particular area. For spatial databases the POSTGIS queries are used. Some queries, which are used in our works, are as follows.

1) To find the length of roads fully contained within each municipality, the query is:

```
SELECT m.name, sum(ST_Length(r.the_geom)) / 1000 as roads_km
FROM bc_roads AS r, bc_municipality AS
WHERE ST_Contains (m.the_geom ,r.the_geom)
GROUP BY m.name
ORDER BY roads_km;
```

Here bc_roads is a table having information about roads and bc_municipality is a table having information about municipality.

2) To find total crossing on a road, the query is:

```
SELECT distinct_crosspoints.geom as crossing, array_agg(roads.gid), count(*)
FROM
(SELECT DISTINCT (geom) geom
FROM
(SELECT ST_Intersection(a.geom, b.geom) geom
FROM roads a, roads b
WHERE ST_Intersects(a.geom, b.geom)) all_crosspoints ) distinct_crosspoints, roads
WHERE ST_Intersects(distinct_crosspoints.geom, roads.geom)
GROUP BY distinct_crosspoints.geom;
```

3) To find total railway tracks:

```
SELECT lines.route, Round (100.0*Sum(popn_white ) / Sum(popn_total),1)AS white_pct,
Round(100.0*Sum(popn_black)/ Sum(popn_total),1)AS black_pct, Sum(popn_total),1)AS popn_total
FROM nyc_census_blocks AS census JOIN nyc_subway_stations AS subways
ON ST_DWithin(census.geom, subways.geom, 200) JOIN subway_lines AS lines
ON strops(subways.routes, lines.route)>0
GROUP BY lines.route
ORDER BY black_pct DESC;
```

Table 1. Spatial database for railway tracks

Sr. No.	Area covered by railway tracks	Nearby Station	Nearby Destination	Train no.
1	500 km	Dausa	Jagatpura	14567
2	200 km	Niwai	Durgapura	56231

Table 2. Spatial database for roads

Sr. no.	National highways(if any)	Length of route	No. of crossings	Nearby toll booth
1	NH-8	5 km	3	Dausa
2	NH-8	2 km	1	Ajmer

Table 3. Geographical objects on an area

Sr. No.	Type	Area covered
1	River	5000 meter
2	Hill	50 meter
3	Forest	16Meter

B. Knowledge Database

It is the important part of our system which makes decision. The system find outs the fertility of soil ability of water, type of census, requirement of industry, type of organization which will beneficial for the specified area. The knowledge database contains the condition required for establishing any organization such as:

- 1) For the establishment of a hospital, the basic requirements are-
 - a) Main road connectivity
 - b) No river is surrounding
 - c) Less populated
 - d) No railway track nearby
- 2) For the establishment of an Industries, the basic requirements are-
 - a) Multiple boundaries from other cities with the area
 - b) Lesser populated
 - c) River nearby
- 3) The conditions for establishment of a School are-
 - a) Good population
 - b) Less number of road crossing
 - c) No railway track nearby

The Decision support system works on predicate condition to generate the decision as-

IF (Road_connectivity = Main_Road)

AND (River_surrounding = 0)

AND (Population < Thousand)

AND (Railway_track = 0)

THEN

organization = 'Hospital';

ELSE IF (Boundary_city > 4)

AND (Population < Thousand)

AND (River_nmbr ≤ 2)

THEN

organization = 'Industry';

ELSE IF (Population > Thousand)

AND (Road_Crossing ≤ 2)

AND (Railway_track=0)

THEN

organization = 'School';

These are the some predicate logics used in our work.

IV. CONCLUSIONS

Any geographical area and its surroundings affect the upcoming organization on that area. To establish an organization, the complete knowledge of that location must be known. Sometime it becomes very difficult. An intelligent system is required to focus on all the affecting factors for establishment of an origination on any geographical area.

The proposed work is helpful in following ways:

1. It includes those factors which really affects an organization.

2. It uses both the knowledge database and the spatial database, one provides the knowledge about the location and another provides the situation of particular geographical area.

3. The decision support system has all the logical options for each type of organizations as schools, hospitals, etc.

The work carried by us provides a better vision for establishment of a new organization on any selected geographical area.

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