

CHAPTER - VII

SPATIAL DECISION SUPPORT SYSTEM - DEVELOPMENT

7.1 SOURCE OF SPATIAL DATA

7.2 WORKPLAN FLOW CHART

7.3 SYSTEM DEVELOPMENT

CHAPTER – VII

SPATIAL DECISION SUPPORT SYSTEM DEVELOPMENT

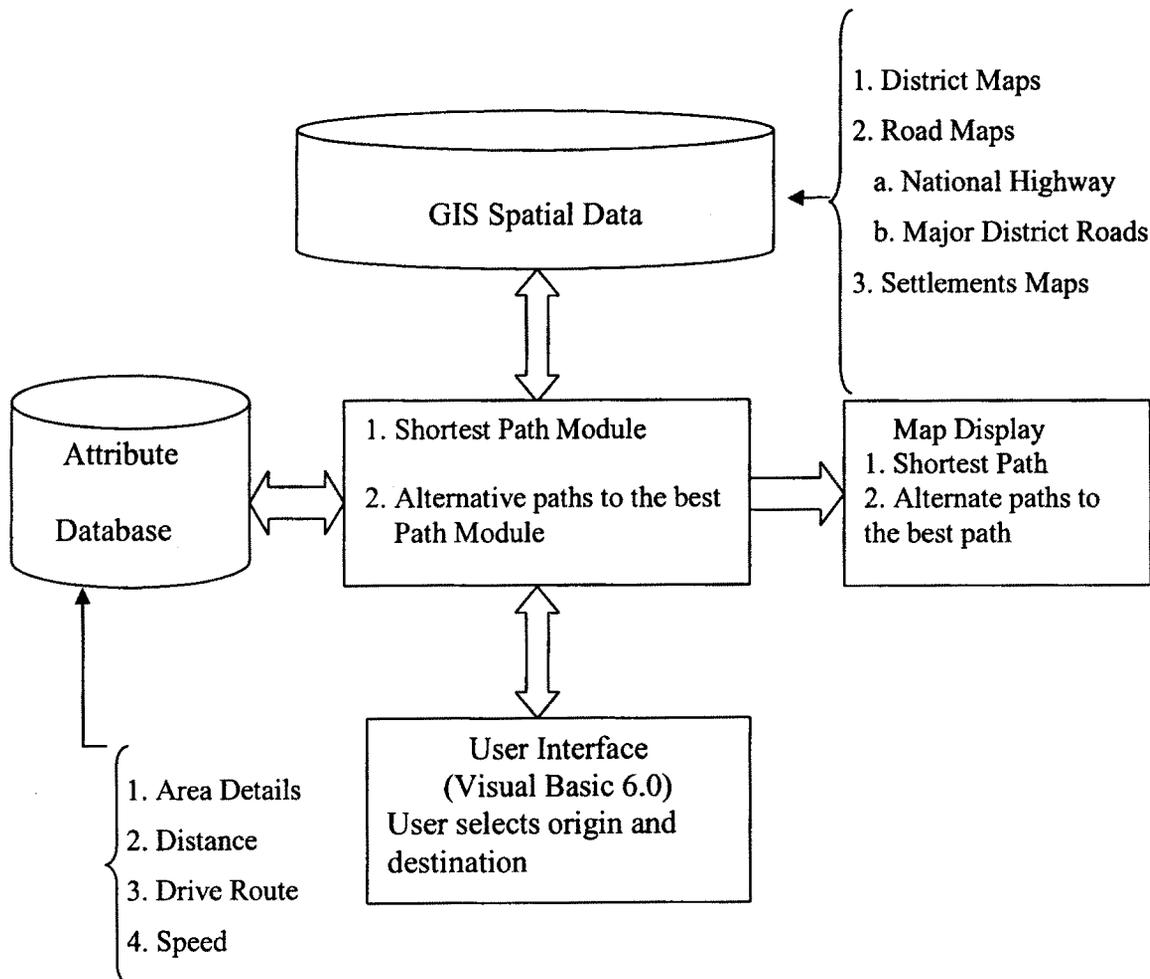


Figure 7.1: GIS Application for Route Generation

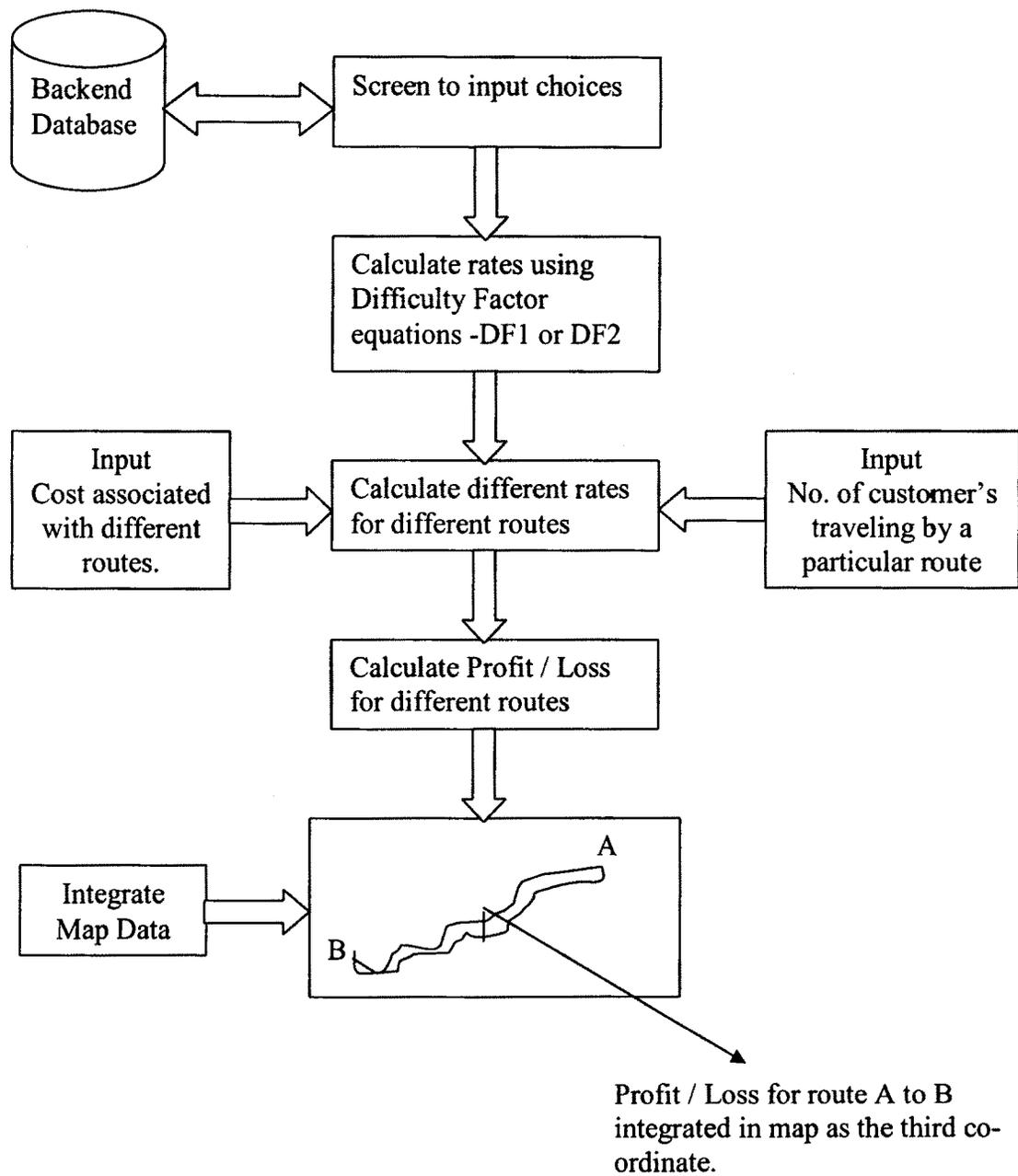


Figure 7.3: GIS Based Decision Support System for Differential Pricing

7.1 SOURCE OF SPATIAL DATA:

Spatial data can be obtained from various sources viz.;

1. Topographical and Cadastral Maps.
2. Satellite Imagery
3. Existing GIS Data
4. Digitizing
5. Global Positioning Systems (GPS)
6. Aerial Photographs, Air Photo Interpretation and Digital Photogrammetric Mapping

7.1.1 Topographical and Cadastral Maps:

Maps are the traditional method of storing analyzing and presenting spatial data. Map is regarded as a means of spatial information transfer. As spatial data is represented in the form of point, line and polygon, the scale of the map plays an important role. Smaller the scale of map lesser will be the amount of details and vice-versa.

7.1.2 Satellite Imagery:

Satellite imagery can also be used as important source of spatial data. Satellites use different sensor packages to passively measure the reflectance from parts of the electromagnetic spectrum or radio waves that are sent out from an active sensor such as radar.

Remote sensing includes all information collected from sensors, which are physically separate from the object. Remote sensing is concerned with deriving

information about earth's surface using an elevated platform, to produce such information as satellite data or aerial photography. Remote sensing allows the measurement and monitoring of surface electromagnetic variation, and as such this data provides a unique way of viewing the landscapes.

Satellite remote sensing has the ability to provide complete, cost-effective, repetitive spatial and temporal data coverage, which means that various phenomena can be analyzed synoptically, and such tasks as the assessment and monitoring of land condition can be carried out over large regions. There are four important aspects of satellite imagery:

1. Spatial Resolution
2. Spectral Resolution
3. Temporal Resolution
4. Extent

7.1.2.1 Spatial Resolution:

Spatial resolution refers to the smallest spatial element that can be sensed, or "resolved", by the satellite these elements are commonly referred to as pixel.

7.1.2.2 Spectral Resolution:

The visible portion of the electromagnetic spectrum is the portion humans are capable of seeing; that is red, blue and green (RGB) light. Whenever photographic film is capable of capturing only the visible and near infrared portions of this spectrum, satellite data from the near and mid infrared portions

the electromagnetic spectrum allows GIS users to finely differentiate such things as vegetation types.

7.1.2.3 Temporal Resolution:

Temporal resolution defines when and how an image of a particular area is captured, existing satellite systems typically pass over an area every 3 to 16 days. The new satellite system will be able to image a given area from as often as twice everyday to once every three days there by increasing the temporal resolution of the available satellite imagery.

7.1.2.4 Extent:

It is the amount of area captured in one satellite image.

7.1.3 Existing GIS Data:

One method of building a GIS database is to simply purchase a GIS data, which another entity has collected. Existing digital map data can be purchased for much less cost than creating it. Many GIS programmers are attracted to this approach of buying GIS data not just that it lowers the initial cost but also helps the programmer produce visible results quickly.

7.1.4 Digitizing:

Digitizing is the tracing of information from analog format, such as paper map, to digital format, so that it can be stored and displayed with a computer. Digitizing can be manual, semi-automatic (automatically recorded while manually following a line), or fully automatic (line following).

Manual digitizing involves an operator using a digitizing table (or tablet). The digitizing table has a fine grid of wires embedded in it acts as a cartesian coordinates system. The procedure involves tracing map features in the form of points, line and polygon with a mouse which relays the coordinates of each sample point to be stored in the computer. Now a day's user scans the paper maps and captures it as a raster image and then using the digitizing tools available in the GIS software or AutoCAD software, digitize the raster image into digital format.

7.1.4.1 Geo-referencing:

Raster data is obtained by scanning maps or collecting aerial photographs and satellite images. Scanned maps don't usually contain information as to where the area represented on the map fits on the surface of the earth thus the image needs to be aligned or geo-referenced. The location information delivered with aerial photos and satellite imagery is often inadequate to perform analysis or display in proper alignment with other data. Geo-referencing is the process of establishing the relationship between an image (row, column) coordinate system, called image space, and a map (x, y) coordinate system, called map spaces.

Geo-referencing image is an important step for overlay technique and to digitize maps after published paper maps. To be integrated into GIS, a non-geo-referenced image like satellite image or scanned paper map image must be converted from image space to map space. The image needs to be registered to

a set of coordinates that are in map space. The parameters necessary to register can be determined in two ways,

1. By extracting them from the information that accompany the image,
or
2. By using a geo referencing tool like GPS to transform the image coordinates.

Depending on the means of collection, images can exhibit a variety of spectral and geometric distortions. Image processing technique like rectifying and rubber sheeting can be used to correct many types of distortions.

7.1.5 Global Positioning Systems (GPS):

One alternative to traditional manual digitizing is the use of GPS survey technique. The GPS satellite circles the earth twice a day, 10,900 miles above the earth. There are 24 satellites in the GPS constellation. Twenty-one satellites can be called on at any time; the other three are spare in case one of the others becomes unhealthy.

GPS collects individual points, lines and areas in any combination necessary for mapping. With GPS one can create complex data dictionaries to accurately and efficiently collect attribute data. This makes GPS a very effective tool for simultaneously collecting spatial and attributes data for use with GIS.

7.1.6 Aerial Photographs, Air Photo Interpretation and Digital Photogrammetric Mapping:

Aerial photographic interpretation has been the most widely used form of remote sensing for environmental applications to date, with techniques being well established. This wide use stems from the availability of aerial photographs, and the fact that they can provide very high spatial resolution data.

Photo interpretation involves a human analyst viewing an image, and extracting information. The success of this technique is highly dependent on the analyst effectively exploiting the spatial, spectral and temporal elements present in the image.

Digital photogrammetric mapping uses digital images of a pair of overlapping photographs and operator uses special 3D glasses to digitize (x, y, z) coordinates of feature

7.2 WORK PLAN FLOW CHART:

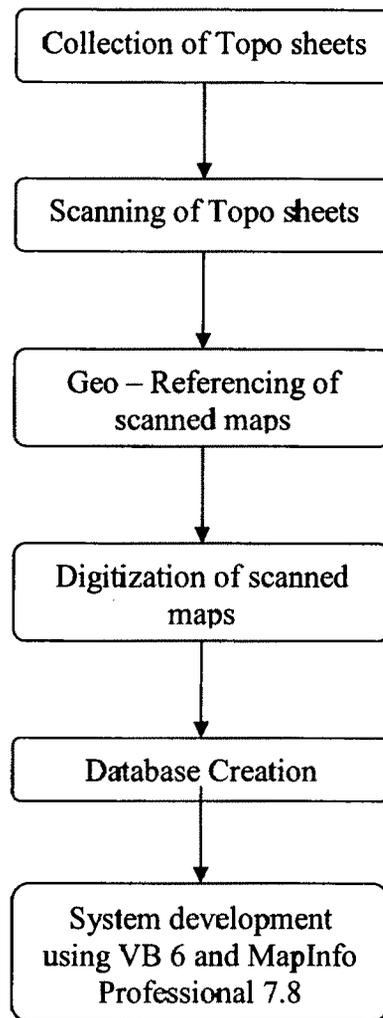


Figure 7.5: Flow Chart

7.3 SYSTEM DEVELOPMENT:

The SDSS is developed using Visual Basic 6 as the front end tool. All the spatial and attribute data is stored in MapInfo Professional version 7.8, which acts as the back-end tool. Shortest path and Alternate path module has been developed using the routing algorithm developed by Dijkstra. Each of the components involved in the system development are discussed below:

7.3.1 Visual Basic 6.0 as a Front – End Tool:

With Visual Basic, the program is written by assembling the objects that will be used for screen display and interacting with the user, adjusting the properties of those objects, determining which event should be responded to, thinking through the variables needed for holding data and for passing information from one part of the program to another, and writing the command lines that will run when events are activated. At each stage of development, any aspect of the program may be added or changed.

7.3.1.1 Components of Visual Basic:

The main components of Visual Basic project are Forms, Controls, Module, Project and Procedure.

The form is the central display unit in visual Basic. It is a window on which controls to create screen or printer display with associated properties, events and methods pasted. Controls are the objects ranging from labels, for display of text, picture boxes for graphic images, buttons, check boxes, dropdown lists and other menus, to file management utilities and spreadsheet style grids. They are objects associated with forms, with their related properties and methods.

Modules are the collection of sub-procedures or sub-functions whose code can be reached from any form in the program. There may be several modules in one program and each is saved as a separate file with a .BAS extension.

The projects are collection of forms, modules. Project file has .MAK extension. The ultimate goal of any programming project is to provide a usable and useful executable application. The user would be able to launch the program directly from windows without having the Visual Basic software in the system. An executable file is a window based application with an .EXE extension that can run outside the Visual Basic development environment.

7.3.2 MapInfo Professional 7.8:

Among several GIS systems, MapInfo is commonly used. Factors such as lower hardware requirements, easy to learn and master, high quality and low cost makes MapInfo become a popular system. MapInfo Professional provides data visualization, including step-by-step thematic mapping and three linked view of data that is Maps, Graphs and Tables. MapInfo Professional supports raster map registration and imports a variety of standard raster formats and vector formats. Maps can be digitized to create vector images and edited using several functions.

MapInfo Professional can be visualized to create thematic maps using ranged shading, bar charts, pie charts, dot densities, graduated symbols and individual values. Range classification of maps can be based on equal count, equal range, inflection point, natural break, standard deviation, quartile and user defined. Thematic option can be combined to create maps that display multiple variables from many tables. Thematic joints can be based on count, sum, value average, weighted average.

This software provides multiple data view, user can overlay various projections and convert between projections. It also supports geo-coding to street address, locations and user-defined match options. MapInfo supports standard mathematical, statistical, logical, measurement, conversion, sorting and aggregation function. It provides direct access to spreadsheet and database data. It supports geographical queries to remote database server containing point data. New maps or tabular database can be created based on new information or results of queries and edits. MapInfo Professional provides tools for managing database fields. MapInfo can also generate HTML image maps that can be included in web pages.

7.3.3 Routing Algorithm:

In a shortest path calculation from an origin to a destination the route with the lowest overall impedance is selected. Impedance can be defined in terms of distance, travel time, speed, or generalized cost. There are a number of shortest path algorithms that have been developed. They differ in terms of whether they are breadth –first (i.e., search all possibilities) or depth –first (i.e., go straight to the target) and whether they examine a one-to-many relationship (i.e., from a single origin node to many nodes) or a many-to-many relationship (All pairs; from each node to every other node).

One of the best algorithms to find the shortest path is the Dijkstra³ Algorithm, which determines the shortest distance from a specified vertex to a final vertex. The algorithm searches all possible paths. But it builds the path one segment at a time. Starting from an origin it identifies the node that is nearest to it and which has not already been identified on the shortest path. After each node has been identified to be on the shortest path, it is removed from search possibilities. The algorithm proceeds until the shortest path to all nodes has been determined. That is the algorithm repeatedly performs the following steps:

1. It starts by determining the direct distance from specified vertex (V1) to all other vertices.
2. It picks the smallest of these (let V1 to V2) as a permanent shortest distance.
3. It adds this smallest distance to the length of the edge from the new vertex (V2) to each other vertex.
4. It compares the sum with the previous distance from V1 to each vertex and it updates the old distance if the new distance is smaller.
5. The new vertex V2 is then removed from the list of those vertices, the shortest distance to that have not yet been determined. **In this application, the shortest path is by distance.**

Great numbers of algorithms have been developed for finding the “Shortest” or the “Best”, where the best can be defined in terms of time, cost, distance, or some combination of the three. Many of these algorithms have been and are

3. Dijkstra's algorithm is of use when working with directional graphs. It constructs the shortest path between a starting-node and a goal-node. It is assumed that every link between two nodes has a certain cost or distance, and this algorithm finds the path between the two given nodes with the lowest cost or distance.

being used in Advanced Traveler Information Systems (ATIS) and Advanced Traffic Management Systems (ATMS).

While these algorithms are quite useful in ATIS and ATMS, they are often not sufficient. In particular, there are many situations in which it is necessary to generate alternatives to the shortest or best path. In pre-trip planning, for example drivers often want to be provided with one path for their outbound trip and an alternative path for their return. Another example could be users of in-vehicle guidance systems often wants to be provided with several alternative paths that they can use to avoid particular facilities. Alternate paths allows a user to prefer a particular path because of light traffic, few boulevard stops, etc. or avert using a particular path because of frequent delays , high tolls, etc. Further the shortest path need not necessarily result in shortest time. This is true because the shortest route may be narrow in width, or it may have higher volume of traffic, or more number of traffic signals or more number of turns.

In view of the above statements it is important to find the alternatives to the best path from a given origin and destination. Each alternate route between an origin and a destination is generated, using the same method employed to obtain the initial least- distance route (i.e., by applying the Dijkstra algorithm), after first discouraging re-use of most street segments used by the least distance route and all previously generated alternate routes. The method for discouraging re-use is to artificially inflate the costs (distance) associated with using those previously-used street segments⁴.

⁴ See Annexure B for details.