Application of GIS In Oil and Gas

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Ashish Garg

U.P.E.S

Certificate of Originality

This is to certify that the dissertation report on "**Application of GIS in Oil and Gas"** submitted to the *University of Petroleum & Energy studies*, New Delhi by **Ashish Garg** (Regd No:R060104004) in partial fulfillment of the requirement for the award of the degree of **Masters of Technology (Petro Informatics)**, is a bonafide work carried out by him under my supervision and guidance.

Place: New Delhi

Date:

Mousumi Dasgupta

Ms Mousumi Das Gupta

Associate Program Director M.Tech (PI)

Objective of My Research

- To develop Online Audit System for BPCL Terminal
- Using GIS Software Presentation of Terminal efficiency
- Locate different companies Retail Outlet at different location.
- Route Optimization for Oil Tankers.

The objective of this study is to provide a on line audit system for BPCL as such there is no online system available in the market. Using this online audit system company can conduct audits at regular interval of time and keep monitoring their process, operations and health safety and environment regulations. This solution can also be useful in Survey of different retail outlet about their safety standards and product handled.

In proceeding with the study we made a random survey of different Retail Outlet in South Delhi. We also collected Information about different safety regulation applied by terminal and retail outlet. Study focused on the Monitoring of Product Handling and mapping of different outlet as well as different terminals.

Abstract

The Management of natural resources requires the integration of very large volumes of information from numerous sources. The information technology, and in particular, the integration of database management system, GIS, remote sensing & image processing, simulation & multi criteria optimization models, expert systems and computer graphics provide effective tools for decision making.

Most environmental and resource management problems like movement potential, natural & manmade hazard zonation, flooding potential, environmental studies, disaster management etc., have an obvious spatial component. Within the domain of environmental modeling this is addressed by spatially distributed models.

The multifaceted nature of many terrain problems needs access to a range of models, data and other information. Modeling allows prediction of an expected future state. Modeling and simulation provide a rapid means of investigating the expected response of a system to possible future changes by undertaking the necessary computation which are commonly complex and Data intensive.

The necessity to integrate simulation models of this kind of spatial process with GIS technology is well recognized. These integrated systems offer a virtual environment where user can assess the scenario and evaluate various strategies.

CHAPTER 1 # Introduction

INTRODUCTION

1.1 What is GIS

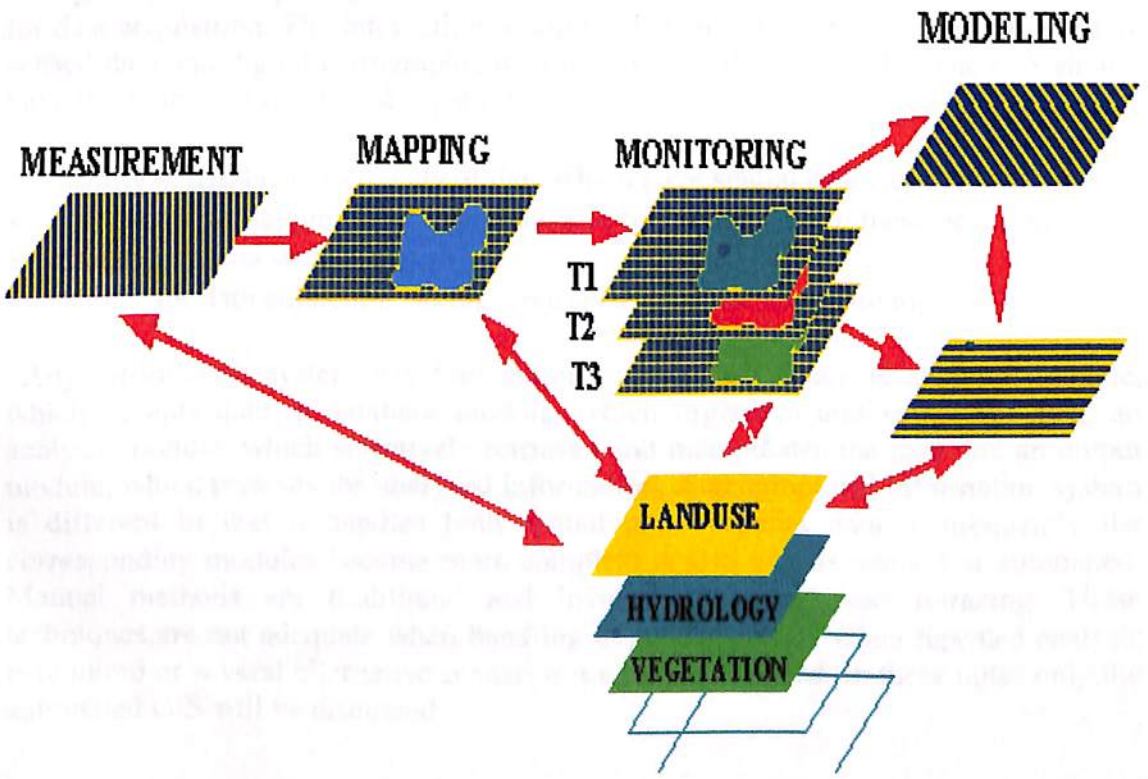
1.2 Data Modeling

1.3 Components of GIS (Hardware & Software)

6.1 *What is GIS*

Geography is the science of spatial relationships. Maps form a major constituent of geography as they are a means of representing very large spatial relationships in a physically handle-able size. Cartography, the science of map making, is a technology for the organization of geographical information into a map. However a map by itself is of no value unless it is put to use. The traditional uses are many. Navigation, delineation of property boundaries and ownerships, and civil engineering are a few of the commonly known applications. This scenario of applications is, however, rapidly changing. The need for environmentally benign and socially accountable development has put a heavy demand on the capabilities of planners. Therefore planning and execution now require more accurate, reliable and timely information and better tools for the management of such information.

Consider for example the sitting of a steel plant. In classical engineering terms the location of the Tata Steel plant at Jamshedpur is often quoted to engineering students as the best positioning from the point of view of raw materials availability. Today, however, there are many more factors to consider. The environmental impact assessment is a major issue. How much forested area will be lost, nearness to habitations, effect on wildlife, impact on the local population are some of the myriad issues to be addressed. This requires not only a variety of maps but a large amount of spatial information, commonly known as statistics, and the tools to handle these complex data sets and to selectively extract relevant information. It can be easily understood that an enormous amount of effort goes into any spatial management activity. These can be classified as:



Measurement

This represents the acquisition of data. Survey of natural resources, inventory of land holdings, measurement of pollutants, record of traffic flow are some examples.

Mapping

The acquired data has to be processed to yield intelligible information. For spatial data this involves the representation of the measurements in their spatial context.

Monitoring

This represents the preliminary analysis which involves the time dimension. Tracking land use changes, forest working plans, land records, municipal plans, and utility maintenance are some examples.

6.2 Modeling

This involves efforts to represent a spatially related real system for the purpose of analyzing and understanding reality; to make predictions and decisions about the system and finally to control the system. Models help rational decision making, strategic analysis and decision support. Modeling helps reduce cost of implementation.

These activities can be organized very efficiently using a tool such as a GIS which integrates hardware, data entry systems, database management, analytic software and cartography in one package. Today, remote sensing provides another powerful tool for data acquisition. The integration of digital thematic maps prepared from remotely sensed data and digital cartographic data is elegantly done in a GIS. The GIS should have the following functional capabilities:

- Ability to handle a large body of data which have spatial or location properties.
- Ability to handle numerical expressions of relations between these data sets
- A common data structure
- Ability for data collection, storage, retrieval, analysis and mapping

Any information system has four major components. There is an input module, which accepts data, a database module, which organizes and stores the data, an analysis module, which selectively retrieves and manipulates the data and an output module, which presents the analyzed information. A geographical information system is different in that it handles both spatial and a spatial data, consequently the corresponding modules become more complex. A GIS can be manual or automated. Manual methods are traditional and involve overlaying and retracing. These techniques are not adequate when handling large data sets or when repeated analysis is required or several alternative scenarios are to be generated. In these notes only the automated GIS will be discussed.

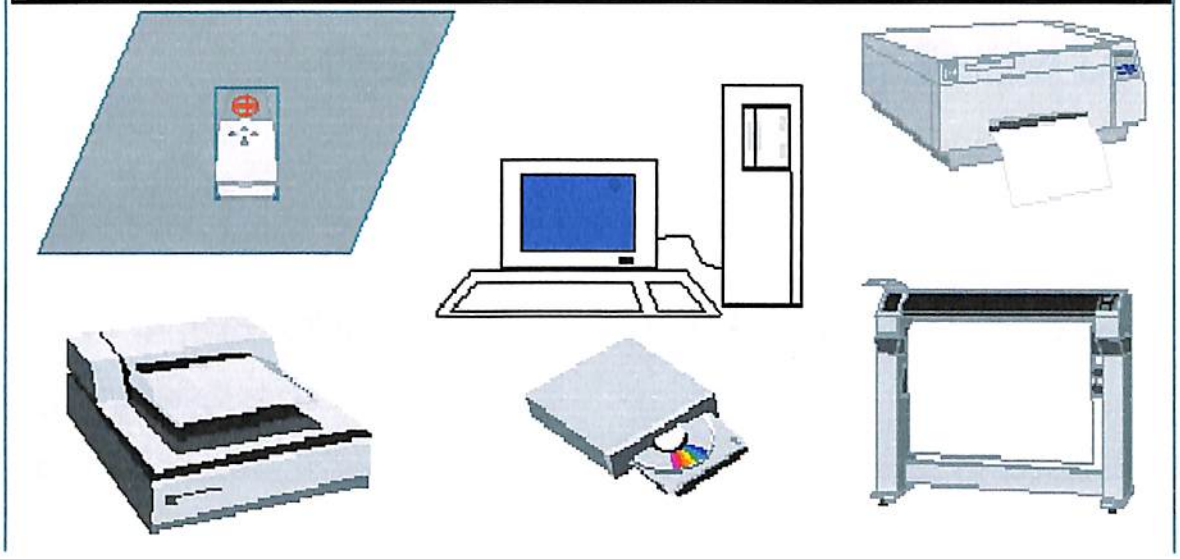
Geographic Information Systems are classified in several ways. They can be grouped by scope and objectives, type of organization, administrative hierarchy, discipline involved, data structure, programming language, type of users and inherent methodology used by the system. There can be overlaps in these classification systems. Further, in the process of evolution a GIS can move from one class to another. Many people have attempted to arrive at a broad functional definition, which encompasses all these systems. In general, a GIS can be considered to be a computer-assisted system for the capture, storage, retrieval, analysis and display of spatial data.

Alternatively, we could describe **Geographic Information System (GIS)** as a system which provides a computerized mechanism for integrating various geo-referenced data sets and analyzing them in order to generate information relevant to planning needs in a given context.

6.3 GIS Software Components

Subsystem	**Components**			
Input	Digitizing	Editing	Transformation	Import
Storage	Format	Size	Medium	Data-Structure
Retrieval	DBMS	Where-is-this	What-is-This	
Analysis	Overlay	Proximity	Connectivity	3D
	Spatial		Non-spatial	
Output	Display Devices		Cartography	Diagrams
Management	Evaluation	Selection	Organization	Info Use

GIS Hardware Components



Digitizer Scanner **Processing Storage** **Printer Plotter**

CHAPTER 2 # Petroleum Industry – Production and Refining Sector(Upstream)

Petroleum Industry -Scope of GIS Integration and Applications

2.1 Petroleum Exploration

2.2 Field planning and development of Oil and Gas Reservoir

2.3 Managing Facilities

2.4 Pipeline Management

Petroleum Industry – Scope of GIS integration and Applications

The word "Geography" though not used often by us in our daily life, but its presence, reference and value has become an integral part of our activities in the way we do business, the way we communicate, the way we manage our resources and the way we live.

Our realization on the importance of Geography in our activities have led into the development of a full fledged Information system supported by cutting edge technology and research work undertaken by various organizations to bring in this power of "Where" to our life and business.

As we see in recent days technologies are converging in a rapid rate and the utilization of GIS technology by multiple disciplines across the organization is a common process to expand business and reach out to more customers providing quality service. We are into the age of Enterprise Wide GIS, which helps to solve

- Business problems
- Automate Business processes
- New ways to analyze business and spatial data

Petroleum Industry – Need of Integrated Business-GIS

The use of geography in analyzing and making decisions is not a new thing in the oil and natural gas industry. A good understanding of geography is required in every step of a petroleum industry starting from locating a place to drill a well, route a pipeline from the exploration site to the refinery plant, finding an ideal location for a refinery and lot more. And all these procedures t rely heavily on geography in order to make intelligent business decisions.

The convergence of GIS and other technologies specially Relational Database Management Systems (RDBMS) with the support of spatial information via spatial cartridges has opened a new era which will allow to manage the spatial components of these everyday petroleum "business objects," such as leases, wells, pipelines, environmental concerns, facilities, and retail outlets, in the corporate database, and apply appropriate geographic analysis efficiently in a desktop-focused application.

Petroleum Industry -Scope of GIS integration and Applications
Petroleum Industry can be functionally divided into 2 categories.

1. **Production and Refining Sector.**
2. **Retail Outlet Management and Distribution Network.**

Production and Refining Sector

This involves the process of exploring new locations as petroleum reserves, managing the production of crude petroleum from earth strata, managing the pipeline network to transfer crude sources to refining plant and facility management of various resources connected to such a huge industry.

2.1 Petroleum Exploration

Discovering new sources of petroleum ahead of the competition is one of the keys to staying successful in the petroleum industry. While the application of GIS is relatively new to the world of petroleum exploration it will no doubt prove to be an invaluable tool. An efficient GIS can help to evaluate the potential for oil in promising locations. One of the biggest benefits of GIS programs is the ability of these programs to do analysis. Petroleum exploration is a very complicated field dependent on a multitude of variables, because of this the analysis capabilities of GIS programs will surly be able to lower the cost of petroleum exploration by analyzing the potential of petroleum being found at a potential location and also the potential yield of an oil field. GIS programs are also used to monitor the condition and flow of pipelines and determine the best locations for the pipelines used to transport the oil out of the fields and to the refineries.

Exploration requires the analysis of a lot of different types of data such as satellite imagery, digital aerial photo mosaics, seismic surveys, surface geology studies, subsurface and cross section interpretations and images, well locations, and existing infrastructure information. A GIS can tie these data together to the location in question and allow you to overlay, view, and manipulate the data in the form of a map to thoroughly analyze the potential for finding new or extending play potential.

In recent years, the significant increase in performance and decrease of prices of the personal computer (PC) platform has accelerated the growth of geographic information system (GIS) usage. GIS is a very dynamic technology enabling the user to display a map of any location in the world and rescale that map instantaneously. The key to the success of any exploration or exploitation team is the integration of the members, the database, and the multiple software functions. GIS is a particularly effective means of providing functionality for all of the disciplines represented on the team. GIS cannot replace all existing software applications, but it can be used to integrate and link other programs. Although GIS can be effectively applied in various petroleum industry settings, its use in exploration and exploitation is of particular interest. One specific exploration application involves the creation of reconnaissance maps. Uses of GIS in exploitation projects are perhaps more varied because exploitation evaluation typically deals with more extensive data sets than those typically used in exploration settings. Exploitation approaches are generally applied to mature producing areas where well control is dense, whereas exploration projects may not involve any wells at all. GIS is a particularly effective technology that enables exploration and exploitation teams to share information, analyze data in new ways, and integrate the evaluation process.

A geographic information system (GIS) is a powerful technological tool that can be used in the problem-solving process facing any exploration and exploitation team. A GIS can provide the team with a whole new way of analyzing, visualizing, and integrating data. GIS technology is now available across all computer platforms, including the Internet. In recent years, its cost has decreased significantly, whereas functionality has been dramatically enhanced. GIS can specifically benefit exploration and exploitation teams in the following ways: sets through the use of symbology

THE BENEFITS OF GIS

A geographic information system (GIS) is a powerful technological tool that can be used in the problem-solving process facing any exploration and exploitation team. A GIS can provide the team with a whole new way of analyzing, visualizing, and integrating data. GIS technology is now available across all computer platforms, including the Internet. In recent years, its cost has decreased significantly, whereas functionality has been dramatically enhanced. GIS can specifically benefit exploration and exploitation teams in the following ways:

- Integration of the contributions of various team members through cross-discipline

  Interpretation and software functionality
- Provision of new methods for visualizing data sets through the use of symbology
- Dynamic mapping of digital databases
- Presentation of data in various forms, such as maps, charts, data tables, and query results
- Sharing of, integration of, and access to centralized databases via computer

  networks or the Internet
- Linkage of multiple software applications
- Technology use across multiple computer platforms
- Enhanced portability of technology and data via laptop and handheld computers
- Proliferation of new tools, which are affordable and easy to use

GIS is a very dynamic technology, and it enables the user to display a map of any location in the world and to rescale that map instantaneously. Interpreters can zoom into a specific area of interest by simply defining the four geographic coordinate boundaries of the map. GIS and digital map data sets create a dynamic combination whose functionality is unlimited in their combined Capabilities.

Symbology is a classification method used in GIS to represent data or individual map features as varying sizes, thicknesses, colors, or styles. In any GIS, there are three types of data: points, lines, and polygons. Each type of data can be represented by different types of symbology. Color, size, and style can represent point data, such as well locations. Color, thickness, and style can represent line data, such as pipeline locations. Polygon-fill color or style can represent polygonal data, such as offshore block boundaries.

APPLICATIONS OF GIS

As previously noted GIS can be used in both the Processes and applications of the technology will vary depending on the task or project and on the type and size of the databases involved. Although GIS can be effectively applied throughout petroleum industry settings, its implementation in exploration and exploitation is of particular interest.

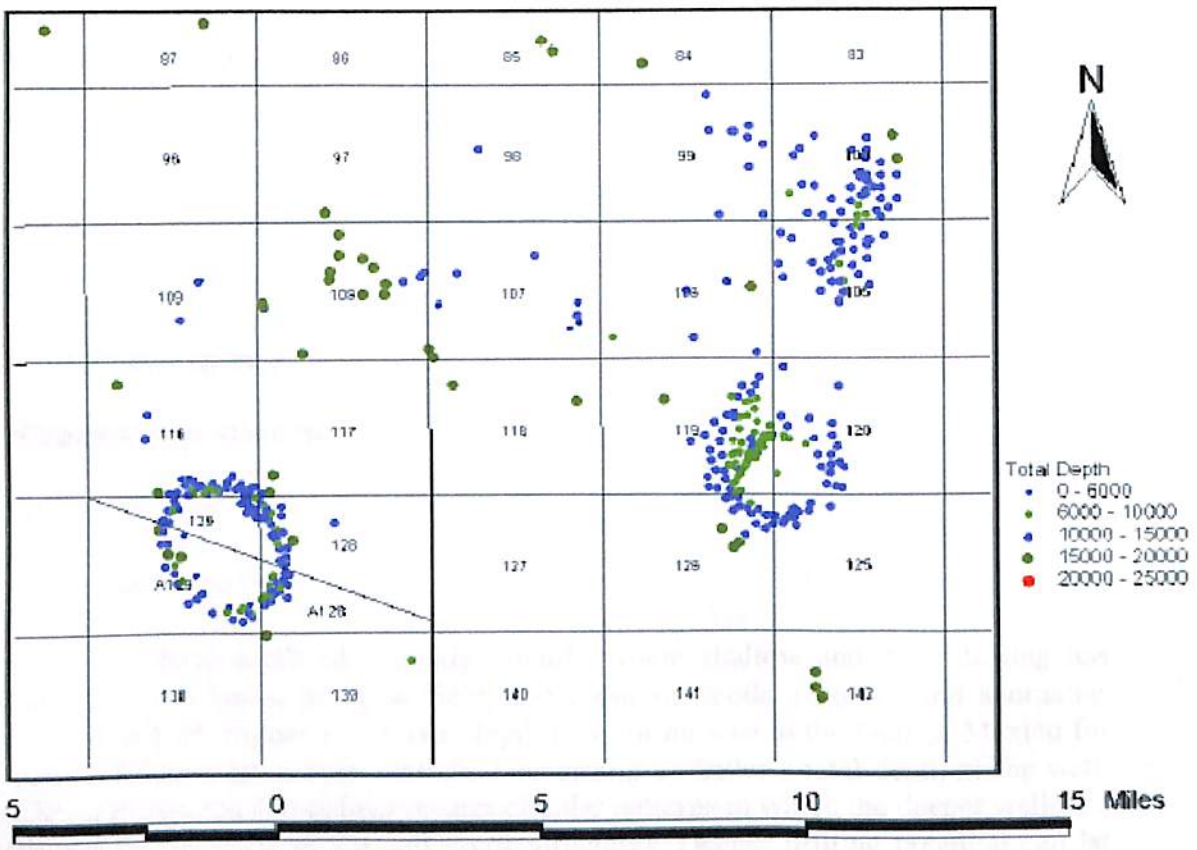


Figure 1: A Gulf of Mexico base map of wells classified by total depth drilled

Exploration Applications

GIS is a powerful tool for petroleum exploration, particularly with regard to exploration mapping. Such mapping is usually performed across large geographic areas, where many data sets or map layers are used in the analysis of hydrocarbon potential. Raster data, such as aerial photos or satellite imagery, can be incorporated with vector data, and surface culture, such as hydrography, elevation contours, and topographic landmarks or points of interest, can be presented. Where appropriate, coordinates from land surveys, such as section, township, and range, can be integrated with well data.

In exploration applications, one of the first steps taken is the creation of reconnaissance maps. Such maps are typically produced relative to the available well or well layers, with the sizes of the well data sets being dependent on the maturity of the area or basin of interest. Reconnaissance maps of mature exploration areas can present distinct trends, patterns, and anomalies.

Maps of the following features and characteristics should be included in the first phase of any exploration reconnaissance mapping program:

- Total depth
- Spud or completion date
- Well operator identification
- Producing formation
- Cumulative production
- Initial potential
- Well classification

A map of total depth can quickly identify where shallow and deep drilling has occurred over a basin, trend, or field, and apparent trends, patterns, and anomalies can be identified. Figure 1 is a total depth map for an area in the Gulf of Mexico for which well layers have been classified according to driller's total depth of the well. In this example, the symbology creates circular patterns in which the deeper wells are indicated on the flank of the salt dome structures. Deeper drilling potential can be identified in between salt dome structures.

Spud date maps represent a chronological history. Figure 2 is a spud date map for an area in northern Louisiana. Using this map, it can be determined when and where drilling has taken place. Such a map is useful when an interpreter has just started evaluating a new trend or basin because it represents a chronological history of the area.

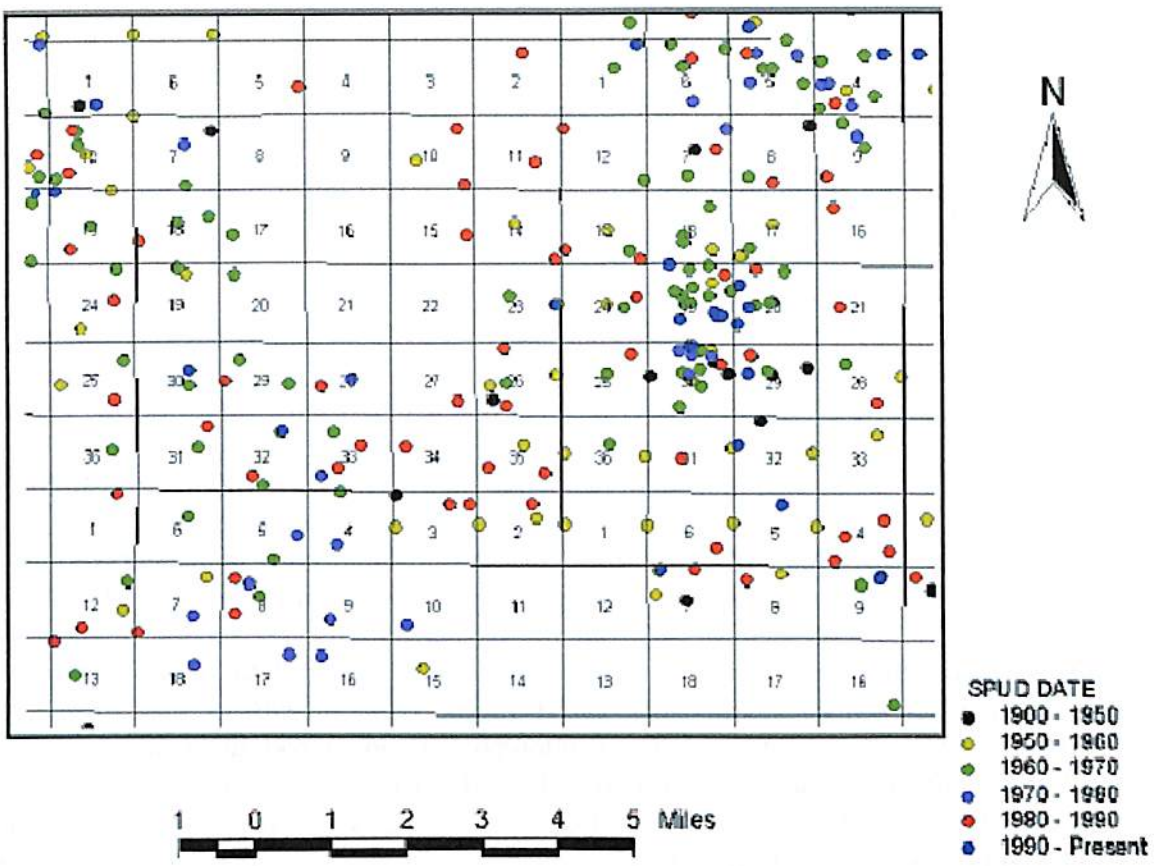


Figure 2: A northern Louisiana base map of wells classified by spud date drilled

Raster data, such as aerial photographs and satellite imagery, can provide powerful backdrops to cartographic map layers consisting of field outlines and well locations. The integration of a raster backdrop enables the interpreter to compare surface expression with the subsurface. For example, digital aerial photographs can be very useful for the design of 3-D seismic surveys when superimposed on a conventional map.

2.2 Field Planning and Development of Oil and Gas Reservoir

To produce found reserves, the company must first understand certain geographic, infrastructure, business conditions, and environmental factors about the area in question. GIS technology is ideally suited to this kind of overlay analysis and can be integrated with other business risk or economic business planning engines to provide a focused business solution toolset.

The activities in advancing a deepwater oil or gas field to production stage are numerous and the interdependency of the activities, complex. Determining how to best extract the discovered fluids from the reservoirs and deliver the products to the market, while minimizing CAPEX, OPEX and risk of failure is critical. A dynamic and time dependent costing and optimization system for field development has been developed that allows flexibility in technical decision revisions, commercial re-evaluation of options available and time value assessment of money. The service combines the application of Geographical Information System (GIS) technology to handle the spatial context of the subsurface, surface and above water field components linked via a GIS Interface to the Cost Model, to facilitate economic evaluation. The Cost Model is in spreadsheet format producing a transparent costing system instead of the more common Black Box model. Multiple field layout scenarios are developed using the available reservoir simulation analysis, drilling constraints, production concerns, facilities requirements and intra-field pipeline architecture. The Cost Model generates costs for each scenario. The flexibility of the system allows sensitivity analysis and what-if investigations to be carried out while evaluating the economic viability of each scenario.

2.3 Managing Facilities

The global nature of the petroleum industry results in an infrastructure that is vast and difficult to manage. A large, integrated oil company must keep track of everything from drilling platforms to pipeline networks to refineries. The commercial, operational, and often harsh environmental conditions in which these facilities exist make it critical that they be planned, operated, and maintained effectively.

Often, finding an economic reserve is as much dependent on a practically and properly implemented facilities structure as it is on the exploration and production itself. Certainly the profitability of a commercial venture is often heavily dependent on the facility and pipeline infrastructure.

GIS can be used to map the gathering and transmission of products to a facility. Once there, integrating with more traditional "in plant" infrastructure management systems, such as CAD, attribute records, and scanned documents, allows the true geographic placement of CAD entities complementing the CAD architecture.

2.4 *Pipeline Management*

The Pipeline network forms one of the most critical and intelligent components of the petroleum industry. The creation and management of a functional pipeline network requires in depth analysis and study of geographical locations, business requirements and managed utilization of resources leading into optimal productions and transfer of crude and refined oil from petroleum reserves to refinery and then to storage units respectively. Competitive pressure and regulatory constraints are placing increasing demands on pipeline operators to operate in an efficient and responsible manner. Responding to these demands requires accessibility to information regarding geographically distributed assets and operations.

GIS can be used in the site location process to minimize impacts to the environment during construction and from accidental release, as well as to lessen the costs of permits and liability risks associated with accidental releases. Ecological variables developed from publicly available spatial data sets can be utilized in this process.

The themes and variables used as input in this process mainly address direct construction costs and pipeline efficiency once the pipeline has been completed. Some of the variables include:

- Shortest distance from source to market
- Least grading (removal of trees, etc.)
- Costs associated with right of way
- Slope of terrain
- Number of stream, road, and railroad crossings
- Substrate (rock, soils, etc., associated with burial)
- Existing laws and regulations (wetlands, etc.)
- Proximity to population centers, etc.
- Utilization of existing utility corridors and easements
- Coverage Analysis

The potential costs of environmental impacts during construction as well as ecological and liability costs that may result from accidental releases after construction also accounts to the cost factor of the petroleum company. Some of these costs can be substantial (potentially millions of dollars) and include:

- Environmental damage
- Litigation and settlement costs
- Environmental response and investigation
- Criminal and civil penalties
- Environmental remediation
- Damage to reputation and community relations

An increasing number of environmental spatial data sets have become available to the general public, offering a great opportunity for companies to avoid these environmental and liability risks with relatively little effort by incorporating them into their normal GIS sitting procedures.

CHAPTER 3 # Retail Outlet Management and Distribution Network (Downstream)

Retail Outlet Management and Distribution Network (Downstream)

3.1 Fleet Management

3.2 Develop Sales Territories

3.3 Locating Optimal position of a New outlet

3.4 Risk and Crisis management

3.5 Route Planning

3.0 Retail Outlet Management and Distribution

This covers the distribution of refined petroleum products from the production center to various countries and finally to the retail units like petrol pumps, gas stations and other petroleum products retail stores.

This is the area where a lot of GIS developmental activities can take place. Retail companies can use the power of GIS systems to optimize their business with intelligent analytical GIS tools and planning tools and provide better customer and outlet services.

3.1 Fleet Management

Organizations with large fleets of vehicles have realized significant return on investment by using GIS for fleet management. Such increased efficiency no longer is limited to Fortune 500-sized organizations. The market has expanded, allowing more small organizations to use GIS-based tools for fleet management assistance. As functionality increases and costs decrease, small organizations in public and private sectors are reaping significant benefits.

Imagine having the daily task of creating routes for an organization with 65 vehicles and 900 stops. You operate the fleet at 90 percent of its capacity, many customers have preferred delivery times, and you only have 60 minutes to complete all routes.

Or perhaps you work for a local agency that needs to modify 50 routes for a "para-transit" operation, picking up and dropping off passengers at multiple locations within a specified time frame. Further complicating matters, your vehicles are small buses that can only carry 12 persons, four wheelchairs or a combination of both, and all passengers have particular ready times and ridership rules. Such troublesome situations are examples of routing puzzles that can be solved using GIS.

Applications Abound Organizations with vehicles that operate within a day's drive of an operating center and typically depart and return on the same day occupy a wide spectrum. Local governments have multiple fleets, including inspectors, technicians, waste-collection crews, para-transit buses, school buses, repair crews, maintenance crews and even prisoner transportation vehicles. Utilities route meter readers and meter re-readers, while the more traditional private sector includes everything from food and beverage distributors to taxis and on-demand couriers.

Software Solution:

ESRI's Arc Logistics Route application can be used for planning daily routes.

Route optimization, automatic vehicle location (AVL) systems, traffic and weather services, in-vehicle mobile devices for route visibility, routing and directions are among the major GIS-based applications in these areas. A digital map can tie the applications together to display, query, interpret and analyze data.

Route Optimization

Route optimization is the routing of multiple vehicles within a fleet, with dozens to thousands of stops, following logical business rules for vehicles and stops. Many low-end routing tools simply sequence a single vehicle's route without considering realistic operating rules.

GIS-based route optimization applications offer fleet managers realistic business rules for vehicles, including items such as operating times, capacities, breaks and operating costs. The software also supports business rules for stops such as order volume, time windows, service time, priority and pre-allocation of stop to driver.

A GIS-based system for route optimization can allow organizations to reduce the number of vehicles, overtime pay, mileage and time spent routing, while increasing productivity. The visualization capabilities of GIS also make vital information easily accessible. Visibility of vehicle locations, activities and costs allows management to analyze operations quickly and accurately.

Route optimization applications meet specific needs according to specific problems. High-density routing, such as meter reading, letter-carrier routes and residential trash pick up, is different from point-to-point routing, such as county inspectors, beverage delivery and para-transit operations.

Vehicle Tracking

Knowing the current status and location of vehicles is essential for many fleet managers. AVL systems have been used for many years, but they have recently come to the forefront as the cost of Global Positioning System (GPS)-enabled devices has reduced and accuracy has significantly increased. Some AVL companies now are offering customers a fully scaleable package that can begin with inexpensive GPS-enabled phones and extend to high-end satellite terminals with ubiquitous coverage.

More than simply tracking vehicle location, AVL systems offer tools such as temperature monitoring of refrigerated trailers, speeding alerts and alerts for just about any vehicle event you could imagine.

Food distributors, in particular, need to know if and when the temperature drops below a critical threshold. Public-works departments operating residential trash routes benefit from knowing the number, time and location of container lifts. And many organizations are scanning material on and off vehicles and transmitting the information with GPS and time data. The ability to capture, monitor and send in real time vehicle-related data in conjunction with location data is proving powerful for fleet managers.

Traffic and weather services are new data input in the fleet manager's GIS toolbox. TeleAtlas recently announced its True Time Maps service that will allow dynamic content such as real-time traffic incidents, speed, weather effects and scheduled events as well as historical information to be added to a routing or tracking system. Historical data may prove particularly useful in calibrating speeds on street segments.

3.2 Develop Sales Territories

Potential users shouldn't have to become GIS gurus to be productive. Powerful development tools in a rapid application development environment afford the opportunity to build exactly the GIS you want. GIS capability can be rolled out to a far greater audience than previously possible.

We develop with ESRI's Map Objects and ArcView GIS. Map Objects is a perfect choice for creating highly focused, light, swift applications, or for embedding GIS capability in an existing application, such as a database or contact manager. ArcView GIS is an excellent choice for creating robust, stand-alone applications which require greater GIS capabilities.

Territory creation/optimization

All too often, sales territories are creating using the easiest possible definitions. "These states, those counties, these reps," might be good enough for your company's sales management goals, but we can help you apply GIS to produce much more realistic, efficient, and productive sales territories.

Consideration should be paid to underlying market potential, competitive activity, workload per sales rep, customer locations, etc. A GIS allows you to resolve these and other realities to produce realistic, results-driven territories

3.3 Locating Optimal Position of a New Retail outlet

Retail Network analysis

Using a variety of data, including store, competitor, and customer locations; as well as demographics, road networks, traffic volumes, and land features, we can work up a full (or partial) analysis of your retail network. The following are available:

- Trade area creation
- Customer and store profiling
- Identification of geographic opportunity pockets
- Merger and acquisition reports
- Competition reports

3.4 Risk and Crisis Management

GIS technology is increasingly being used in spatial decision support systems. In the past few years, GIS emerged as a powerful risk assessment tool and is being put to use to assess risk to property and life stemming from natural hazards such as earthquakes, hurricanes, cyclones and floods. Manipulation, analysis, and graphic presentation of the risk and hazard data can be done within a GIS system, and because these data have associated location information which is also stored within the GIS, their spatial interrelationships can be determined and used in computer based risk assessment models. This assessment can be used by insurance companies to help them make decisions on their insurance policy rates, by land developers to make decisions on the feasibility of project sites, and by government planners for better disaster preparedness.

Risk Assessment

A fundamental principal of Risk Assessment is that risk due to natural catastrophes such as earthquakes, hurricanes and flood, is location dependent, and that it can be assessed within an acceptable range of uncertainty if reliable historical and location specific data is available. Risk assessment of natural catastrophes has two components-hazard and vulnerability. The hazard is a measure of the physical intensity of the peril (earthquake, wind, surge, etc.) at a particular location and the associated probabilities of these intensities. Hazard is location dependent. For example a location which is surrounded by seismic faults and has a weak surface geology has a higher hazard potential than a location for away from faults and with strong surface geology. Similarly, hurricane, hazard at a location near the coast and with a flat, bare terrain is far higher than at a location which is inland and has a rugged terrain.

GIS as a Tool in Risk Assessment

GIS in conjunction with remote sensing and photogrammetry, can be used to identify hazards. Seismic faults and flood prone areas can be identified by scientists using GIS to analyze satellite image, aerial photos and field survey data.

Once the hazards have been identified, their representation can be stored conveniently in GIS databases. The information required for earthquake risk assessment includes the location and properties of seismic faults, surface geology, terrain slope, water table levels and inventories of epicentres and landslide occurrences. For hurricane risk, information on land use, land cover, coastline and distance from coast are important. Similarly topology data is required for flood assessment and storm surge analysis.

In addition new hazard layers can be generated within a GIS by combining hazard layers. For example, a landslide hazard layer can be generated by overlaying elevation, surface geology, water table level landslide inventory data, and liquefaction hazard can be generated in a GIS by overlaying geology with water table level data.

Inventory data can also be stored easily in a GIS database. Data on building stock, liveliness, utilities, etc. can be aggregated into manageable geographic regions such as census wards, pin codes, or larger administrative regions such as villages, talukas, and even districts. Using statistical functions available in GIS systems, the average value of various properties of different building classes can be computer (e.g. average monetary value of residential dwelling in particular village) and stored with their corresponding geographic regions in the GIS database.

The information retrieved by querying the GIS database serves as inputs for the risk assessment models. These risk assessment models can run both deterministic as well as probabilistic risk assessment. Deterministic risk assessment involves defining a disaster event and computing the damage associated with that event, whereas probabilistic risk assessment computes damage for different events, accounting for the probability of each event. Deterministic events could be defined using a GIS front-end system.

The result loss patterns per regions and their associated uncertainties that are computed through this risk assessment can be mapped and again used for querying information through GIS applications. GIS technology provides a powerful tool for displaying outputs and permits users to "see" the geographic distribution of impacts from different peril scenarios and assumptions and allows the user to perform a quick graphical sensitivity analysis of the factors affecting the risk potential. A GIS based software system create the ideal framework to integrate the various components of the model

3.5 Route Planning

Transport planning often causes problems due to large complexity and many different factors that influence the optimal solution. COWI's route planning applications are ideal to get an overview and for decision support.
COWI has developed a number of advanced IT solutions for route planning, which are used for the daily planning and logistics planning.

Traditional or Internet-based

COWI offers a serious of solutions within route planning. This may be "traditional" or Internet-based route planning for advanced supply chain management solutions that integrate route planning with inventory control.
COWI's solutions are developed for transport by both road and ship and we continuously develop new solutions in cooperation with our customers.

Based on GIS functionality

COWI'S route planning solutions are based on GIS functionality to present data and interaction with the user. Combined with an advanced functionality to optimize routes, this contributes to give the customer overview and support when making decisions.
The solutions also contain facilities that our customers can integrate with their other IT solutions, including ERP systems.

CHAPTER 4 # GIS Software and Application of Software in Oil and Gas

GIS Software and Application of Software in Oil and Gas

4.1 Types of software

i. Desktop GIS
ii. Attribute database management systems
iii. Spatially-enabled database management systems
iv. Internet GIS

4.2 Main Players

GIS companies and solutions for Petroleum Industry

The integration of GIS into the current business model of petroleum industry is not an easy process, and requires through understanding of the detail requirements and practices of the Petroleum companies. Seeing a positive sign of growth and advancement of GIS in this sector major GIS companies and their partners have started to capitalize this multi billion dollar industry.

All major GIS companies have been instrumental in evolving new solutions for the petroleum industry for the last 3 decades. User Groups, GIS consultants, Oil service companies, Petroleum Engineers, GIS data providers, Hardware suppliers and Software suppliers all add up to growth and development enabling innovative solutions and analytical processes for the industry.

There is a sharp increase in offering a special petroleum application package and analysis component that can be added to the core GIS product. Especially partners of all the major GIS companies are offering customized solution on the base product.

Some of the GIS solutions currently offered by various vendors and their partners are:

- Corporate GIS data management
- Map production and presentation
- Digital Elevation Models and hydrology
- Environmental sensitivity analysis and modeling
- Pipeline route optimization and pipeline leakage risk
- Internet mapping and image web server solutions
- Workflow analysis
- Crisis Management on the Internet
- GDA 94 and datum conversion
- Conversion of current environmental data to GIS format
- Linkage of oil spill model to GIS.
- Retail market analysis.
- Distribution analysis.
- Market pattern analysis by demographics.
- Retail outlet supply routing and many more…

4.1 Types of Software

4.1.1 Desktop GIS software

The beginning: Arc Info

- Launched in 1980 by ESRI
- Built Arc (GIS functionality) over Info (a RDBMS)
- Mainframe-based
- Set the standards until the mid-1990s

ArcReader ("adobe acrobat" for maps) & Arc Explorer (spatial data viewer)

ArcGIS 9.x Desktop: two primary modules (MS NT/2000/XP only)

ArcMap: for data display, map production, spatial analysis, data editing

ArcCatalog: for data management and preview

ArcToolbox, for specialized data conversions and analyses, available as a window in both

ArcView: viewing, map production, spatial analysis, basic editing

ArcEditor: ArcView, plus specialized editing

ArcInfo: ArcView & ArcEditor plus special analyses and conversions

ArcObjects: build specialized capabilities within ArcMap or ArcCatalog using VB for Applications

ArcGIS Workstation (for UNIX and MS NT/2000/XP)

ArcGIS Engine (MS NT/2000/XP)

- Set of embeddable GIS components (ArcObjects software objects) for use in building custom applications
- Runs under Windows, Unix and Linux, with support for Java, C++, COM and .NET
- Replaces Map Objects which were based upon a previous generation of GIS objects

SDE (Spatial Database Engine)

- Middleware to support spatial data storage in standard DBMS
- Supports all major industry databases:
- Oracle, SQL-Server, IBM DB2, Ingres

ArcGIS Server

- Permits the creation of server-based GIS services using any ArcGIS capability
- Provides GIS capabilities to a user without a desktop GIS system:
- Inward focus—user goes to server

ArcIMS

- Software to develop Internet server-based mapping and basic analysis
- Provides maps to the user without a desktop GIS system :
- Outward focus—gives user a map

The Mid-1990s:

MapInfo:

- MapInfo Corporation
- Windows-based
- Point and click user interface
- Moved GIS software into the mainstream

ArcView:

- ESRI's response
- Originally just a viewer for ArcInfo
- Became (at 3.0) a fully-fledged PC-based GIS software package

ArcInfo:

- pcArcInfo – Cut down version of ArcInfo available from the early 1990s
- Full ArcInfo – Available under Windows NT by the late 1990s
- Retained more functionality than ArcView

4.1.2 Attribute Database Management Systems

- Using a GIS does not require transferring all attribute data into a GIS
- Attribute data linked to spatial data through a relational join
- Can be accessed through either the GIS software or the host database management system

Examples:

MapInfo: Dbase, Access, Excel, Lotus 123, Oracle

ArcView: Dbase, Access, Excel, Visual FoxPro

ArcInfo: Oracle, Ingres, Dbase

4.1.3 Spatially-Enabled database Management Systems

- Spatial extensions to existing DBMSs
- Capable of handling spatial data

  Eg. point-in-polygon operations

- Do not provide full GIS capability

  Eg. Vector overlay

- Limited mapping capability

  Examples: Oracle Spatial, ArcSDE (ESRI)

4.1.4 Internet GIS

- Allows vector GIS data to be disseminated on the web

Clients can:

- Turn layers off and on
- Perform spatial and attribute queries

  Eg. ArcIMS

4.2 *Major Player*

ESRI, Inc., Redlands, CA

- Clear market leader with about a third of the market
- Originated commercial GIS with their Arc Info product in 1981
- Privately owned by Jack Dangermond, a legend in the field
- Strong in gov., education, utilities and business logistics

MapInfo, Troy N.Y.

- Aggressive newcomer in early 1990s, but now well-established.
- Strong presence in business, especially site selection & marketing, and telecom

A leading competitor is MapInfo which produces a suite of GIS software. MapInfo Professional is their leading GIS product containing the most advanced analytical tools. MapInfo also offers plug-ins called add-ons to enhance the functionality of MapInfo Professional. For the development side, MapInfo offers Map-X. Through an Active X component, developers can embed mapping applications into other applications such as Excel. Although it can be used for a variety of analysis, the makers of MapInfo market the software more towards the business sector. Demo versions are available for downloading for some of MapInfo's products.

Platforms: Windows OS

Further Resources: MapInfo, MapBasic, MapInfo Tutorials

Intergraph (Huntsville, AL)

- Origins in proprietary CAD hardware/software
- Older UNIX-based MGE (Modular GIS Environment) evolved from CAD
- "New generation" GeoMedia product based on NT is now their main focus
- Strong in design, public works, and FM (facilities management)

Bentley Systems (Exton, PA)

- MicroStation GeoGraphics, originally developed with Intergraph, is now their exclusive and main product.
- Strong in engineering; advertises itself as "Geoengineering"

Autodesk (San Rafael, CA)

- Began as PC-based CAD, but now the dominant CAD supplier
- First GIS product AutoCAD *Map* introduced in 1996
- Primarily small business/small city customer base

CHAPTER 5 # Future Expectations

FUTURE EXPECTATIONS

5.1 Geologic Evaluation

5.2 Reservoir Analysis

5.3 Land / Lease Management

5.4 Drilling Activity Analysis

5.5 Gas Marketing

5.6 Improved integration with our relational databases.

Future Expectations

Although GIS technology brings lots of benefits to the oil industry already, it can still be made better. Where our requested improvements can be stated and implemented in a generic way, they can benefit all users of GIS. Some things on our "oil industry wish list" include:

Improved integration with our relational databases. Fortunately, the newly-announced Spatial Database Engine (SDE) makes a major leap in the right direction. However, we still have a way to go to link hardcopy and CAD data (though a large part of this problem results from poor record keeping and data management, which can't be fixed by the GIS...)

A truly global paradigm, where locations on the earth include "metadata" like geodetic datum, Cartesian projection/spheroid parameters, etc. I am pleased to state that the next releases of ArcView and SDE appear to be comprehensively addressing this issue.

- An even shorter learning curve to effectively be able to use GIS technology
- Better management and access of seismic data and well logs

Improved "conflation" tools. "Conflation" is the process of merging two or more GIS datasets, so that the output has the highest-accuracy data from all the inputs. As surveying tools and GIS data from satellite and orthophoto images continues to improve, existing maps and GIS datasets must be "high-graded", i.e. adjusted to remain consistent with the newer data. Managing this process may well be our biggest challenge.

3-dimensional GIS. Right now, our use of GIS stops at the Earth's surface. To visualize subsurface reservoirs, we must change to completely different systems, which rarely present a "seamless" interface to the GIS.

5.1 Geological Evaluation Process

During the reservoir evaluation, a significant amount of geological research and analysis was performed prior to using the GIS. Conventional core measurements were evaluated to determine reservoir rock types. These rock types were combined with well log data to create a rock-to-log correlation. Well log cross-sections were then constructed and analyzed, which resulted in the definition of 16 individual reservoir units. Tops of the reservoir units in measured depth were entered into the GIS for mapping. The tops were also imported into the log analysis application to allow petrophysical calculations to be performed on each individual reservoir unit. Reservoir unit calculations were subsequently imported back into the GIS for mapping of multiple attributes on all 16 reservoir units. The result of the mapping exercise was the determination of original gas in place and remaining gas reserves for each individual reservoir unit.

Geophysical Evaluation Process

Using the geophysical workstation, synthetic seismograms were incorporated into the evaluation. Tops were imported from the GIS and merged into the synthetic seismograms. Fieldwide correlatable, continuous time reflectors were defined and mapped. Faults and stratigraphic features were also identified and mapped. Time structure and isochronal maps were generated on the definable time horizons. The time structure and isochronal maps were converted into depth and thickness. The structure and isopach maps were then exported to the GIS.

Petrophysical Evaluation Process

Rock types identified by the geologist were input into the petrophysical evaluation software. As noted, these data were combined with the well logs to determine a rock-to-log correlation index. The correlation index consisted of a probability tool that enabled the petrophysicist to predict rock types over intervals where conventional core was not available. Knowing rock types for each 1 ft interval in the well enabled the petrophysicist to apply different log parameters to each rock type for calculation. The result was a more accurate determination of the presence of hydrocarbons. Petrophysical values, such as average water saturation, net effective sand, and net pay were exported into the GIS for each of the reservoir units. For purposes of sensitivity analysis, a different set of values was calculated for each of the three different porosity values.

5.2 Reservoir Analysis

Each well was evaluated to determine original and current water levels in the reservoirs. These values were input into the GIS for spatial analysis. Production analysis was performed to predict future hydrocarbon recoveries. Cumulative production was first assessed and assigned to each perforated interval and was then allocated to each reservoir unit. Following the mapping process in the GIS, net pay contour areas were exported into a spreadsheet. Reservoir volumes were then calculated from the net pay contour areas. These calculated volumes were compared with cumulative production volumes and originally calculated ultimate reserve recoveries. Numerous iterations were then performed on the map layers in the GIS to obtain reasonable net pay contour areas.

5.3 Land / Lease Management

Mapping in the oil and gas industry is a critical tool for the management of our properties. Maps are used to display what we own and its location, to lay out an acquisition or development strategy, to display the relationships between one company's acreage position and a pipeline, or a seismic line, or a well or another company's acreage position. They are used to analyze the mineral ownership and surface topography and relate it to the subsurface stratigraphy or to a region's economics thus enabling a company to select the most optimal location to drill a well. A map is used to display what we want to sell or what we want to buy. They are used as exhibits to contracts and as evidence in judicial and regulatory hearings. In

summary, maps are an integral part in the day to day work of all of our operational disciplines.

Historically our industry has managed these assets through mainframe based textual information systems while the spatial data was captured separately as hand drawn or CAD maps. The maps were not derived from the text. At best they only represented the text at a certain point in time. Due to the time involved in their creation, they became living documents maintained by hand. Therefore, the text and maps were always out of sync. Additionally, maps of the same geographical area were created multiple times by different end users reflecting each user's own query or analysis and subsequently were stored in their individual files where other users had either no access or knowledge of their existence. Decision making was a painstaking labor intensive process based on out-of-date and unreliable data with opportunities lost through the paralysis of data gathering, display and analysis. Business processes were developed just to ensure that quality decisions could be made regardless of the time, costs or people involved.

5.4 Drilling Activity Analysis

Analysis of the well header data has provided enough information to examine the growth of the field since its beginning. Mapping by the wells' First Production Date has allowed for visualization of the field growth over time. One can see that as the field expands it is encroaching on the DFW area and municipalities. Also, a query on companies involved in the field produced a map showing the major operators in the field. By mapping the spatial data an understanding of the evolution of the field has been presented in this study. An appreciation of the cultural and/or land use limitations on further expansion of the field has also been presented. It is evident from the mapping that further growth is being complicated by the urban centers. Producers will have to deal with land use issues, right of way issues, mineral rights issues, and local ordinances. Expansion of the field appears to be limited to the south and southeast by the population centers.

5.5 Gas Supply Network Management using GIS

This paper is about the benefits of the Gas Supply Network Management using GIS for Gas Transmission and Gas Distribution clients. The functionalities are specific to city gas distribution where there in an extensive underground steel pipe network and polyethylene pipe network serving gas for cooking purpose etc to a large number of residential buildings, hotels/restaurants and for industrial purposes to factories.

The salient features are:

Linkage of the external customer database with the GIS application.

The linkage serves the following purposes:

- Used to logically link the customers to the gas supply points in GIS.
- For carrying out customer GeoCoding in GIS
- For carrying out actual load analysis. The customer database provides the actual loads at the gas supply points
- For identifying the points in the network with excess potential and where new customers can be added

GIS has a two-way interface with gas network analysis software

The pipe network graphic layout and the attribute information like actual loads, design loads, pipe diameters, pipe lengths (picked automatically from the graphics) etc are exported from GIS to the network analysis software. The software analysis the information and provides pressure drops at regular intervals in the pipe network. These pressure values are imported back into GIS as the result of the analysis. These pressure values are used for functionalities such as locating the upstream valves, valve closure analysis, line pack analysis etc

Decision support tool for emergency situations like fire, leakage, gas stoppage etc and prompt handling of the same.

Functionalities serving this purpose:

- To locate the upstream valve/valves, which are supplying gas to the point of leakage – In the case of gas leakage or fire due to rupture in the underground pipe it identifies and displays the closest upstream valve(s) which are to be closed to stop the supply of gas at the point of rupture of the pipe.
- Valve Closure Analysis – To get the number and locations of effected customers during valve closure and to find out the customer details like customer name, customer reference number, address etc. It will also highlight the portion of the gas pipe network downstream of the valve, which has been closed.

Line Pack analysis –

- To find the total amount of gas (volume of gas at atmospheric pressure) escaping during a leakage from the ruptured hole and the time it will take to do so.
- In the case of valve closure it calculates the time the gas which is entrapped in the pipe will be able to serve the customers. This will be useful is ensuring continuous supply of gas to the customers even in the case of gas leakage.
- To highlight the gas supply path for a particular customer from the main gas supply point – It will identify the pipes (and the single line path they make) through which the gas is coming to the customer and display the details of all the meters, valves, junctions and regulators in this path.

- GeoCoding of a customer building location in case of emergency – It will identify the building from which the emergency complaint came on the basis of the customer reference number or the customer's telephone number and will display the building location on the map. This will assist the emergency crew to reach the building quickly.
- Identify and geocode of a prominent building nearest to the customer premises – To assist the emergency crew to reach the building quickly.
- Identify and highlight of the shortest path from the crew location to the emergency location – To assist the emergency crew to reach the building quickly.

5.6 Improved Integration with our Relational Databases

Although GIS technology brings lots of benefits to the oil industry already, it can still be made better. Where our requested improvements can be stated and implemented in a generic way, they can benefit all users of GIS. Some things on our "oil industry wish list" include:

Improved integration with relational databases. Fortunately, the newly-announced Spatial Database Engine (SDE) makes a major leap in the right direction. However, we still have a way to go to link hardcopy and CAD data (though a large part of this problem results from poor record keeping and data management, which can't be fixed by the GIS...)

A truly global paradigm, where locations on the earth include "metadata" like geodetic datum, Cartesian projection/spheroid parameters, etc. I am pleased to state that the next releases of ArcView and SDE appear to be comprehensively addressing this issue.

CHAPTER 6 # Research Design, Methodology and Plan

Research Design, Methodology and Plan

6.1 MAP Info
6.2 Research, Design and Methodology
6.3 BPCL Data Collection
6.4 Import Data in MAP Info
6.5 Workshop

6.1 MAP Info

Overview

MapInfo Professional is a powerful Microsoft Windows-based mapping application that enables business analysts and GIS professionals to easily visualize the relationships between data and geography. With MapInfo Professional, you can perform sophisticated and detailed data analysis by leveraging the power of location. Including location in your decision making and daily operations can help you increase revenue, lower costs, boost efficiency and improve services.

Use MapInfo Professional to:

- Create highly detailed maps to enhance presentations and aid in decision making
- Reveal patterns and trends in your data that may otherwise be impossible to see in spreadsheets and charts
- Perform sophisticated and extensive data analysis
- Understand customer and marketplace demographics
- Manage geographically based assets, such as stores, people and property

Plan logistics and prepare for emergency response

Features

Crystal Reports version 8.5 provides powerful, user-friendly controls for creating complex reports, including the ability to embed maps via OLE and add charts; new wizards and templates for report layouts extensive export options to formats such as PDF, HTML or XML. The reporting engine comes with a powerful yet user-friendly interface for creating complex reports. Some of the feature highlights are: Back end Microsoft Access engine (MDB Files) ability to embed MapInfo maps, add charts, wizards and templates for report layout. Extensive export options such as PDF, XML, HTML and Excel formats are also available.

Export Window allows you to choose a resolution that meets your needs.

Workspace Packager, a workspace sharing tool provides an interface that can copy all open files to a single directory and recreate the workspace referencing the new directory. The utility facilitates the successful sharing of complex workspaces that often access many network locations and data types.

Scale Fill Patterns, another feature found in the Preferences/Output Settings dialog enables the scaling of region area fill-patterns. This option is of particular importance when printing to high resolution printers at 300, 600 or 1200 DPI.

6.2 Getting Your Data on the Map

Geocoding

MapInfo Professional's built-in geocoding capability allows for fast and accurate placement of address data onto maps. Numerous controls are at your disposal, including the ability to specify how far to offset an address from the side of a street and how far to inset an address from the ends of street segments.

MapInfo Professional also allows you to create points quickly and easily. If your data already contains coordinates - longitude and latitude or others, you can map it directly by creating point objects from the coordinates.

If not, you can still get your data on the map either by geocoding it or by joining it to an existing map layer to create a thematic map.

Create Points

The enhanced create points interface in MI Pro provides the ability to use non-numeric fields to create points. It also provides the option to recreate existing points. The overall benefit is greater simplicity and flexibility of visualizing customer data.

Analysis

MapInfo Professional makes your analysis effortless with the ability to measure distance, length, perimeter, and area. You can aggregate the count, sum, average, min, max, and weighted average. You can also perform geographic joins, contains or within as well as textual matches. Finally, use these tools and options to extract information from your data:

Info Tool: click on any point of the map and retrieve the database records of all the objects located there.

Statistics Tool: show the sum and average of all the numeric fields in all the records in the current selection. Dynamically changes with the selection.

Calculate Statistics Option: calculate the minimum, maximum, range, sum, mean, variance, and standard deviation of a single numeric column of all the records in the current selection.

3D Views and Prism Mapping

Prism Mapping

Uncover patterns and trends based on data values with Thematic Mapping. You can shade, use bar & pie charts, graduated symbols, dot density, and grids. The new prism mapping feature lets you take a flat map and turn it into something special. You can select regions on your map, extrude them to any height and your maps pop off the page.

Choose from hundreds of colors, symbols and line types to enhance comparisons and store popular combinations in Thematic Templates. Save frequently used templates for future reference and modification.

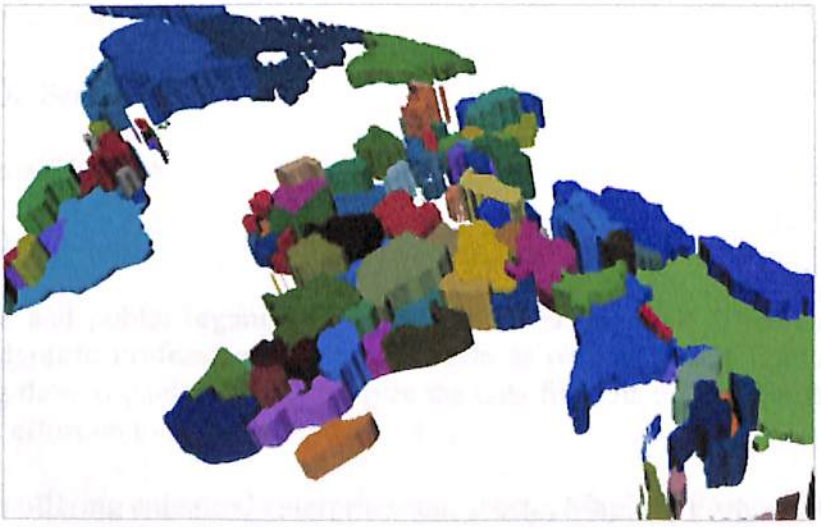
3D Views

3D window and Prism maps continue to be a distinctive and powerful way to visualize and analyze data and MI Pro v7.5 makes this feature even more compelling.

The drape files over 3D terrain are now of significantly higher quality, resulting in more legible labels and higher quality 3D maps.

Create a 3D view of any map containing a continuous thematic grid layer. Based on Microsoft's implementation of OpenGL software graphics interface, our 3D viewing feature allows freehand tilt and rotation of the image as well as traditional panning and zooming.

Create 3D views with any grid format by directly reading MI Grid, VM Grid, DEM, DTED and GTOPO30. Make the terrain stand out by interpolating the data or by using relief shading.



Raster Display Option

One of the most powerful aspects of MapInfo Professional is its ability to combine data from widely different sources, even with different formats and projections, in the same map window. Once combined in the map window, relationships that only exist geographically are revealed. You can also overlay vector and raster data together. In the map window, you can control the order of layers, their display characteristics, and labeling. You can also control the translucency of raster images. Now, instead of simple backdrops, raster images can be made semi-transparent and mixed with vector and other raster images.

MapInfo Professional adds optimized "look ahead" logic for raster display. This code enhances the overall map processing by skipping invisible raster layers that do not need to be processed. This results in greater response from the product even with large data sets.

MapInfo Professional also enhances the raster registration process by providing the ability to select the control points from the map. This enhancement saves time and streamlines the geo-referencing process of aerial imagery. MapInfo Professional adds a new vector registration utility that provides an option to re-project a vector layer. This utility significantly simplifies the import process of AutoCAD or Micro station files since this data often does not have projection information.

Data Access

MapInfo Professional has been enhanced to offer even more powerful enterprise data access with support for the following applications:

Oracle Spatial 10G including 10G Locator, 9iR2

Microsoft Access XP

Microsoft SQL Server version 2000

MapInfo SpatialWare 4.8

Informix 9.21

Many private and public organizations use Oracle as the back office standard for their data. MapInfo Professional supports Oracle as well as Oracle Spatial directly, thus enabling these organizations to analyze the data from its original source without additional IT effort on middleware.

In addition to offering enhanced enterprise data access, MapInfo Professional enables you to access local data in a wide variety of formats.

6.3 Importing and Exporting Data

With the Universal Translator, MapInfo Professional makes importing and exporting data in different formats easier than ever before.

Import vector data with these formats MIF/MID, DXF, DGN, SHP, E00, VPF, and SDTS

Export vector data with these formats MIF/MID, DXF, DGN, SHP, and E00

Compress raster images into the ECW format

SQL Selection with Geographic Extensions

Hunt for answers in your data with standard SQL queries. In addition to the standard key words - Select, From, Where Group By, Order By, and Into, MapInfo Professional offers these special geographic key words:

Contains, Within, Partly Within, Entirely Within, and Intersects

You can also aggregate data with:

Sum (), Min (), Max (), Count (*), Avg. (), and WtAvg () functions

Build and save SQL queries that access and integrate data from multiple tables. Frequently performed queries can be written once, re-used and even distributed to others. You can also invert a selection. Instead of crafting a complex query to select all but a few records or objects, just select the few you want to exclude, and invert the selection to unselect them and simultaneously select all the others.

MI Pro has made selecting geographic objects a piece of cake. Simply utilize point, marquee, and radius, polygon, and boundary tools to complete your tasks. Select the appropriate tool and click or click and drag on the map to select the geographic objects you want.

Object Processing

In addition to the simple drawing and editing tools, MapInfo Professional has powerful object processing capabilities. These include Combine, Disaggregate, Buffer, Convex Hull, Enclose, Split, Erase, and Erase Outside. Also included are smooth, unsmooth, convert to polygon, and convert to polyline. MapInfo Professional has new ways for you to clean and modify your data with new object processing functions including check for self-intersections, gaps and overlaps; clean self-intersections, gaps and overlaps; snap nodes together; and thin or generalize. These functions allow you to detect and correct self-intersections, gaps and overlaps as well as simplify geometry --- making your data more accurate.

MI Pro offers tremendous advantages for creating, managing and analyzing data within your own custom-defined regions such as trade areas, sales territories, school or municipal districts.

Split Objects simplifies the creation of custom areas in cases where you want to split a region (along a highway or river, for instance) by adding a line or polyline.

Redistricting

MapInfo Professional has a built-in feature that gives you the ability to build and manipulate districts and territories. It can work with any layer and over 500 different districts. As you build or modify territories, it displays running statistics that you specify on each: count of objects, sum and percentage of total of any numeric value in the data.

Internet Connectivity

MapInfo Professional is enabled for the Internet in three different ways: First, the Hotlink Tool lets you make any object or label into a hotlink. You can launch web sites, open images such as BMP, JPEG, GIF and almost any other file including multimedia AVI, WAV or documents like DOC, PPT or XLS. And you can even open map files like TAB, WOR MDX and of course, HTML Image Maps. Second, the HTML Image Map Tool lets you turn any map into a clickable web page. Select one or more layers of points, lines, and polygons to be active. Specify which, if any, columns should be included on the landing pages and which should be links. Finally, use the MapInfo Metadata Browser, included on the CD, to hunt for data on FGDC compliant clearing-house servers.

Creating and Modifying Graphical and Tabular Data

Create and modify graphical and tabular data with MapInfo Professional's drawing and digitizing tools. Create professional looking maps by creating points, lines, polyline, polygons, square/rectangles, circle/ellipses, text, multi-point, region (multi-polyline), and collection objects.

Modifying your maps is a breeze with tools like snap to node, move adjacent nodes and trace. Editing your maps is also easily done with tools that cut, copy, paste, move, resize, reshape and undo.

You can rotate labels and symbols and in all types of styles including vector, raster, TrueType symbols as well as custom line styles. You can even fill patterns and use TrueType fonts. MapInfo Professional's tools make drawing and editing quick and simple.

Manipulating Table Structure

MapInfo Professional gives you the power to manipulate tables easily with intuitive tools. You can add/modify/delete/index columns and pack tables, quickly and easily.

Projections

MapInfo Professional offers automatic, on-the-fly, and customizable, coordinate systems derived from any of 30 major projections. Users modify existing and/or add new coordinate systems based on these projections.

MI Pro also offers the ability to rotate maps with an Affine transformation as well as being able to display cursor location in decimal degrees, DDMMSS, meters, and Military Grid Reference System.

Charts & Graphs

Get noticed with MapInfo Professional's interactive graphs and charts including 3D, bubble, column, histogram, surface, area, bar, line and pie scatter charts. Select graph templates from thumbnail sketches. Graphing style control includes position, tilt, rotation and pie explosion. Choose database records by clicking on sections of a chart or graph.

- Customization
- Map Basic Development Language
- Custom menus, dialogs, buttons
- External function cells
- Integrated Mapping
- Visual Basic, C++, and PowerBuilder
- APIs
- Raster
- Grid
- Interpolation

Map Creation and editing options

With the enhanced data editing functions, customers now can rotate a selection of any map objects at a specified pivot point or offset map objects using precise units for a move or a copy operation. This capability is particularly important when creating custom geographies or editing and maintaining existing ones. MI Pro also adds the ability to zoom in/out while in data creation mode. Another enhancement to the editing function is the addition of continues visible snap area and option to toggle into cross-hair mode.

In the area of tools and utilities, MI Pro provides two new utilities. The first is the enhanced line creation by bearing and distance tool which now supports any unit of measure and the output can be directed to any editable layer. The second utility is a line snap/extend tool that will extend or snap specified intersecting line objects.

Major Improvements in Ease of Use

Enhanced Keyboard Control:

MapInfo adds many new keyboard shortcuts to frequently used operations such as find, previous view, find selection and clear target as well as pan using the arrow keys and zoom in and out using the +/- keys. The keyboard support further simplifies the usability of the product and facilitates greater productivity.

Enhanced Open Windows Management:

MapInfo Professional enhances the Window Name/Rename utility to rename any open window and reworked the window management user interface for more efficient management of multiple open windows.

Working in MapInfo Professional is a delight with upgrades to several features that let you operate swiftly and efficiently.

New File Open Dialog Box opens Tables, Workspaces raster images, ESRI Shape files or Database connections all for the same dialog box

Set Default Locations for TAB files, Workspaces and MapBasic applications – much like Windows' "My Documents" folder

Create New Table now includes an option to use an existing table as a template

Data Import option for MS Excel has been enhanced

MapInfo and OGC

MapInfo is fully dedicated to providing software that enables users to easily create, provide and share geographic data with other users.

Support for numerous File Types

MI Pro now offers more options and more flexibility for working with a wide array of file types - it brings you:

Direct reading of **ESRI Shape File** format

Support for **GML V2** (Geography Markup Language). Allows the importing of individual files for OS Master map Independent polygon format, which is supplied by the UK Ordnance Survey.

Extensive support for imagery (Raster) formats including:

Built-in **MrSID and ECW** support

JPEG2000 Import and Export support

Built in support for **ADRG, CADRG, CIB, ASRP and NTIF** (Government Raster Formats)

PDF and XML support for exporting reports (through Crystal Reports 8.5)

With the Universal Translator, MapInfo Professional makes importing and exporting data in different formats easier than ever before.

Import vector data with these formats MIF/MID, DXF, DGN, SHP, E00, VPF, and SDTS

Export vector data with these formats MIF/MID, DXF, DGN, SHP, and E00

Compress raster images into the ECW format

6.4 Research Design, Methodology and Plan

Objective:

- Online Audit System for BPCL Terminal.
- Terminal Efficiency Based upon Operations and HSE.
- Online Retail Outlet Monitoring System.
- Route Optimization for Retail Outlet

BPCL:

- BPCL has 96 Terminal across the country.
- Out of theses 96 Terminal I have selected 10 terminal for my research.

Data Collection:

- Questionnaire (Terminal)
- Questionnaire (Retail Outlet)
- Data Collection

  Terminal Operation Data

  Terminal HSE Data

  Product Handled by Terminal

  Product Handled by Retail Out

Type of data

The type of data is available from two sources

Primary data: BPCL Terminal Survey (Project Udaan)

Secondary data: Internet, Company Manuel, External source

Primary data sources:

Survey Method: It was done by survey with the help of questionnaire and personal interview

Secondary data sources:

Internal sources: Meeting with the Retail Outlet official.

External sources

Company journal

Previous project

Newspaper

Internet

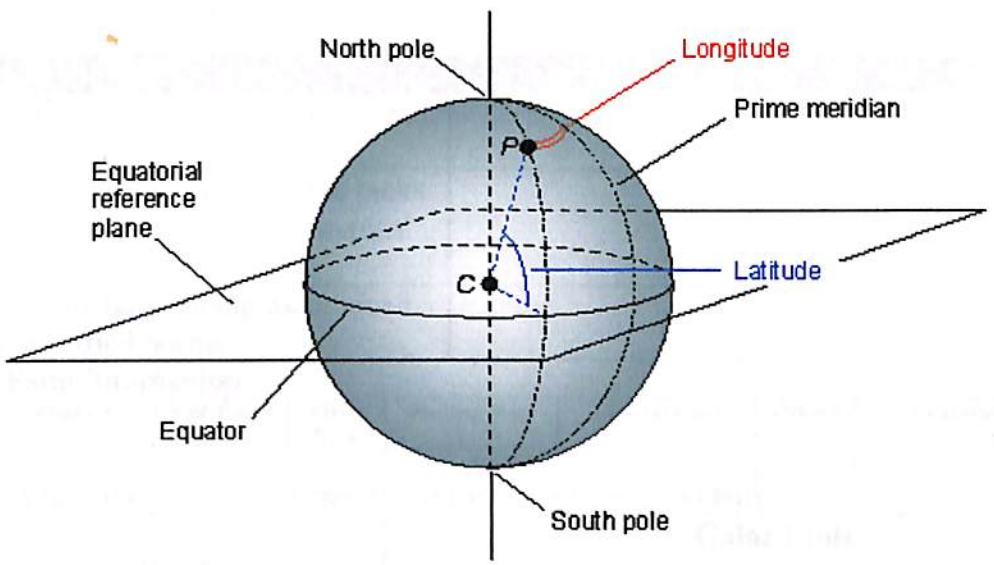
The objective of this study is to provide a on line audit system for BPCL as such there is no online system available in the market. Using this online audit system company can conduct audits at regular interval of time and keep monitoring their process, operations and health safety and environment regulations. This solution can also be useful in Survey of different retail outlet about their safety standards and product handled.

In proceeding with the study we made a random survey of different Retail Outlet in South Delhi. We also collected Information about different safety regulation applied by terminal and retail outlet. Study focused on the Monitoring of Product Handling and mapping of different outlet as well as different terminals.

Latitude and longitude

Latitude and longitude are angles that uniquely define points on a sphere. Together, the angles comprise a coordinate scheme that can locate or identify geographic positions on the surfaces of planets such as the earth.

Latitude is defined with respect to an equatorial reference plane. This plane passes through the center C of the sphere, and also contains the great circle representing the equator. The latitude of a point P on the surface is defined as the angle that a straight line, passing through both P and C, subtends with respect to the equatorial plane. If P is above the reference plane, the latitude is positive (or northerly); if P is below the reference plane, the latitude is negative (or southerly). Latitude angles can range up to +90 degrees (or 90 degrees north), and down to -90 degrees (or 90 degrees south). Latitudes of +90 and -90 degrees correspond to the north and south geographic poles on the earth, respectively.



Longitude is defined in terms of meridians, which are half-circles running from pole to pole. A reference meridian, called the prime meridian, is selected, and this forms the reference by which longitudes are defined. On the earth, the prime meridian passes through Greenwich, England; for this reason it is also called the Greenwich meridian. The longitude of a point P on the surface is defined as the angle that the plane containing the meridian passing through P subtends with respect to the plane containing the prime meridian. If P is to the east of the prime meridian, the longitude is positive; if P is to the west of the prime meridian, the longitude is negative. Longitude angles can range up to +180 degrees (180 degrees east), and down to -180 degrees (180 degrees west). The +180 and -180 degree longitude meridians coincide directly opposite the prime meridian.

Questionnaire Design Format for BPCL Terminal

GENERAL INFORMATION	
Type of terminal	
Name the main equipment /fittings	
List the major operations carried out at the terminal	
List the facilities provided outside the boundary wall	
What specific measures have been adopted for increasing productivity in the terminal	

PRODUCTS HANDLED

Details of products handled by the terminal

Name of Product	Source of Supply	Volume Handled per Day (Kl)	Customer Description	Number of Customers

TANK FARM

What are the major operations carried out at the tank farm	
How is the liquid volume in the tanks determined (Level gauges or manual dips)	
Are pressure tanks being maintained as per specified norms	

Tank Farm Information

S No	Product	# of Tanks	Fixed Roof	Floating Roof	Underground	Others	Total storage capacity (Kl)

What is the color coding scheme for vertical above ground tanks

SNo	Product	Color Code

Maintenance schedule of tank farm

Type of maintenance	Frequency
Visual inspection	
Internal inspection of roof	
Internal inspection of roof drain	
Testing of tank shell	
What are the details listed on the body of each tank	

6.5 Workshop

- Presentation of Location data
- Process Efficiency – Operation and HSE
- Locate BPCL Retail Outlet
- Provide Retail Outlet Information
- Route Planning

6.5.1 Locate Different BPCL Terminal

Figure 1 Shows India Map in JPEG format opened in MAP Info GIS software. To open this Map go to file and select Raster format option.

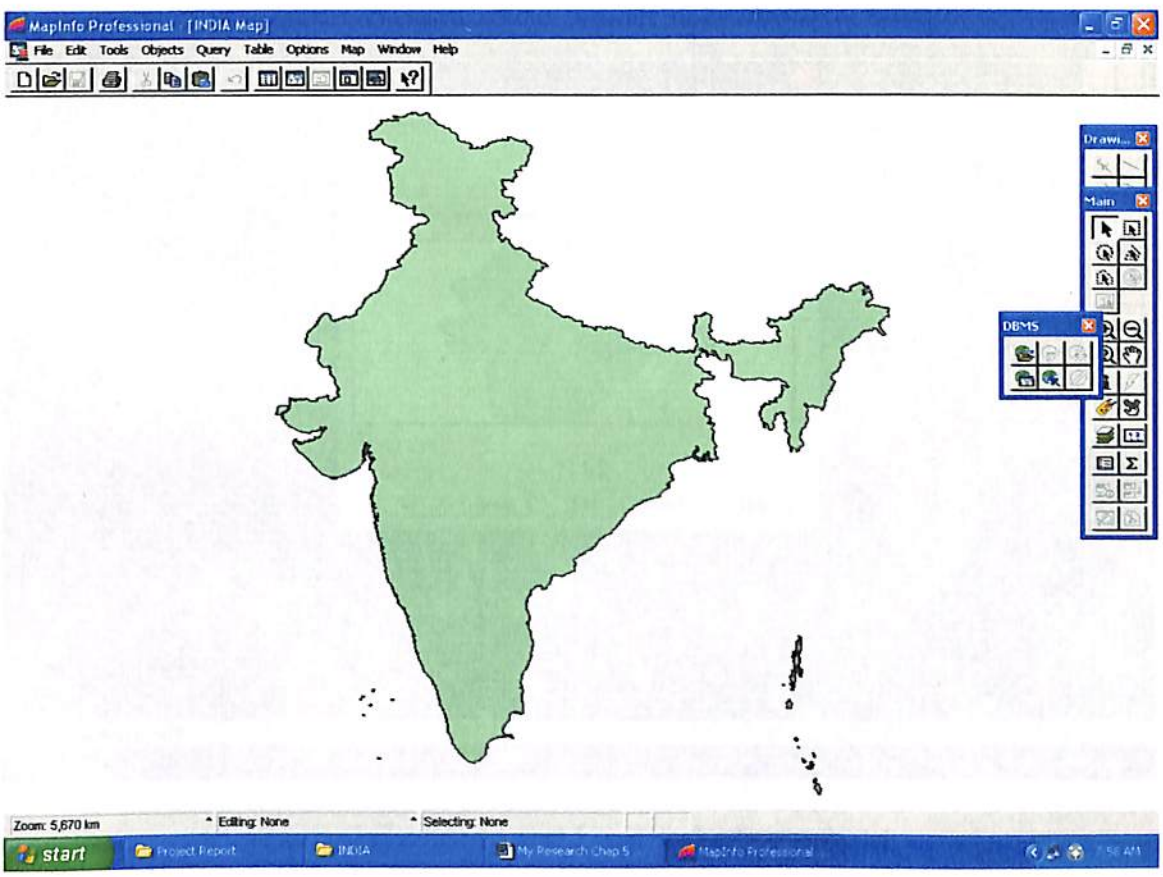


Figure 1: JPEG Image in MAP Info

- Select Raster Format from File Menu
- Click on Open in Raster Format will open JPEG image.

- Select Register Coordinate from Menu.
- Point out latitude and longitude on different MAP location

Figure 2 shows assigning of Latitude and Longitude for this India map, as this map is in JPEG format, this formant don't have latitude and longitude .we will assign this by selecting assign latitude and longitude option.

For assigning latitude and longitude we have to select three points on this map and assign latitude and longitude.

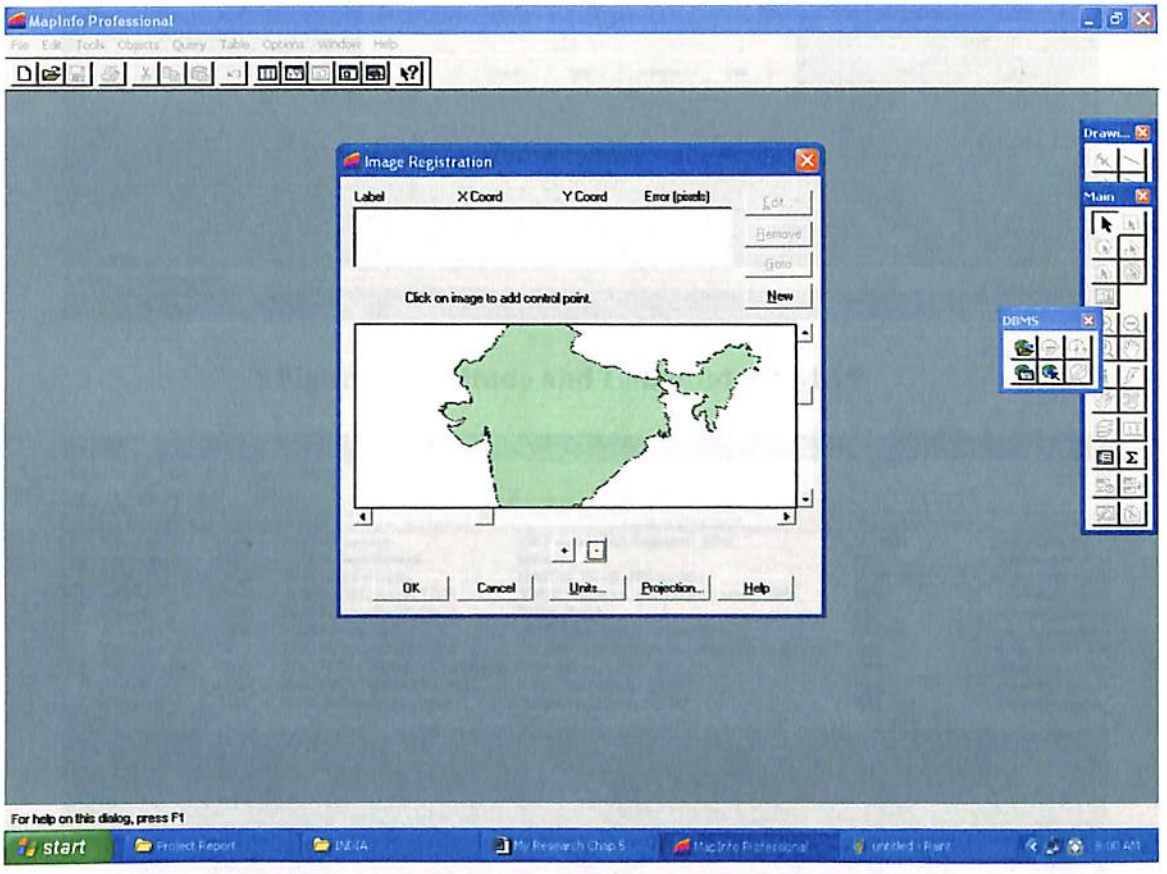


Figure 2: Latitude and Longitude Assignment

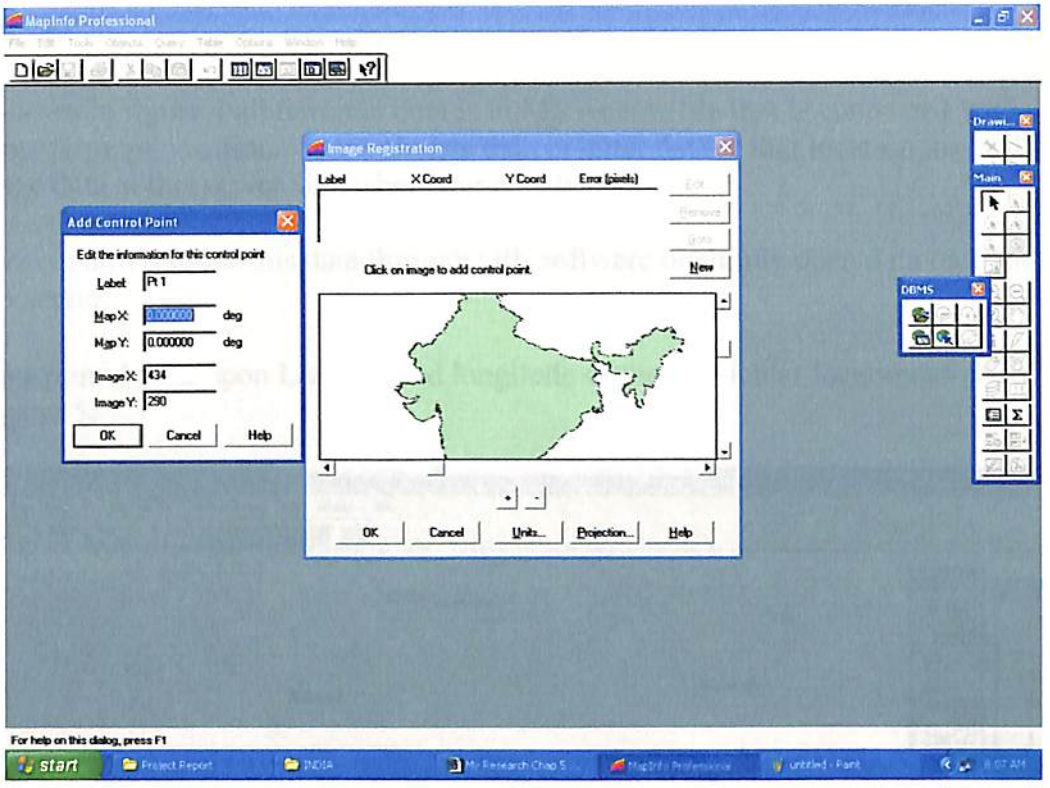
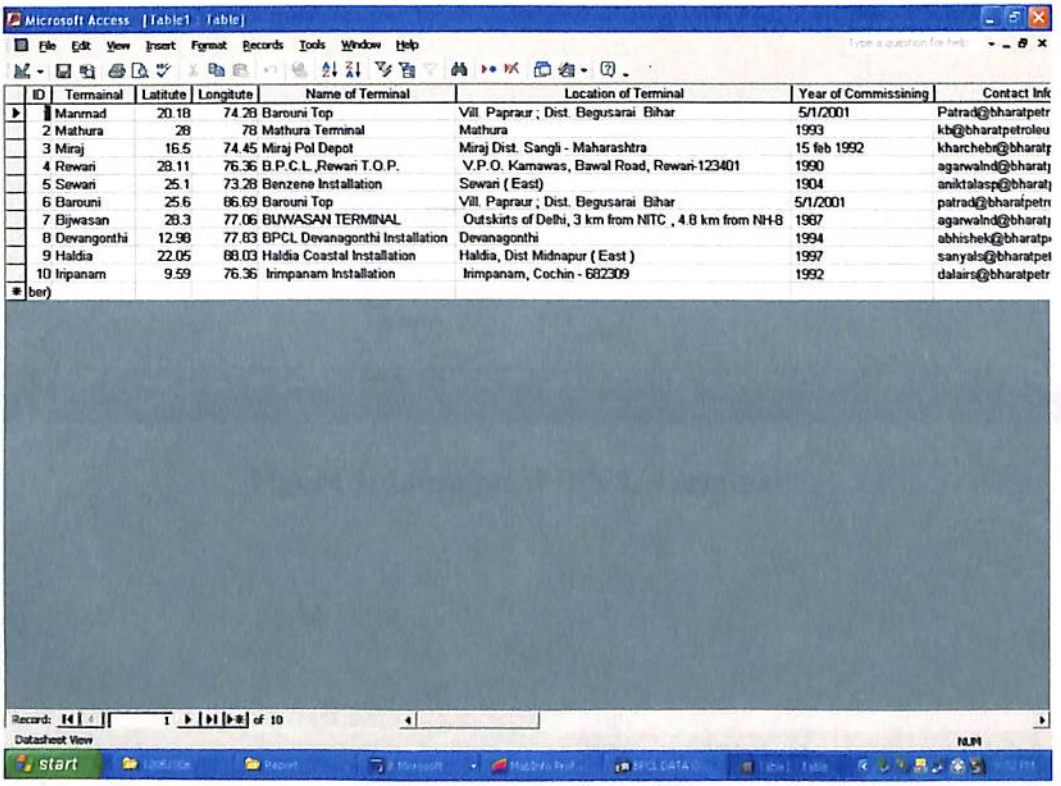


Figure 3: Latitude and Longitude of MAP



ID	Termainal	Latitute	Longitute	Name of Terminal	Location of Terminal	Year of Commissining	Contact Inf
	Manmad	20.18	74.28	Barouni Top	Vill. Papraur ; Dist. Begusarai Bihar	5/1/2001	Patrad@bharatpetr
2	Mathura	28	78	Mathura Terminal	Mathura	1993	kb@bharatpetroleu
3	Miraj	16.5	74.45	Miraj Pol Depot	Miraj Dist. Sangli - Maharashtra	15 feb 1992	kharchebr@bharatp
4	Rewari	28.11	76.36	B.P.C.L.,Rewari T.O.P.	V.P.O. Kanawas, Bawal Road, Rewari-123401	1990	agarwalnd@bharatp
5	Sewari	25.1	73.28	Benzene Installation	Sewari (East)	1904	aniktalasp@bharatp
6	Barouni	25.6	86.69	Barouni Top	Vill. Papraur ; Dist. Begusarai Bihar	5/1/2001	patrad@bharatpetr
7	Bijwasan	28.3	77.06	BIJWASAN TERMINAL	Outskirts of Delhi, 3 km from NITC , 4.8 km from NH-8	1987	agarwalnd@bharatp
8	Devangonthi	12.98	77.63	BPCL Devanagonthi Installation	Devanagonthi	1994	abhishek@bharatp
9	Haldia	22.05	88.03	Haldia Coastal Installation	Haldia, Dist Midnapur (East)	1997	sanyals@bharatpet
10	Iripanam	9.59	76.36	Irimpanam Installation	Irimpanam, Cochin - 682309	1992	dalairs@bharatpetr
*	ber)						

Record: 1 of 10

Figure 4: All Terminal Data in MS Access

Create MAP

As shown in figure 4 all terminal data is in MS Access file that is connected with remote terminal location. As we change data or enter data at that location that will change data at this server side where our data is kept.

Now we can visualize this data through GIS software or simply open data base table from server.

Create point based upon Latitude and longitude of that particular location as shown in figure 5.

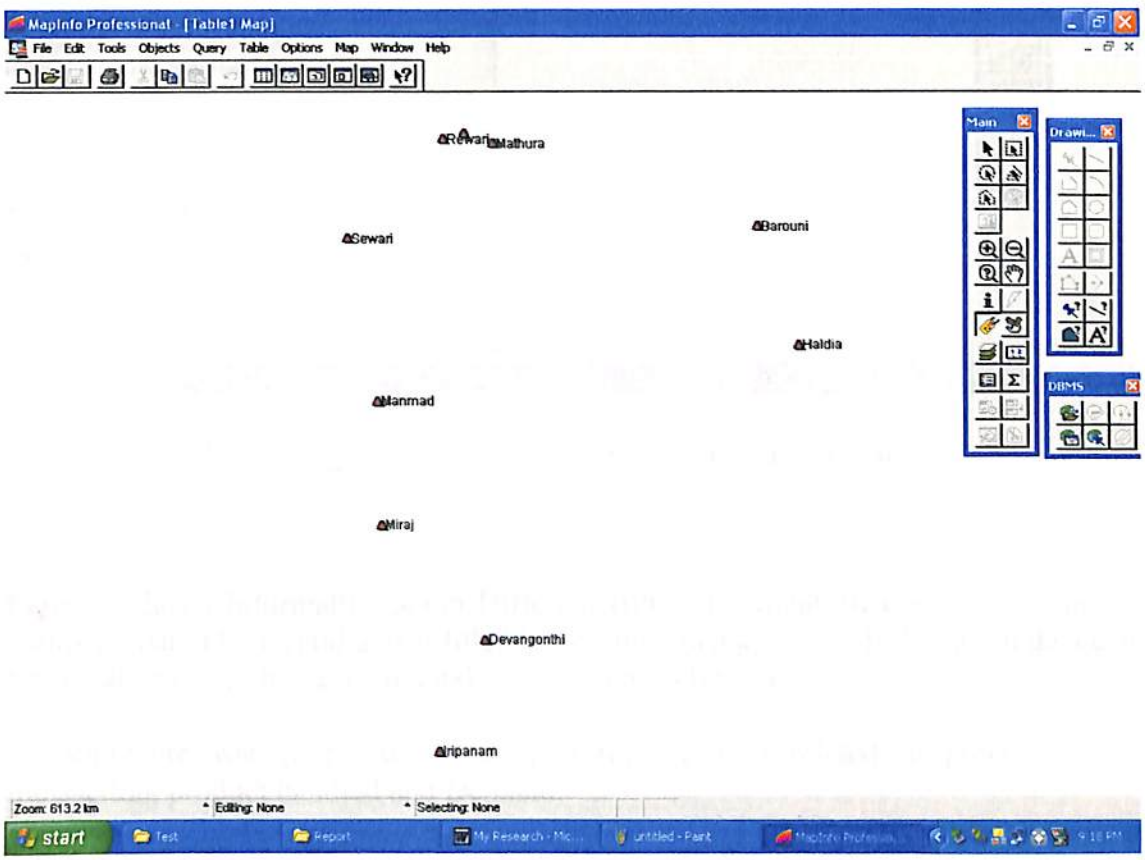


Figure 5: Location of BPCL Terminal

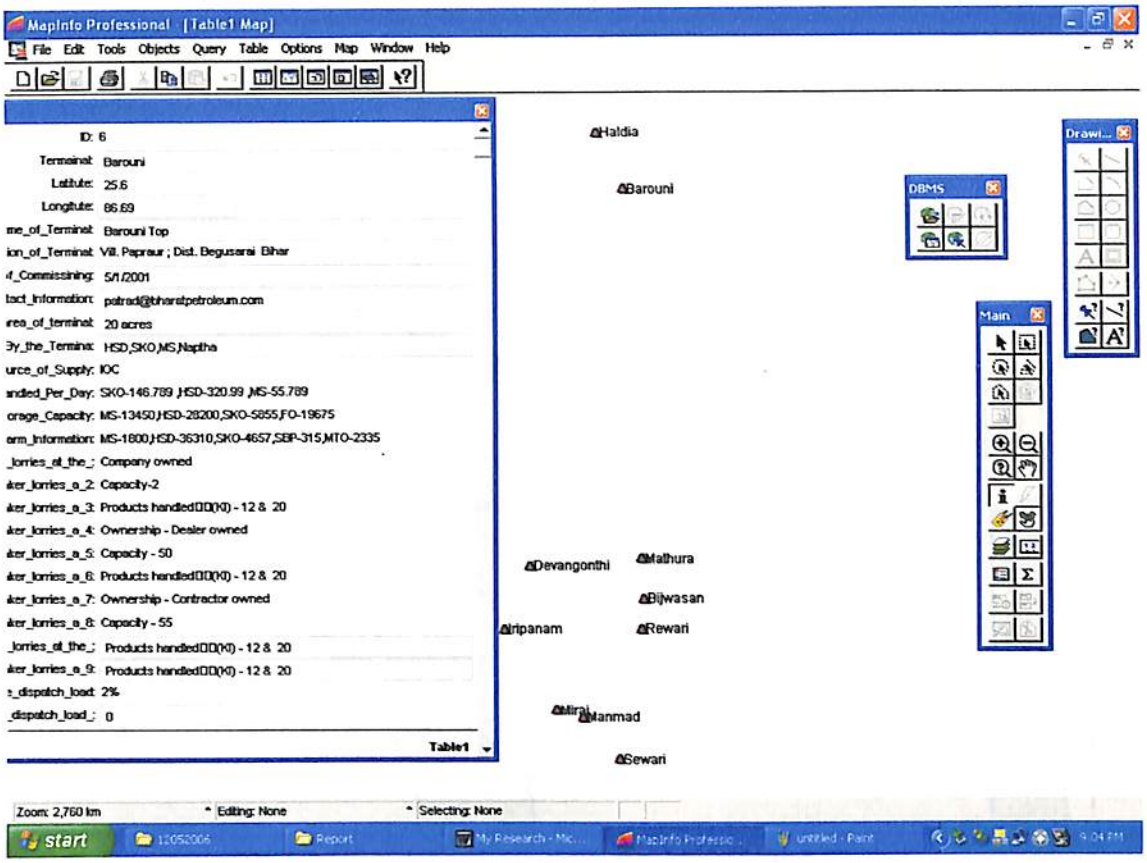


Figure 6: Terminal Operation and HSE Information

Figure 6 shows Information about Different BPCL Terminal, this is a questionnaire that is prepared by us and gets it filled by terminal manager. All 10 Location data can be visualize using the same method, by clicking each location.

Questionnaire was prepared based upon the question related to process, daily transaction, product handled and Demand.

Import another Layer

Next task is to import another layer on this MAP that is India MAP, Combining both these layer would give exact location on one Layer.

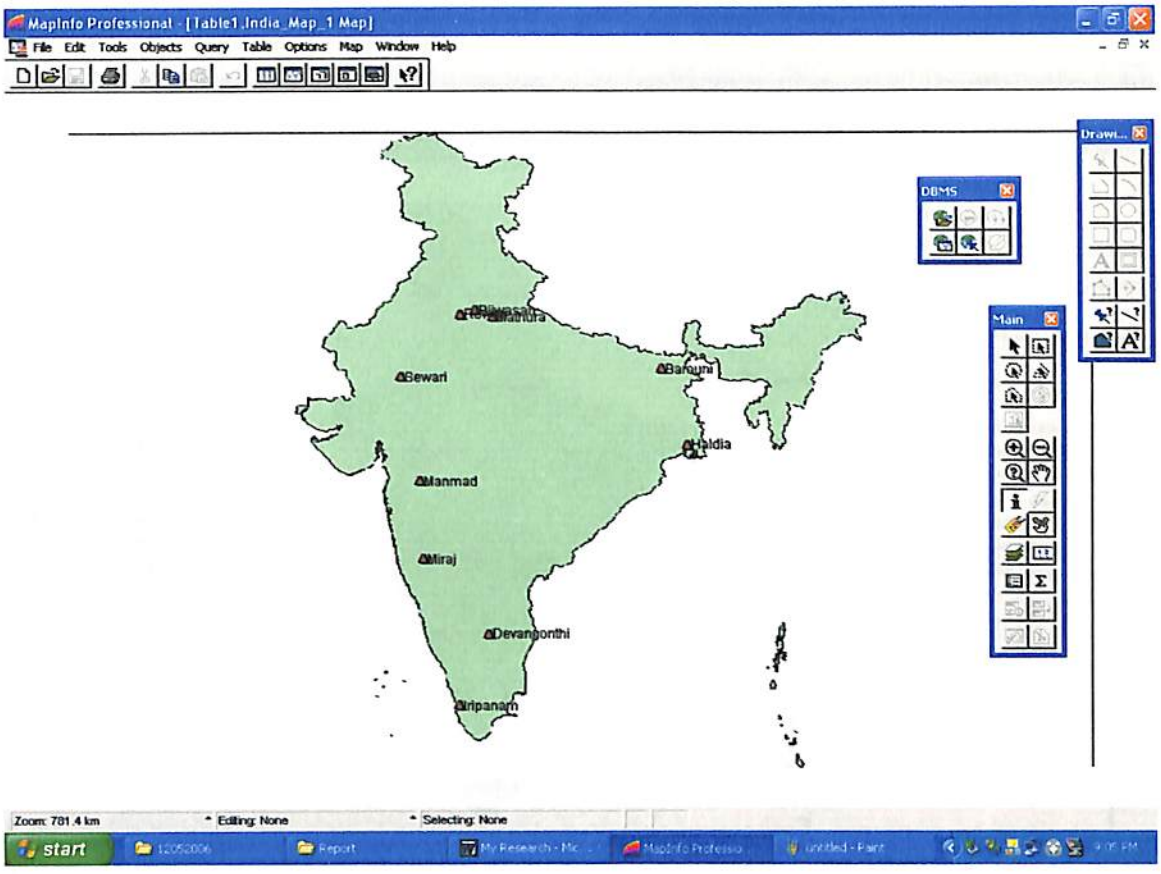


Figure 7: Map Overlaying

This Figure shows how maps are overlaid over each other. After assigning latitude and longitude for India map it was a single layer then we open MS Access Database contain information location wise that location coordinate is to be put on different layer. This is layer two and at last combine these two layers showing a complete map containing BPCL location.

Online Data that came from terminal is shown in figure 8, after clicking on different BPCL Terminal Location.

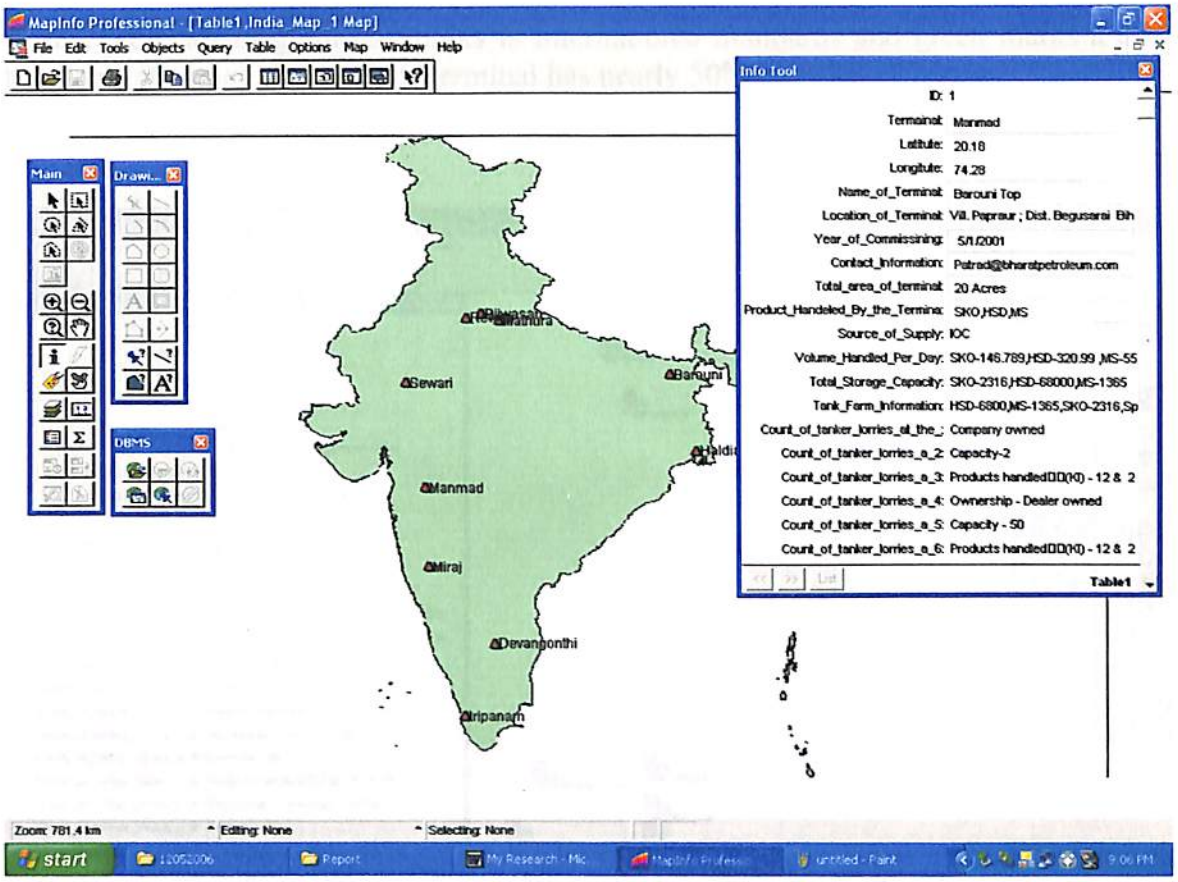


Figure 8: BPCL Terminal Data

6.5.2 Operation and HSE Efficiency

This online data that is been stored is compared with international standards that are set by American petroleum institute. We do gap analysis by different software's and calculate Terminal Efficiency based upon percentage marks given to every terminal. We present this result on MAP Info Software as shown in figure 9.

In this pie chart diagram red marks Is International Standards and green marks are terminal efficiency. Most of the terminal has nearly 50% terminal efficiency.

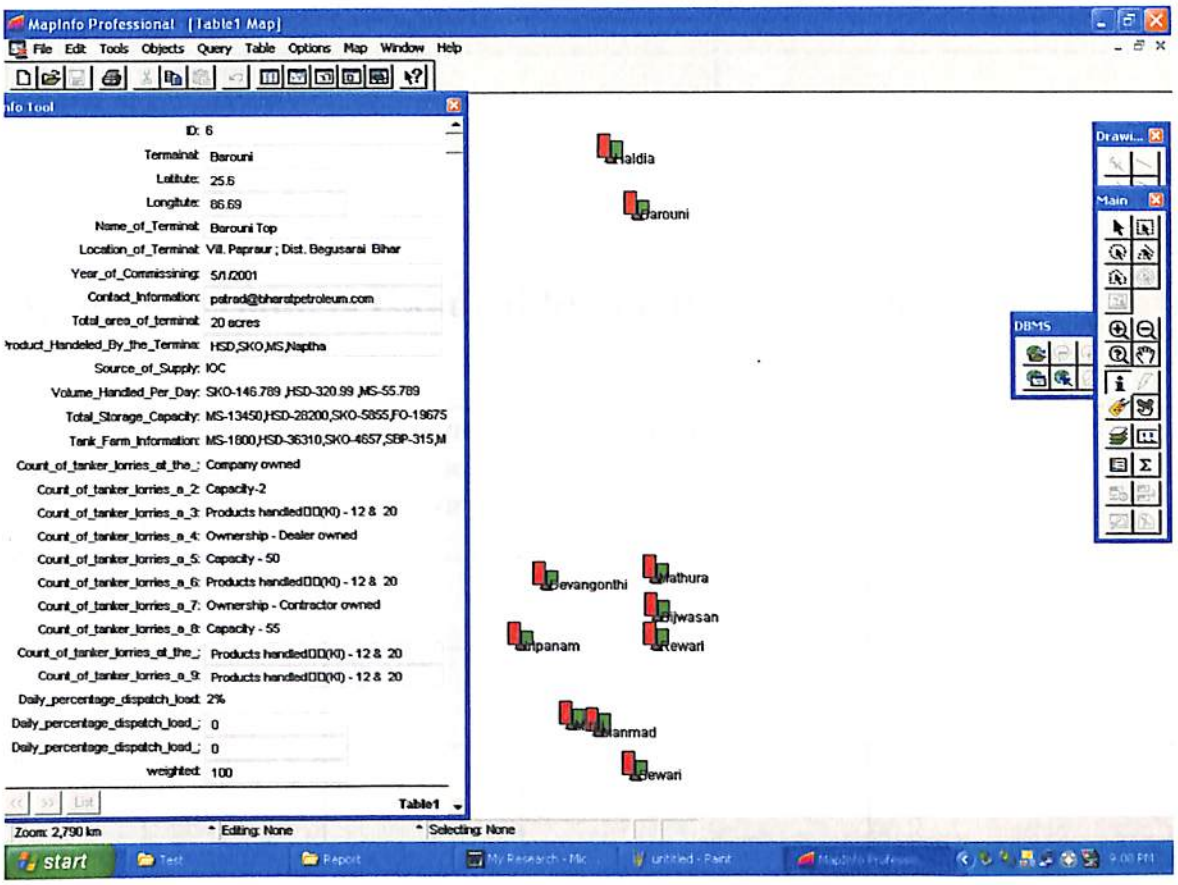


Figure 9: Process Efficiency Display

Questionnaire Design Format

DATA COLLECTION QUESTIONNAIRE	
Name:	
Position:	
Name of the Retail Outlet:	
Location of the RO:	

Details of Products Handled by the Retail Outlet				
Name of Product	**Source of Supply**	**Volume Handled per Day**	**No of Tanker**	

6.5.3 Locate Retail Outlet

The Objective of this workshop is to location different retail outlet that would help terminal manager to monitor inventory level on retail outlet and do future forecasting.

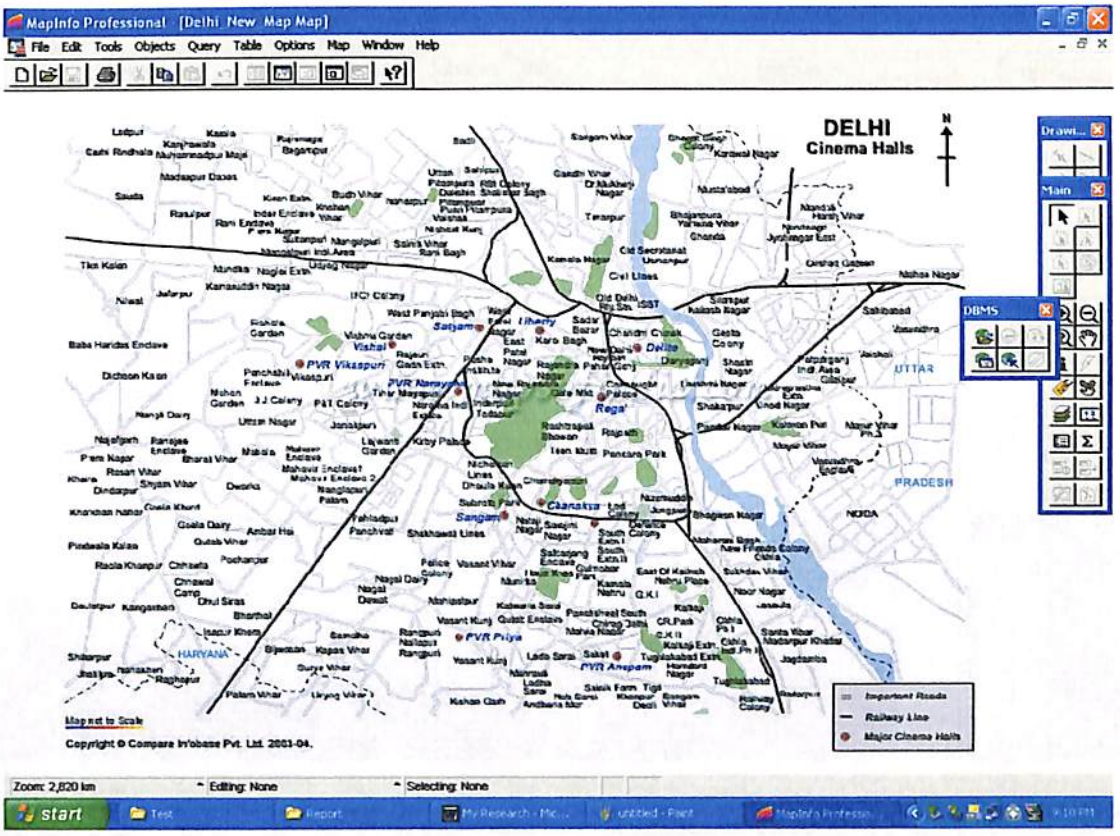
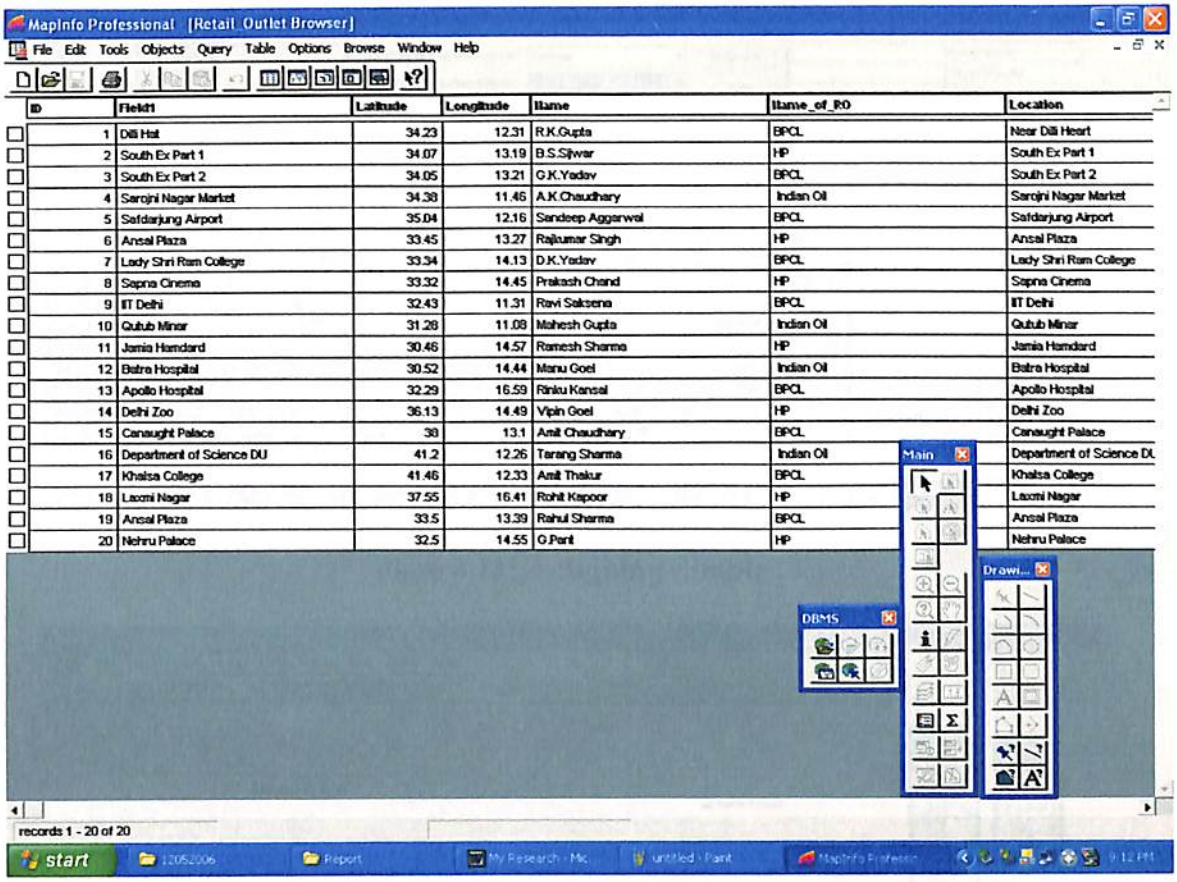


Figure 10: South Delhi MAP

- Import this Delhi Map in MAP Info by using select Raster format.
- Do digitization of this map by putting latitude and longitude at different location.
- Select three different locations for putting points.

Import Location Data

By putting data into database or through online process import database into MapInfo software as shown in figure 11.



ID	Field1	Latitude	Longitude	Name	Name_of_RO	Location
1	Dili Hat	34.23	12.31	R.K.Gupta	BPCL	Near Dili Heart
2	South Ex Part 1	34.07	13.19	B.S.Sijwar	HP	South Ex Part 1
3	South Ex Part 2	34.05	13.21	G.K.Yadav	BPCL	South Ex Part 2
4	Sarojni Nagar Market	34.38	11.46	A.K.Chaudhary	Indian Oil	Sarojni Nagar Market
5	Safdarjung Airport	35.04	12.16	Sandeep Aggarwal	BPCL	Safdarjung Airport
6	Ansal Plaza	33.45	13.27	Rajkumar Singh	HP	Ansal Plaza
7	Lady Shri Ram College	33.34	14.13	D.K.Yadav	BPCL	Lady Shri Ram College
8	Sapna Cinema	33.32	14.45	Prakash Chand	HP	Sapna Cinema
9	IIT Delhi	32.43	11.31	Ravi Saksena	BPCL	IIT Delhi
10	Qutub Minar	31.28	11.08	Mahesh Gupta	Indian Oil	Qutub Minar
11	Jamia Hamdard	30.46	14.57	Ramesh Sharma	HP	Jamia Hamdard
12	Batra Hospital	30.52	14.44	Manu Goel	Indian Oil	Batra Hospital
13	Apollo Hospital	32.29	16.59	Rinku Kansal	BPCL	Apollo Hospital
14	Delhi Zoo	36.13	14.49	Vipin Goel	HP	Delhi Zoo
15	Canaught Palace	38	13.1	Amit Chaudhary	BPCL	Canaught Palace
16	Department of Science DU	41.2	12.26	Tarang Sharma	Indian Oil	Department of Science DU
17	Khalsa College	41.46	12.33	Amit Thakur	BPCL	Khalsa College
18	Laxmi Nagar	37.55	16.41	Rohit Kapoor	HP	Laxmi Nagar
19	Ansal Plaza	33.5	13.39	Rahul Sharma	BPCL	Ansal Plaza
20	Nehru Palace	32.5	14.55	G.Pant	HP	Nehru Palace

Figure 11: Location Data in MS Access

Create Points

- Select Symbol that will represent data attribute.
- Configure Latitude and longitude.
- Location is shown in Figure13.
- This is one layer that shows only location

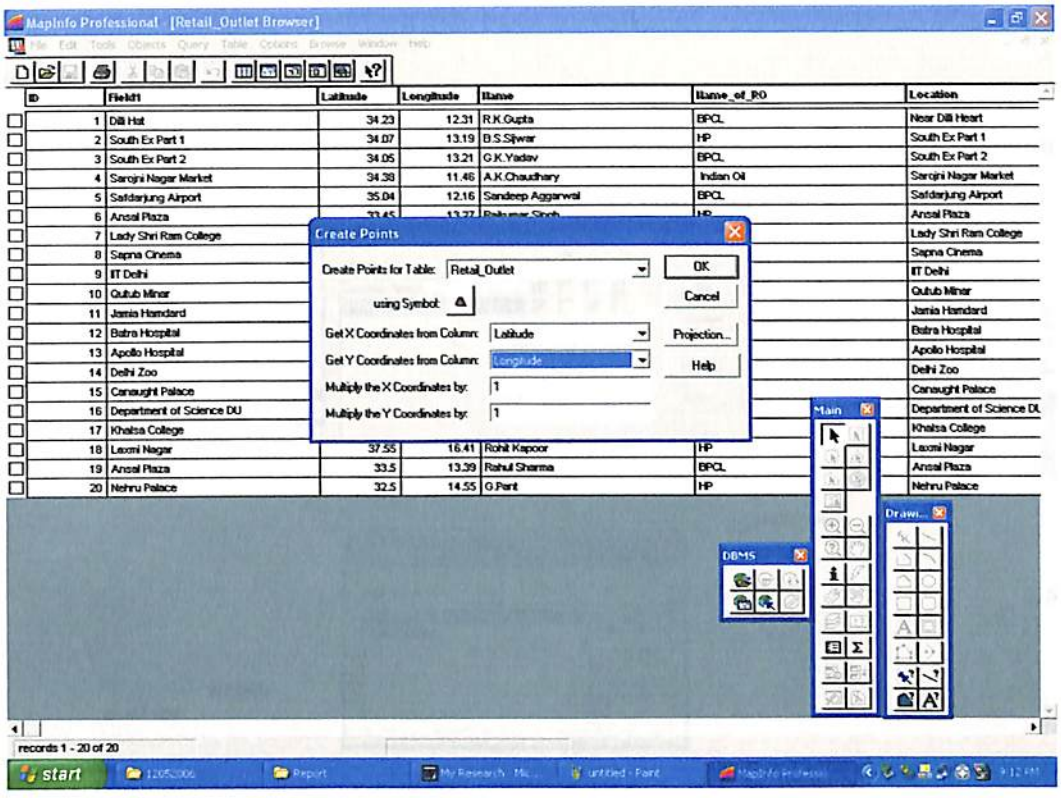


Figure 12: Assigning Simble

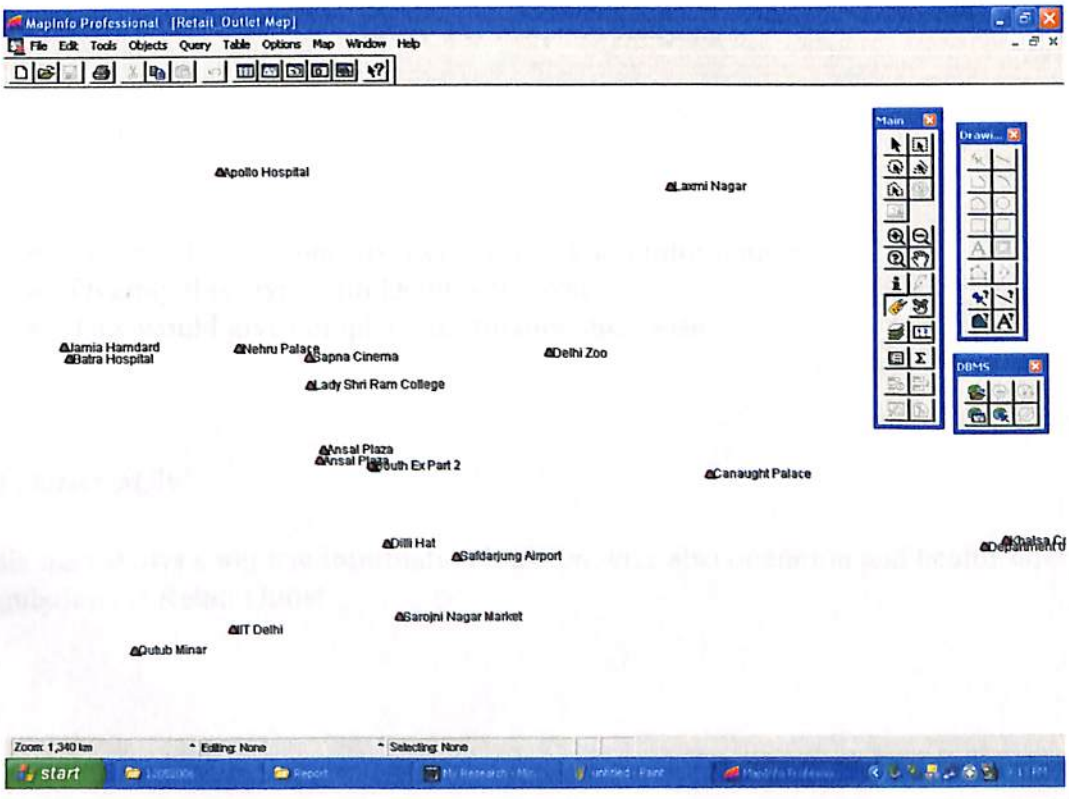


Figure 13: Different RO

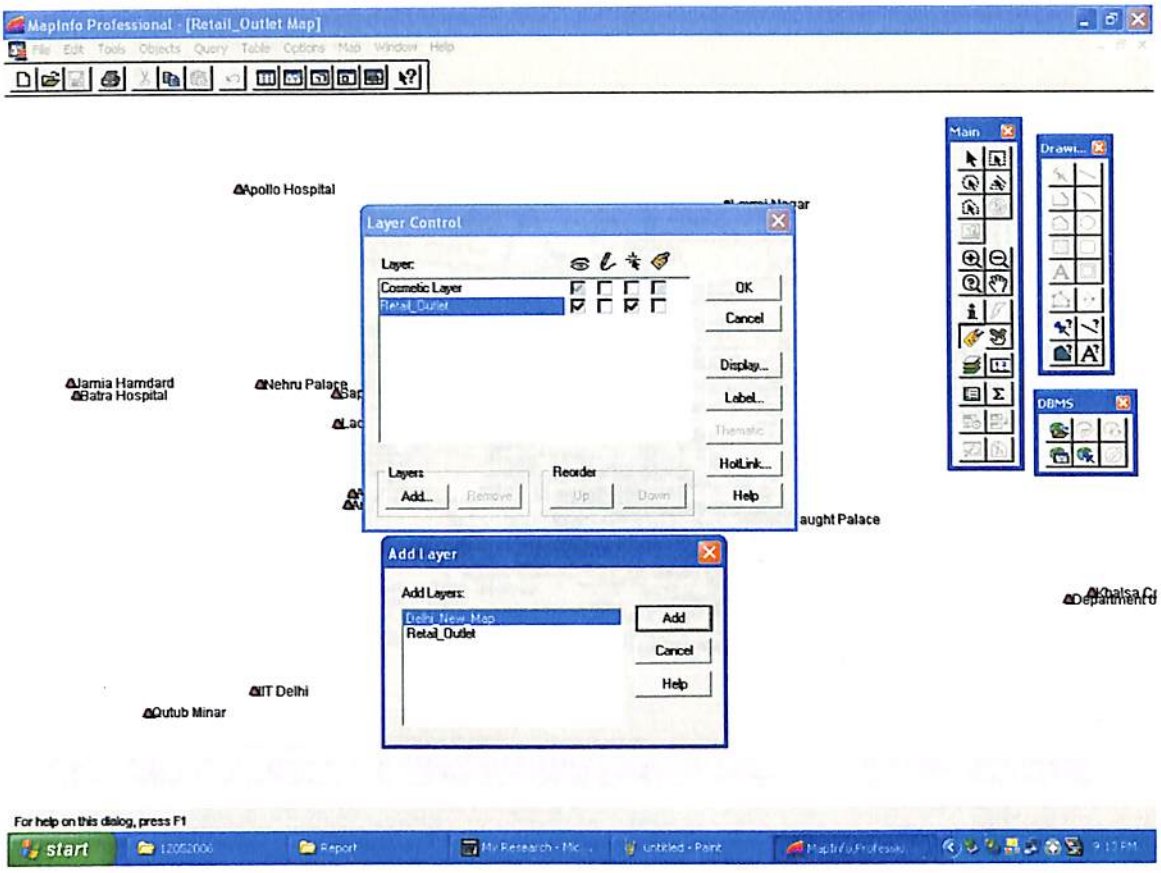


Figure 14: Map Overlaying

- Figure 14 shows one layer contain location information
- Overlay this layer with Delhi map layer
- This would give complete information area wise

Retail Outlet MAP

This map shows complete information location wise also operation and health safety regulations at Retail Outlet.

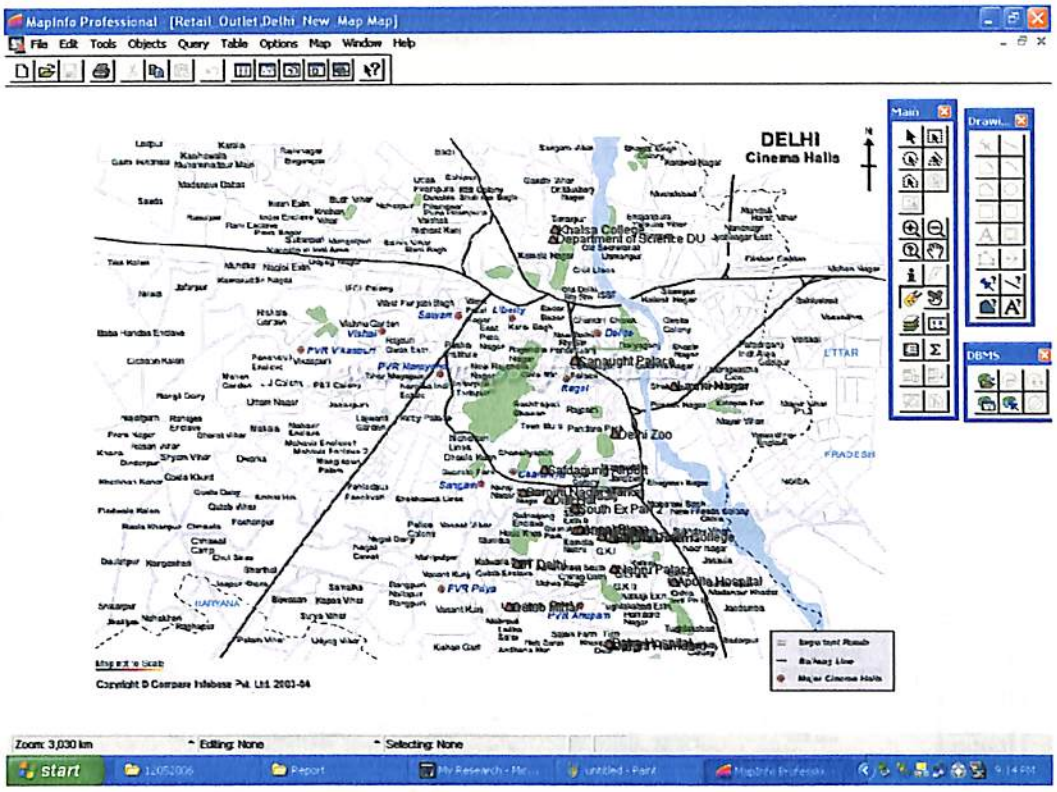


Figure 15: Location of RO on MAP

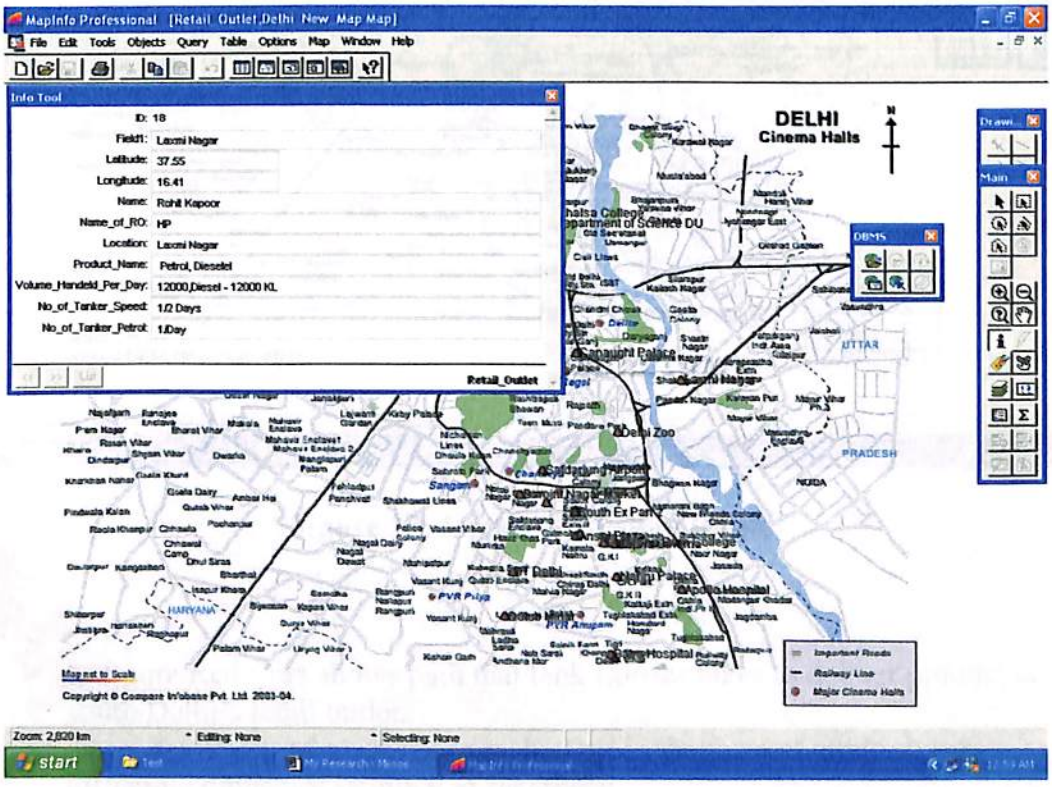


Figure 16: Retail Outlet Information

6.5.4 Route Planning and Optimization

Terminals from different companies that supplies petroleum product to south Delhi follows different routs based upon travel time. They select shortest distance when they travel in night and lass traffic route when travel in day time.

As shown in figure 17 there are different terminal of different company in Delhi at Sakarbasti. These terminals have different routes for their supply; using GIS we can look which is the route for deliver of product and at what time. Combining GIS with GPS also track exact location of product Lorries.

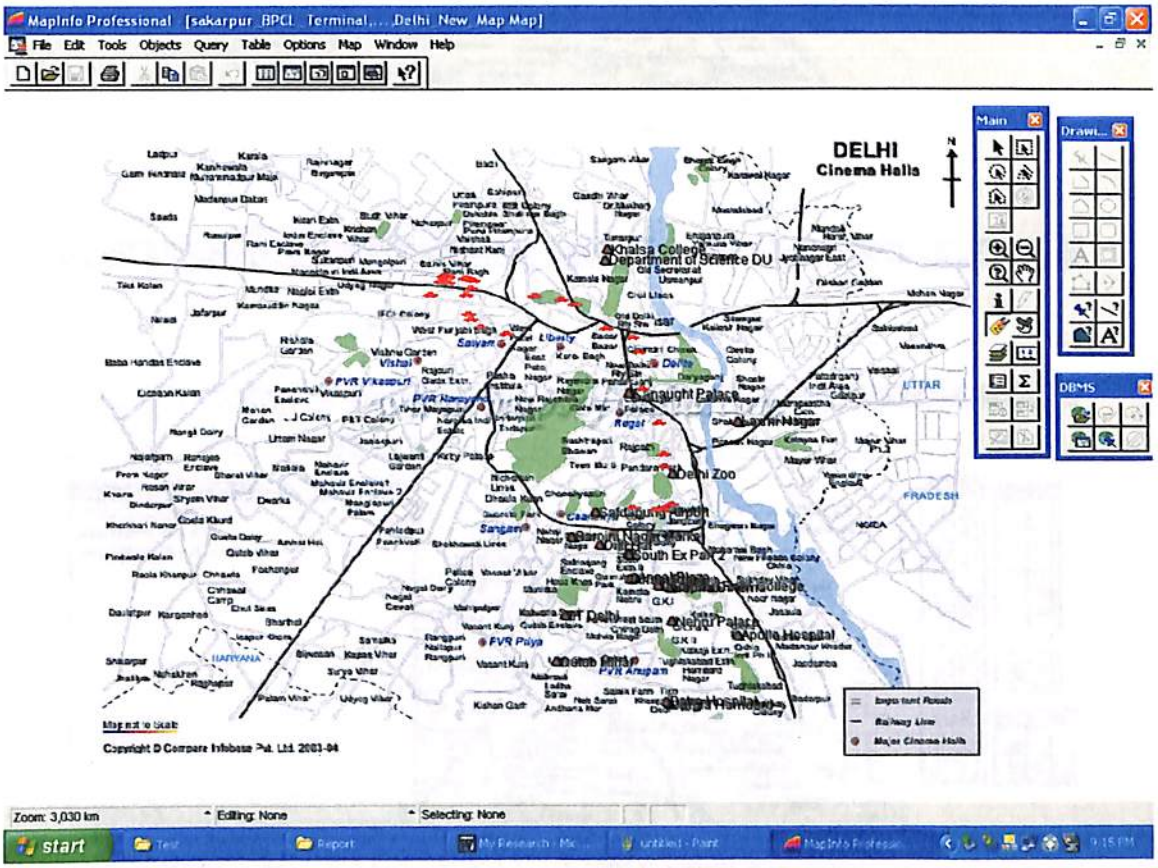


Figure 17: Locate Traveling Route

- In figure Red Cars shows path that tank Lorries takes to deliver product at south Delhi's retail outlet.
- There are some red marks near each other in the form of circle shows different companies terminal at sakarbasti.

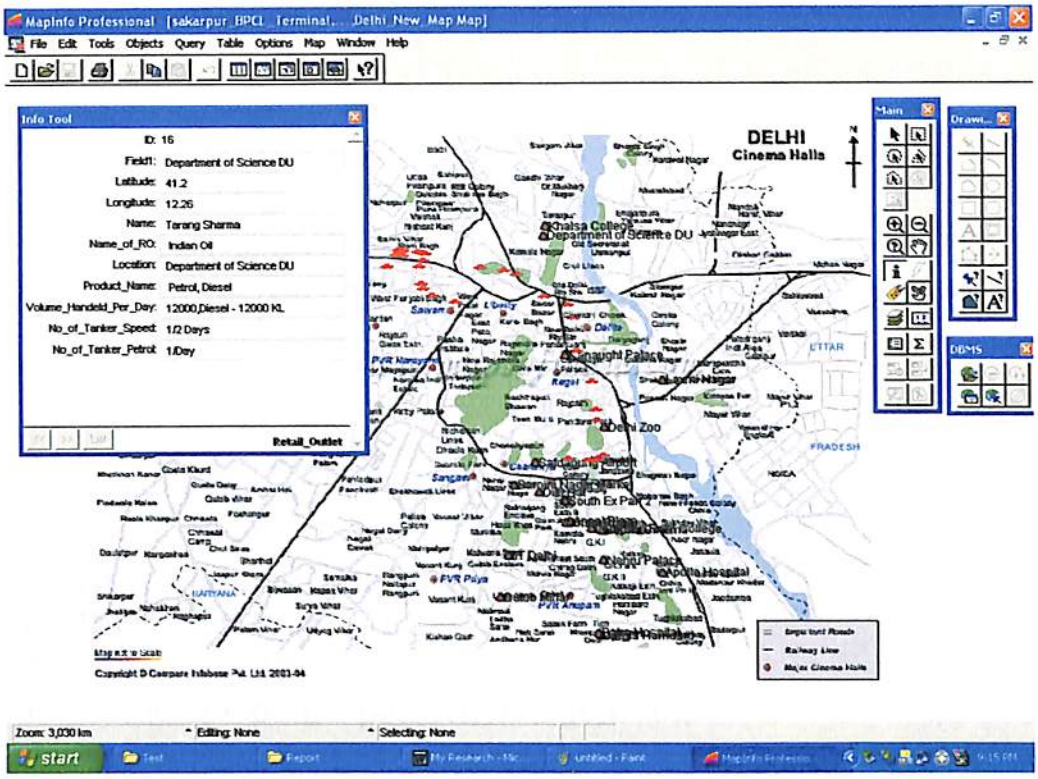


Figure 18: Retail Outlet Data

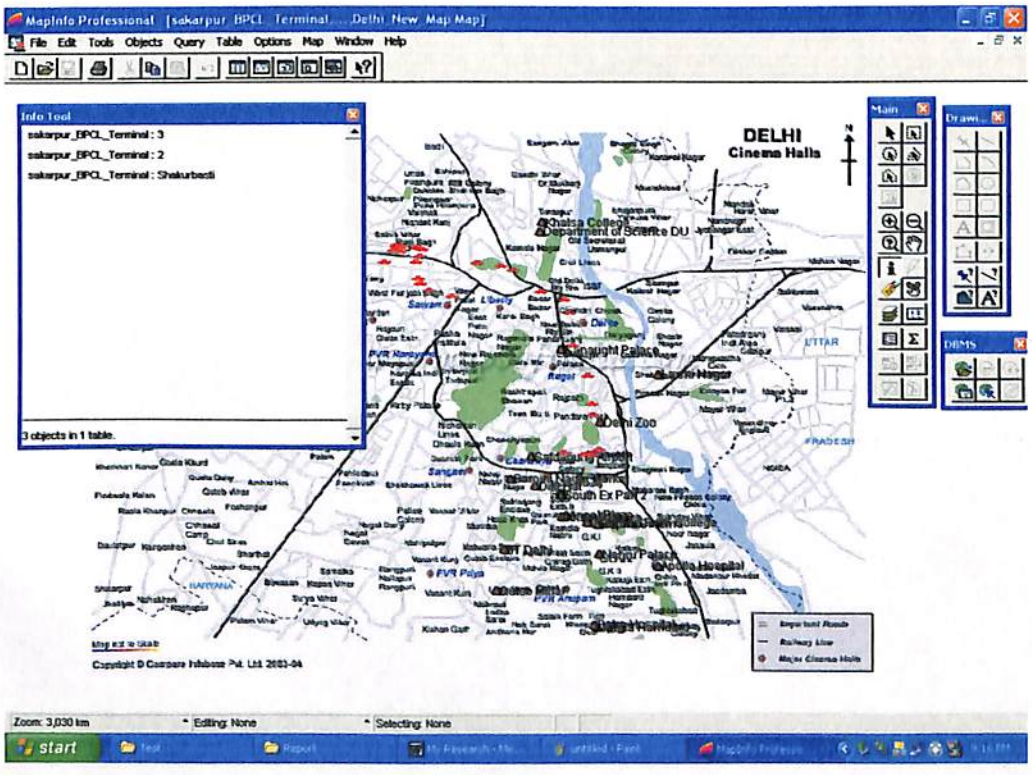


Figure 19: Companies Terminal at Sakarbasti

Benefits:

- Fast Information Transfer
- Process improvement
- Improve Decision Making Capability
- Regular Monitoring
- Better Customer Satisfaction

Application of Research:

- Petroleum Exploration
- Monitoring Different Wells
- Assets Tracking
- Development of Oil and Gas Reservoir
- Route Planning
- Market Analysis
- Locating Optimal position of a new outlet
- Route Optimization
- Pipeline Management
- Facilities Management
- Gas Marketing

CHAPTER 7# RECOMMENDATIONS

RECOMMENDATIONS

Regional Geographic Information systems are indispensable for the integrated research undertaken in this study. The effort required to build and maintain a GIS is cost effective for small users. Data, knowledge, and cost sharing will be required to build and maintain the most comprehensive GIS archives. A model of a central archive serving a distributed user community with appropriate datasets and analysis could be effective in getting the useful information to the widest possible user community. The costs and overhead of such a service and archive activity should not be underestimated, but it is much less expensive than duplicating data base activities and creating many small centers with limited data and analytical capacity. The concept and structure of a data library for BPCL is developed as part of this research activity.

CHAPTER 8 # Annexure

Annexure

8.1 Questionnaire
8.2 Abbreviation

Questionnaire Design Format

GENERAL INFORMATION	
Type of terminal	
Name the main equipment /fittings	
List the major operations carried out at the terminal	
List the facilities provided outside the boundary wall	
What specific measures have been adopted for increasing productivity in the terminal	

PRODUCTS HANDLED				
Details of products handled by the terminal				
Name of Product	**Source of Supply**	**Volume Handled per Day (Kl)**	**Customer Description**	**Number of Customers**

TANK FARM	
What are the major operations carried out at the tank farm	
How is the liquid volume in the tanks determined (Level gauges or manual dips)	
Are pressure tanks being maintained as per specified norms	

Tank Farm Information

S No	Product	# of Tanks	Fixed Roof	Floating Roof	Underground	Others	Total storage capacity (Kl)

What is the color coding scheme for vertical above ground tanks

SNo	Product	Color Code

Maintenance schedule of tank farm

Type of maintenance	Frequency
Visual inspection	
Internal inspection of roof	
Internal inspection of roof drain	
Internal inspection of pontoon	
Testing of tank shell	
What are the details listed on the body of each tank	
What is the frequency of calibration of tanks	

Retail Outlet Mapping

Questionnaire Design Format

DATA COLLECTION QUESTIONNAIRE	
Name:	
Position:	
Name of the Retail Outlet:	
Location of the RO:	

Details of Products Handled by the Retail Outlet				
Name of Product	**Source of Supply**	**Volume Handled per Day**	**No of Tanker**	

ABBREVIASTIONS

CNG	Compress Natural Gas
PNG	Pipe Natural Gas
LNG	Liquefied Natural Gas
MMSCMD	Million Standard Cubic Meter per Day
SCM	Standard Cubic Meter
BCM	Billion Cubic Meter
ATF	Aviation Turbine Fuel
API	American Petroleum Institute
RO	Retail Outlet
MMTPA	Million Metric Tone Per annum

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- http://www.coordinates.org/
- http://www.roadsofindia.com/
- http://www.mapinfo.com/
- http://www.gisqatar.com

US EPS Geospatial Data Clearinghouse. http://www.epa.gov/nsdi/.

California Geospatial Information Library. http://www.gis.ca.gov/.

Geographic Information North Carolina. http://www.cgia.state.nc.us

Massachusetts Geographic Information System. http://www.state.ma.us/mgis/

Texas Natural Resource Information System. http://www.tnris.state.tx.us/digital.htm.

Arkansas Geographic Information System.
http://www.gis.state.ar.us/defaultntscp.htm.

New York State GIS Clearinghouse. http://www.ctg.albany.edu/gisny.html.

Iowa GIS Clearinghouse. http://www.gis.state.ia.us/.

Oregon Geospatial Data Clearinghouse. http://www.sscgis.state.or.us/.

Georgia Spatial Data Infrastructure. http://www.gis.state.ga.us/.

State of Kansas Geographic Systems initiative's Data Access and Support Center.
http://gisdasc.kgs.ukans.edu/.

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